JUACEP Summer Program 2022 at Nagoya University

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Japan-US-Canada Advanced Collaborative Education Program

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<1> About the Program

1-1 Overview

Summer 10-week course 2022 for the students from North Carolina State University, Bandung Institute of Technology and Technical University of Munich

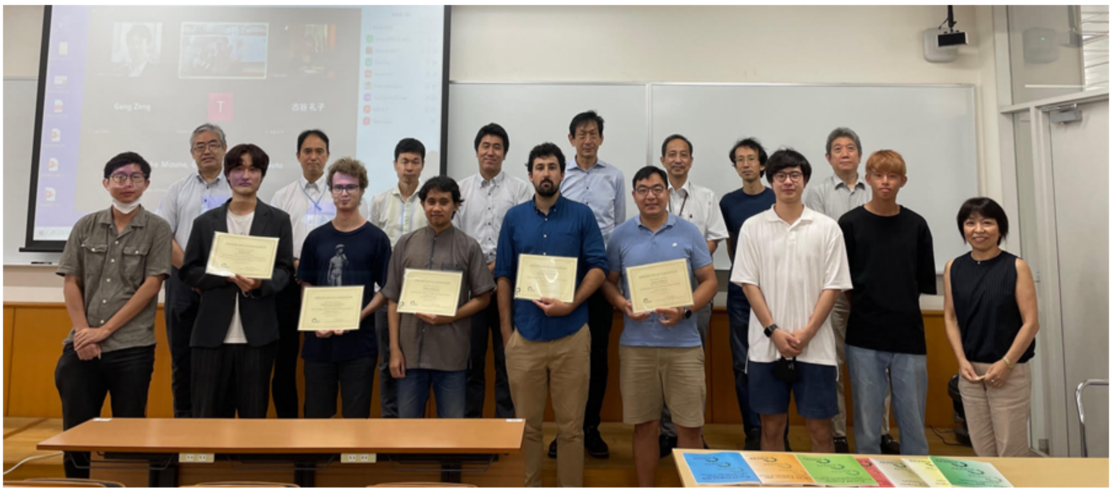
Duration: June 17 – August 30, 2022
Research presentations: The 27th JUACEP Workshop on August 26, 2022

This program is originally designed for graduate students from the partner universities in US and Canada, and in 2022 five students participated. Among them three are from North Carolina State University, one from Bandung Institute of Technology and one from Technical University of Munich.

Each participant chose a research laboratory at Nagoya University in accordance with his/her research interest and carried out a research project under the supervisor of the laboratory. Japanese language class for beginner, the hands-on engine-model assembly course and some special events were organized for the program.

During the program period, they took part in the labs' activities such as seminars, sessions, trips, casual parties, and so on. Teaching Assistants (TA) assigned by the program supported the participants not only in research scenes but also in daily life.

At the end of the program, they submitted the research report to each supervisor and gave the final presentation at the 27th JUACEP Workshop, which was delivered in a hybrid style at IB building and via Zoom on August 26. Based on the evaluation of the report and presentation by each supervisor, the participants were accredited 2-3 units by Nagoya University.



Participants with their advisors, TAs and program committee members at the 27th Workshop on August 26, 2022

1−2 Participants

	Name	Adviser & Teaching Assistant at NU
1	**George Peiyuan LI** NCSU	Prof. Akira Fujimaki TA: Tomoyuki Nakano Electrical Engineering, Electronics, and Information Engineering
2	**Jacob Patrick MC KIBBIN** NCSU	Prof. Ryoji Asahi TA: Takayuki Semba Institute of Innovation for Future Society
3	**David Laszlo KOMOROWICZ** Technical University of Munich	Prof. Toshiaki Fujii TA: Kei Suzuki Electrical Engineering, Electronics, and Information Engineering
4	**Diksan MUHAMMAD** Bandung Institute of Technology	Prof. Yasumasa Ito TA: Muyang Wang Global 30 Automotive Engineering
5	**Hiromu KOYAMA** NCSU	Assoc. Prof. Tomoaki Nakamura TA: Ren Motosugi Civil and Environmental Engineering

Japanese Course Instructor

Ms. Sumie Yasui

Coordinator of Partner Universitiy

Mr. Tomohisa Koyama
Executive Director, NU Tech

JUACEP Members

Prof. Yang Ju
Micro-Nano Mechanical Science and Engineering

Prof. Noritsugu Umehara
Micro-Nano Mechanical Science and Engineering

Prof. Toshiro Matsumoto
Mechanical Systems Engineering

Prof. Yasumasa Ito
Global 30 Automotive Engineering

Assoc. Prof. Takayuki Tokoroyama
Micro-Nano Mechanical Science and Engineering

Assoc. Prof. Dina Grib
International Academic Exchange Office

Tomoko Kato
Administrative staff

1-3 JUACEP Summer Program 2022 Schedule

Day	Date		8:45-10:15	10:30-12:00		13:00-14:30	14:45-16:00	16:15-
1	June 16	Thu	Arrival and dormitory check-in					
2	June 17	Fri	Orientation @ ES Meeting Room			13:30 Stipend@JUACEP Office		
3	June 18	Sat						
4	June 19	Sun						
5	June 20	Mon	9:30 Japanese Class① @ E3S-572					
6	June 21	Tue	Research @ each Lab					
7	June 22	Wed				Research @ each Lab		
8	June 23	Thu	9:30 Japanese Class② @ E3S-572					
9	June 24	Fri	Research @ each Lab					
10	June 25	Sat						
11	June 26	Sun						
12	June 27	Mon	9:30 Japanese Class③ @ E3S-572					
13	June 28	Tue	Research @ each Lab			Research @ each Lab		
14	June 29	Wed						
15	June 30	Thu	9:30 Japanese Class④ @ E3S-572					
16	July 1	Fri	Research @ each Lab				Meet-up by JUACEP	
17	July 2	Sat						
18	July 3	Sun						
19	July 4	Mon	9:30 Japanese Class⑤ @ E3S-572			Research @ each Lab		
20	July 5	Tue	Research @ each Lab					
21	July 6	Wed				13:30 Stipend@JUACEP Office		
22	July 7	Thu	9:30 Japanese Class⑥ @ E3S-572					
23	July 8	Fri	Research @ each Lab			Hands-on workshop @Creation Plaza by JUACEP		
24	July 9	Sat						
25	July 10	Sun						
26	July 11	Mon	9:30 Japanese Class⑦ @ E3S-572					
27	July 12	Tue	Research @ each Lab					
28	July 13	Wed				Research @ each Lab		
29	July 14	Thu	9:30 Japanese Class⑧ @ E3S-572					
30	July 15	Fri	Research @ each Lab					
31	July 16	Sat						
32	July 17	Sun						
33	July 18	Mon	(Marine day)					
34	July 19	Tue	Research @ each Lab					
35	July 20	Wed				Research @ each Lab		
36	July 21	Thu	9:30 Japanese Class⑨ @ E3S-572					
37	July 22	Fri						
38	July 23	Sat						
39	July 24	Sun						
40	July 25	Mon	9:30 Japanese Class⑩ @ E3S-572					
41	July 26	Tue						
42	July 27	Wed	Research @ each Lab			Research @ each Lab		
43	July 28	Thu						
44	July 29	Fri						
45	July 30	Sat						
46	July 31	Sun						
47	Aug 1	Mon						
48	Aug 2	Tue	Research @ each Lab			Research @ each Lab		
49	Aug 3	Wed						
50	Aug 4	Thu	Excursion by JUACEP					
51	Aug 5	Fri				13:30 Stipend@JUACEP Office		
52	Aug 6	Sat						
53	Aug 7	Sun						
54	Aug 8	Mon						
55	Aug 9	Tue	Research @ each Lab			Research @ each Lab		
56	Aug 10	Wed						
57	Aug 11	Thu	Mountain Day					
58	Aug 12	Fri	Research @ each Lab			Research @ each Lab		
59	Aug 13	Sat						
60	Aug 14	Sun						
61	Aug 15	Mon						
62	Aug 16	Tue						
63	Aug 17	Wed	(Bon Holidays)					
64	Aug 18	Thu						
65	Aug 19	Fri						
66	Aug 20	Sat						
67	Aug 21	Sun						
68	Aug 22	Mon						
69	Aug 23	Tue	Research @ each Lab			Research @ each Lab		
70	Aug 24	Wed						
71	Aug 25	Thu						
72	Aug 26	Fri	10:00 Workshop @ IB bldg.			Deadline of submitting reports		
73	Aug 27	Sat						
74	Aug 28	Sun						
75	Aug 29	Mon				Closing session @ each Lab		
76	Aug 30	Tue	Closing Ceremony					
77	Aug 31	Wed	Check out dormitory and departure					

JUACEP Event | Stipend Day | Japanese Class | Holiday

<2> Research Achievements

2-1 Research Internship

Research Reports

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2-2 Presentations

JUACEP Independent Research Report
Nagoya University, Japan

Performance Characterization of Half Flux Quantum and Single Flux Quantum-based Digital Logic

George Li

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ABSTRACT

Pulse-based logic has advanced to the point of working complex microprocessor circuits, operating at high frequencies, low energy consumption, and temperatures of 4K and below. As is true with all digital logic, timing closure is a crucial part of the circuit design process for proper functionality. With superconducting devices operating at cryogenic temperatures, miniscule temperature fluctuations can propagate to large variances in circuit switching performance. In this research, we set up a simulated experiment for the purposes of analysing the jitter of half-flux quantum and single-flux quantum-based Josephson transmission lines.

1. INTRODUCTION

Quantum computing scaling presents many technical challenges that must be overcome for the objective of producing usable, meaningful results. Many of these issues can be overcome with brute force through the fabrication of sheer higher numbers of interconnected qubits, at an acceptable error rate (T_1, T_2). Quantum bits, named qubits, must operate at near absolute zero temperatures around the milliKelvin range, to minimize the available energy states of the system to only ground state and first order excited levels. Any additional noise, in the form of heat and electromagnetic interference, can cause disturbances to the delicate energy states and configurations in the qubits, which will cause errors observed in the output.

Figure 1: Dilution Refrigerator Setup in Laboratory

Aside from inherent difficulties in fabrication of quantum processors, there lies a more fundamental physical challenge with current quantum hardware designs – classical computation largely occurs outside of the dilution refrigerator, which necessitates additional wires for every quantum bit in the system. At least one wire for control and one wire for readout. This leads to a simple physical constraint as well as the “heat wall” problem. More wires carrying signals will generate more heat and inadvertent transmission of EM interference. Even further, there is a fundamental issue of more wires taking up more space in the refrigerators, which leads to the need for larger refrigerators with the current scaling paradigms.

There are potential alternatives to this hardware framework, though, which largely fall under the same objective of reducing energy consumed by the microprocessor. Scaling down CMOS circuits as cryo-CMOS efforts have been one avenue of research by ongoing quantum computing hardware, by identifying more resilient fabrication structures for low energy operations.

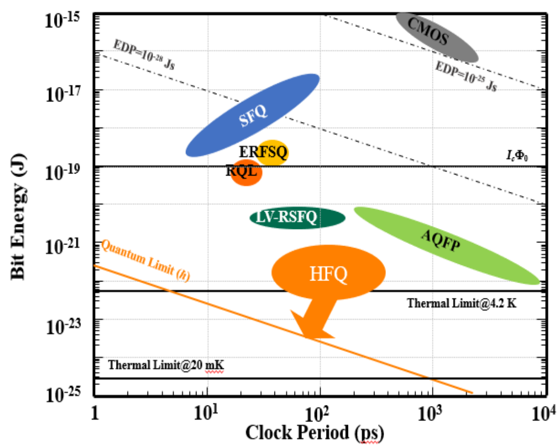


Figure 2: Energy Delay Product of Devices [1]

The circuits explored in this research, superconducting pulse-based digital logic with single-flux quantum and half-flux quantum, operate at 4 Kelvin and below, as well as having very fast clock periods of 50-80GHz, which is required to be compatible with the operating and readout frequencies of the hardware qubits. With the introduction of HFQ SQUID-based devices, significantly lower bit switching energy can be explored, and potentially operate alongside the quantum bits as digital logic if optimized enough. These trapped-flux quantum-based devices serve as a potential solution for many scaling problems encountered with current quantum computer solutions.

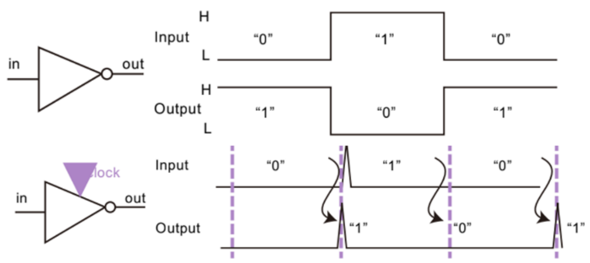


Figure 3: CMOS vs SFQ behavior [2]

2. FLUX QUANTUM LOGIC

3.1 Single Flux Quantum

Superconductor circuits utilize a different device paradigm to operate as digital logic compared to CMOS devices. CMOS semiconductors are composed of PMOS and NMOS junctions, with p-n and n-p transitions of charging and discharging electron channels. These are made of layers of substrate, silicon, doped silicon, and metals. Superconducting rings are fabricated with a ring of superconducting niobium material, interrupted by an insulating layer in between, which creates an energy gap structure called a Josephson junction. These Josephson junctions have an inherent critical current, which is dictated by the area of the junction and the current density of the material used. The smaller the area of the junction, the smaller the effective critical current and, accordingly, the less energy the device will consume to operate.

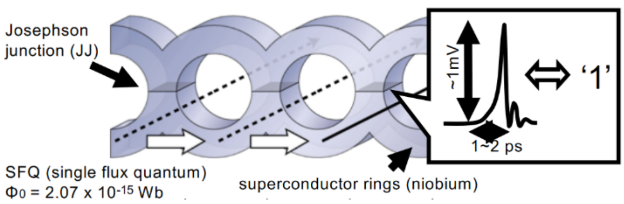


Figure 4: Single Flux Quantum Structure [2]

The superconducting ring, when in the superconducting state, will have a constant quantified current, and in effect this change in current generates a "single quantized flux" through the middle of the superconducting loop. With the current flowing in one inductor-junction structure, the next connected loop will then "switch" on into a superconducting state. This switch will then effectively push the trapped flux into the adjacent junction, continuing the effect repeatedly. This single trapped flux can be measured and observed by "pushing" this single pulse to an output, where it will be measured as a pulse signal output.

These structures start from the most basic Josephson Transmission Line, or JTL, which effectively a wire, to an entire design library of equivalent logic circuits, like AND/OR, adders, multiplexers, shift registers, and flip-flops. SFQ pulse-based microprocessors can be manufactured and designed.

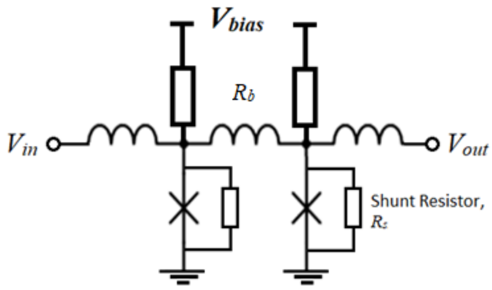


Figure 5: SFQ JTL Schematic

2.2 Half Flux Quantum

With single flux quantum, the chains of linked individual loop rings are single junction loops of trapped flux. Recent developments have led to a new type of manufactured structure with a phase-shifted flux response to signals. By adding a ferromagnetic layer in between the superconductor and insulator layers, a different junction, with a pi-shifted phase difference from the 0-junction. [3] This pi shift creates a different physics paradigm for how the device functions, and structures such as 0-pi and 0-0-pi device loops have also been made. Upon initialization of the loop, the presence of both the pi and zero junction causes the current direction to go either clockwise or counter clockwise. Upon pushing another input pulse through, the current will switch directions, inducing an output signal from the flux switching behaviour. These then operate as chains, like the how the SFQ circuits are built and function.

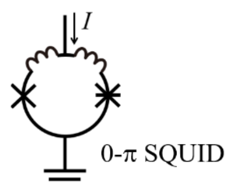


Figure 6: Half Flux Quantum SQUID Schematic

One notable difference with this half-flux quantum circuit is that the change from full rotations to half rotations of each individual junction allows for significantly lower bit energy. Using the same junction area, and thus process node, devices with significantly lower nominal current can be made, which allows for lower operating temperatures. [4] Currently, the circuit design flow for these devices is a work in progress, with basic flip-flops and logic gate layouts being optimized for different fabrication processes.

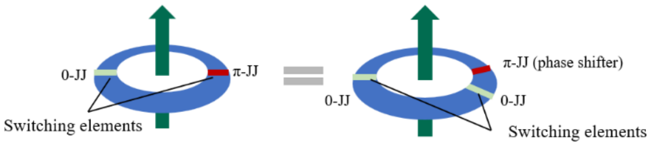


Figure 7: HFQ SQUID Loop [1]

2.3 Josephson Transmission Line

The most basic logic structure used with these SFQ and HFQ circuits are Josephson transmission lines, or JTLs. Because the signal propagation is through a single pulse, simple metal wires to carry current won't work for these signals. Thus, JTLs carry the signals across any distance long enough to make. They are behaviorally clock gated wires, but the pulse "clock" is an inherent transition time from the operating conditions and circuit parameters of the transmission line chain. To design functional circuits would require a thorough understanding of the timing behavior of these structures, as all clock signals in SFQ and HFQ circuits use JTLs to operate. Being able to accurately guess these transition times is an important part of this study.

3. SIMULATION

3.1 Timing and Jitter

The most basic logic structure used with these SFQ and HFQ circuits are Josephson transmission lines, or JTLs. Because the signal propagation is through a single pulse, simple metal wires to carry current won't work for these signals. Thus, JTLs carry the signals across any distance which can be fabricated. They are essentially clock gated wires, but the "clock" is an inherent transition time built into the operating conditions and circuit parameters of the transmission line chain. To design functional circuits would require a very in depth understanding of the timing behavior of these structures, as all clock signals in SFQ and HFQ circuits use JTLs to function. Being able to accurately guess these transition times is an important part of this study.

Within any signal transition, there is always an amount of variance involved with the time involved. Noise generated from sources such as EM interference and heat causes statistical variations in the measured timing values of the superconducting devices. [5] When building logic devices which are clock gated, it is imperative for timing values to align in a way that the proper signals reach the correct gates at the synchronized times. These are referred to as setup and hold times, which indicates the proper timing windows for which signals to be properly received and processed in the allocated time frame. Not following these guidelines will result in lost signals and false values. The interference from noise adds another constraint on top of this timing to improve performance margins and mitigate the risk of errant noise triggering an early or later transition, missing timing closure of some part of the circuit. This data can be obtained by collecting a large sample of circuit switching transition times and conducting a statistical analysis on the output values.

3.2 Simulation Tool

The tool used to run these circuit simulations is named JoSIM. It is a Josephson Junction device simulation tool. A netlist is generated, where the input signal, circuit schematic, device parameters, and operating conditions are input. The tool then takes in and outputs a signal waveform data for the duration simulated. These output waveforms can be plotted using a visualization tool, and the saved data outputs can be tabulated and analyzed using statistical analysis tools and data management workflows with the tools of choice. Used for these experiments are python modules for graph visualizations and Matplotlib and Pandas for data management and handling.

3.3 Circuit Parameters

The simplest structure used with these SFQ and HFQ circuits are Josephson Transmission Lines. With a chain of these devices triggered in a line together, the most basic transition times and delay times can be plotted together as a larger circuit to be simulated. Thus, the schematic made for such a device is very simple to evaluate, with only a few SQUIDs or Josephson junctions used. For our studies, an examination of the relationship between timing variation and device type and parameters is the topic of interest. As such, we work to create a circuit schematic for both the HFQ and SFQ circuits which allows for both device types to operate under as similar conditions as possible. Loop inductances, effective critical currents, bias currents, shunt resistors should be set to values that mirror between the Josephson junction and HFQ SQUID devices.

Table 1: HFQ Device Parameters

Parameter	Value
$I_{c,nominal}$	~13 μA
Loop Inductance	40 pH
L_1, L_2	1.75 pH
Bias Voltage	1 mV
Bias Resistor	95 Ω
junction I_c	50 μA

Table 2: SFQ Device Parameters

Parameter	Value
I_c	13 µA
0-junction area	0.13 µm^2
Loop Inductance	80 pH
Bias Voltage	1 mV
Bias Resistor	108 Ω
Shunt Resistor	59 Ω
Temperature	4.2 K

From previous experiments with JTL chains, some interference behavior can be observed from the input waveform triggering the pulse chain when observing voltage and current outputs from devices too early in the chain. To produce a more consistent timing variation in the output waveform, a buffer of devices in the beginning and end of the transmission lines is used, so the timing values for the devices only in the middle of the chains are used, recorded, and analyzed. This allows for a cleaner, spike free waveform output from our circuit schematic. What was finally used for simulation and experiments was a total chain length of 84 for both the HFQ and SFQ circuits, so the length 64 chains in the middles allow for an eight times standard deviation value recorded.

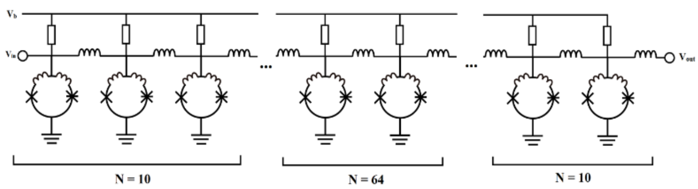


Figure 8: HFQ JTL Schematic

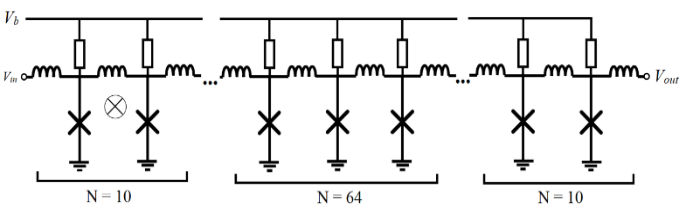


Figure 9: SFQ JTL Schematic

4. RESULTS

4.1 Simulation Output

The results of the simulations are an output waveform, with user defined resolution for voltage steps and timesteps. We observe the devices in the chain which correspond to 25th, 36th,49th, and 64th transitions in the Josephson transmission line chain. Each of the lines represents a different recorded and plotted device, and the input signal triggers 3 phase transitions. In the SFQ JTL, this system is a direct phase transition, but in the HFQ the transition is broken in to a pair of transitions between the 0 and pi junctions.

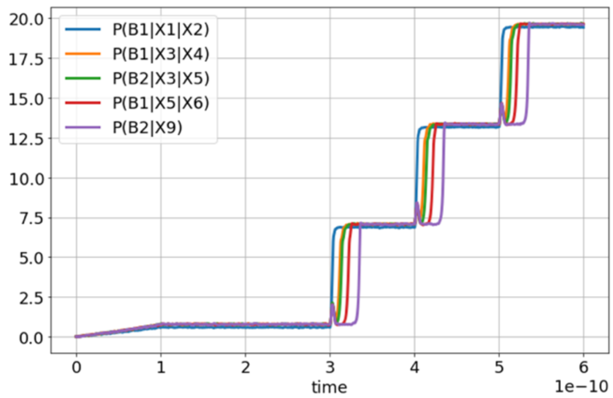


Figure 10: SFQ JTL Output Waveform

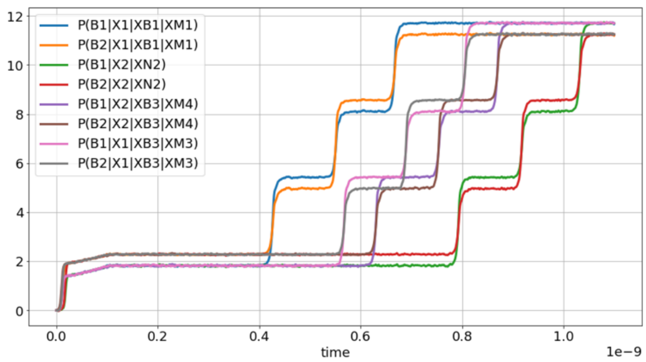


Figure 11: HFQ JTL Output Waveform

4.1 Data Analysis

The timing data for each of the recorded devices is then output into a file to be processed. A python script is used to extract the switch timings of each transition on each device, and these switch timing values are then processed and analyzed for timing variation, after the timing value between the transition times is standardized for and extracted. These values generate a sigma (standard deviation) value as well as a mean (average) for the transition timing values, as the input signal for the timings are at a simulated ideal interval. This means the extracted values are the simulated jitter inherent in the devices themselves, at the user defined parameters.

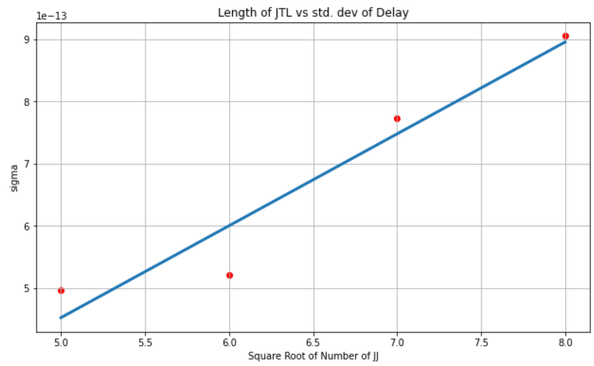
Table 3: SFQ Mean and Sigma Transition Time

SFQ	Mean delay time (μ)	Std. dev	Normalized std. dev. (σ)
N=64 JJ	29.54 ps	905.08 fs	113.14 fs
N=49 JJ	17.25 ps	773.25 fs	110.47 fs
N=36 JJ	9.524 ps	520.76 fs	86.792 fs
N=25 JJ	6.951 ps	497.03 fs	99.406 fs

Table 4: HFQ Mean and Sigma Transition Time

HFQ	Mean delay time (μ)	Standard Deviation	Normalized std dev. (σ)
N=64 JJ	367.98 ps	1.481 ps	185.16 fs
N=49 JJ	280.41 ps	1.329 ps	189.82 fs
N=36 JJ	204.46 ps	1.137 ps	189.46 fs
N=25 JJ	140.16 ps	0.915 ps	183.04 fs

With these extracted values, then a plotted relationship can be observed between the extracted standard deviation of timing, or our simulation "jitter", and the length of the Josephson transmission line used. This relationship should be observed to be linear with the square root of the length of the JTL.



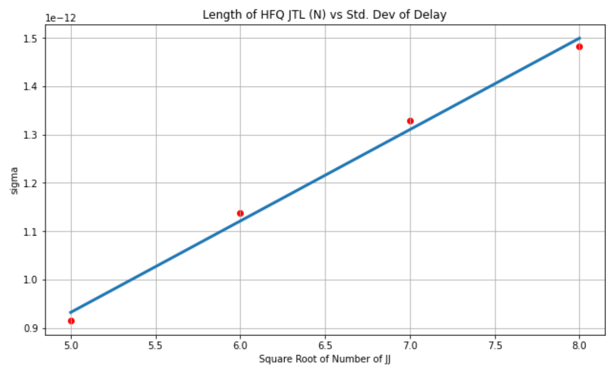


Figure 12: sqrt(N) vs σ Linear Relationship

5. CONCLUSION

With these results, a rudimentary understanding of the device physics, design methodology, design tool flow, and simulation flow involved with building Josephson junction-based logic has been achieved. For novel research value, we have explored a previously unexplored relationship between timing jitter of single flux quantum as compared to half-flux quantum-based SQUID device circuits. The designed experimental framework used to run simulations and extract timing data was used to, as a cursory introductory exploration, demonstrate and report a relationship between JTL circuit depth and jitter. This same framework has potential to be used and expanded to help deepen the understanding of the nature of the simulation tools as well as the designed circuits.

More relational understanding and effects need to be explored, such as a more in depth understanding of how to model temperature-based noise across different tools, as well as a better compromise of optimal operating circuit parameters to cross compare between HFQ and SFQ circuits need to be done to help expand some of the uncovered questions from this work. Ideally, experimental work with a test chip and lab recorded data could be used to bolster the findings from simulations.

ACKNOWLEDGEMENTS

- Gratuitous thanks to the JUACEP program for the opportunity and support to make this exchange possible.
- Thank you to the faculty, students, and staff of the Fujimaki Lab for welcoming, supporting, and teaching me in this experience, with special regards to Professor Akira Fujimaki and Assistant Professor Masamitsu Tanaka.

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[1] Li, Feng et. al, *International Symposium on Superconductivity* (ISS2021)

[2] Tanaka, M. *SIMIT-NU Joint Workshop (2018)*

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[4] Tanaka, M. et al., ACASC/Asian-ICMC/CSSJ Joint Conference (2020)

[5] Terabe et al, *IEEE Trans. Appl. Supercond,*. vol. 17, no. 2, pp. 552–554, (2007)

Molecular dynamics simulations of hydrogenated amorphous silicon using machine learning potential

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ABSTRACT

A substantial hydrogenated amorphous silicon - crystalline silicon interface has been simulated via an on-the-fly machine learning force field integrated into electronic structure code. Our results show excellent agreement with first principles simulations, with over 1000 times efficiency for large systems. In addition we examine details of the interface not directly accessible via experiment, at simulation times not typically accessible via first-principles simulation. In particular we examine hydrogen movement within the amorphous medium, and coordination defects as a function of temperature, and hydrogen density.

INTRODUCTION

Photovoltaic cells have been estimated to have one twentieth the carbon footprint of natural gas per MWh of energy produced.[1] Renewable energy sources make up 29% percent of global power generation, with a record 168 GW of solar capacity added in 2021 alone, bringing the global capacity up to 850 GW, which is expected to surpass 1 TW in 2022. Thus, even an incremental increase in efficiency will have a rippling effect on global energy output.[2]

90% of all solar panels in use today are so-called first generation solar panels, a layered device of crystalline silicon (c-Si) stuck between an anode and a cathode. In short, a photon passes through the optically transparent glass and anode, and strikes the n-type silicon, so called because it is relatively negative compared to the relatively positive p-type silicon. This charge differential drives the electrons to the cathode, and then through the circuit to complete its work, finally re-entering in the anode. Of course, in practice this type of panel has an efficiency bottleneck of around 20 to 25%, primarily due to so-called recombination centers. At any interface, a recombination center is a site in which excited electrons may discharge their energy, thus bypassing the need to go through the circuit and do useful work.

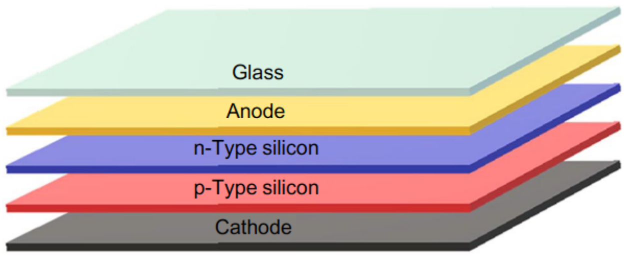

Figure 1: A first generation solar panel. Source Pavel M. Sokolov *et al.*[3] Photons excite electrons in the n(egative) type silicon, which drives them to the p(ositive) type silicon, which can then be used as electrical power.

It has been shown that a thin layer of amorphous, hydrogenated silicon (a-Si:H) will reduce this recombination effect, by passivating dangling bonds on the interface. This is a second generation solar panel. Hydrogen is present to both prevent recrystallization, and passivate dangling bonds by filling nano-voids within the amorphous region. This procedure has been shown to improve efficiency by several percentage points, up to 26% overall.[4] Further, experimental observations have shown particular hydrogenation percentages, annealing temperatures, and degrees of recrystallization all have optimal values to maximize open circuit voltage.[5]

Direct observation of this interface experimentally is extremely challenging. Thus a simulation of this c:Si - a-Si:H interface could provide novel mechanistic insights into hydrogen movement, and recrystallization within the cell, and inform future solar panel design. This simulation is by no means straightforward, as a high degree of precision, a large number of atoms, and a long simulation time are preferable for accurate results, and this can make computation time prohibitively long.

METHODS

Bulk crystalline silicon was prepared by relaxing a 0 K silicon supercell, in an FCC arrangement to the chosen temperature, with a lattice constant of 5.4309 Å, and a corresponding density of 2.329 g / cm^3. A 2x2x2 supercell, with dimensions 10.8618 x 10.8618 x 10.8618 Å and 64 silicon atoms was preparedIn this work, the machine-leaned forcefield (MLFF) was trained initially on 64 crystalline silicon for a total of 160ps: 100 ps at 700 K, 30 ps at 500K, 30 ps at 300K. Training time was reduced at 500K and 300K.

The radial distribution function was chosen as a point of comparison, as it would make any aberrations in average radial distance very apparent.

Amorphous silicon was prepared first by melting a perfect crystal at 2370 K, well above silicon's melting temperature, and rapidly quenching to 300 K over 1500 fs. First a 2x2x2 sample of 64 atoms was prepared, and later a 2x2x4 sample of 128 atoms. Lack of long-range order was confirmed via its radial distribution function.

To produce hydrogenated amorphous silicon, atoms were drawn from a uniform distribution, and hydrogen was placed at a random-angled unit vector adjacent to the silicon. Hydrogen which happened to be too close to a silicon nucleus were manually adjusted. As hydrogen atoms are much more mobile than the silicon within the amorphous matrix, it was found that they quickly relaxed to fill areas of low density, and so the random scheme produced a physically reasonable system with little adjustments required after a short relaxation period of 500 fs.

To prepare an interface, the two systems were simply placed next to each other. Any silicon nuclei which were unrealistically close to one another were manually adjusted, to avoid an ion shooting away due to a huge amount of potential. The simulation was advanced piecemeal, and problem silicon at the interface could be 'nudged' towards an equilibrium bond distance of around 2.5 Å.The system was then relaxed for 2 ps. A 2x2x4 sample of 64 crystalline silicon, and 64 amorphous silicon was used for training. The MLFF was trained for a total of 440 ps: 200 ps at 700K, 120 ps at 500K, 120 ps at 300K. The timestep was doubled to 2 fs for the interface model, and the mass of hydrogen was quadrupled.

A 2x2x6 sample with 64 crystalline, and 128 amorphous silicons was used for production runs. The production runs we performed at 700K, varying hydrogen content from 0, 16, and 32 hydrogen respectively. Thus the simulation with 16 atoms represents the same conditions as the training period. Hydrogen's mass was set back to one.

For both the training, and production runs we focused our analysis on the average coordination of each silicon, and hydrogen density as a function of the z-coordinate (perpendicular to the a-Si:H and c-Si interface). We also calculated a relative distribution of coordination numbers of each phase. Due to periodic boundary conditions, these models will have two interfaces. See figures 2,3,4 for models.

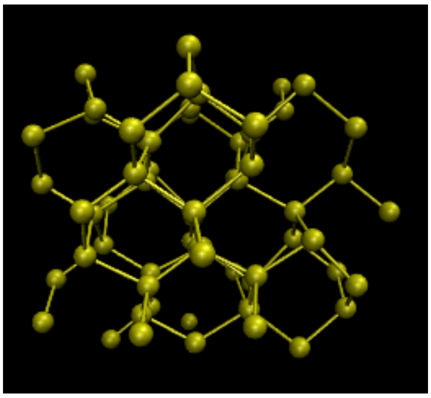

Figure 2: Bulk silicon model of 64 silicon atoms, relaxed at 700K

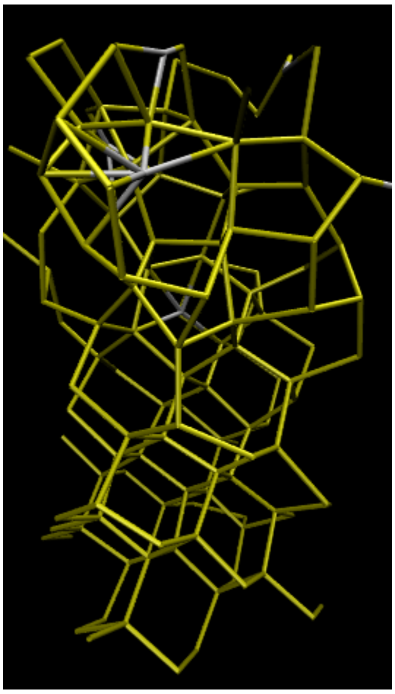

Figure 3: Interface training model with 64 crystalline silicon, 64 amorphous silicon, and 8 hydrogen.

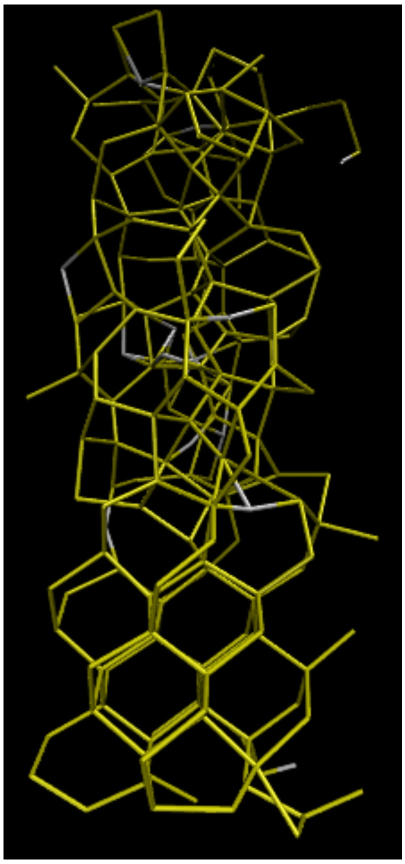

Figure 4: Production run model, 64 crystalline silicon, 128 amorphous silicon, and 16 hydrogen.

Coordination was calculated simply by finding all silicon-silicon neighbors within a cutoff radius of 3 Å, corresponding to the first shell. For the functions of the z-coordinate, we simply divided the simulation area into 1000 equal 'slices,' and averaged over each X and Y coordinate within each region. Coordinates were averaged every 2 ps.

All simulations were performed via VASP 6.3, and all analyses were performed via an *ad hoc* suite of python codes.

RESULTS

The machine learned force-field showed excellent agreement with the first principles calculations. Very small MSE and MAE were observed, and overall the MLFF performed practically identically to *ab initio* methods, figure 5.

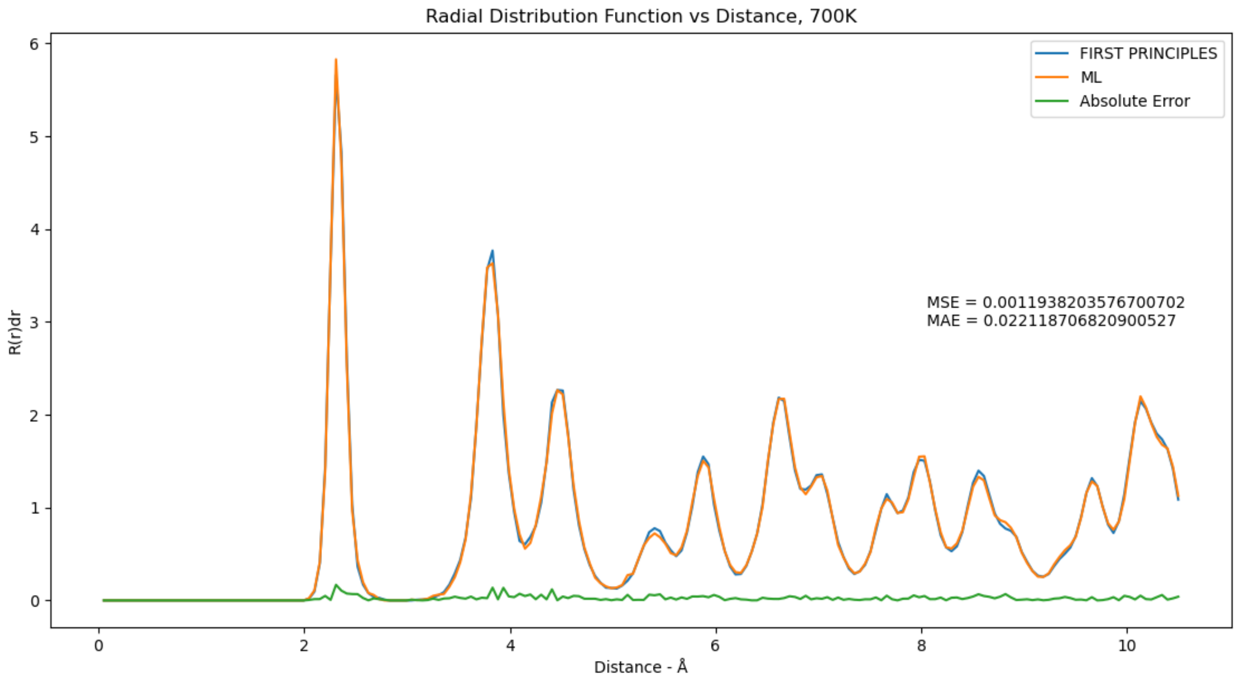

Figure 5: Radial distribution function of the Bulk training model at 700K. MSE and MAE are mean squared error and mean average error respectively.

Both the bayesian error estimate, and root mean square error converged to small, constant values for both the force and the energy. The RMSE of force and energy both converged to 0.06 eV/Å and 0.0008 eV/atom respectively for the final 20 ps of simulation.

Overall, the 160 ps of training took 10,931.72 seconds of CPU time, or 81.58 seconds / ps of simulation. This compared to 1740.03 seconds for three ps of *ab initio* results, or 580.01 seconds / ps of simulation. An ML timestep took an average of 0.25 seconds, whereas a FP timestep took 58.001 seconds, or a speedup on the order of 250 times.

The interface training model proved to be more of a challenge, as with 136 atoms, it became challenging to produce a first principles trajectory for direct comparison. Relative distributions of coordination show a stable 4-fold coordination in the crystalline phase, and a wider distribution in the amorphous phase. Values ranged from 2-fold to 7-fold in a right-skewed distribution with a mean of 4. This skew is more pronounced at higher temperatures, figure 6.

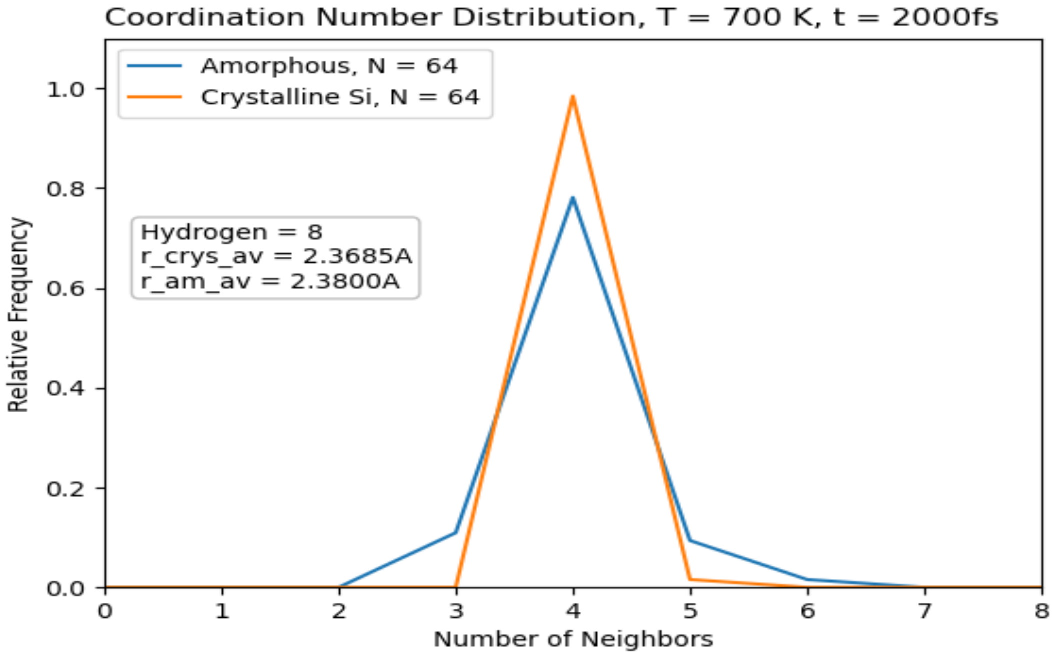

Figure 6: Relative frequency of Coordination number for both the crystalline and amorphous phases. Assuming no recrystallization, coordinates averaged every 2ps

Average coordination as a function of the z-coordinate within the cell reveals interesting dynamics. The amorphous region sees fairly significant deviations in coordination, with regions jumping up to five-fold coordination, before falling down again. In addition, we see a drop in coordination on the crystalline-amorphous interface present due to the periodic boundary conditions. Due to the drop in coordination in the crystalline region, we see a nearly equivalent uptick in coordination in the amorphous region. Again, these deviations are more significant at higher temperatures, figure 7.

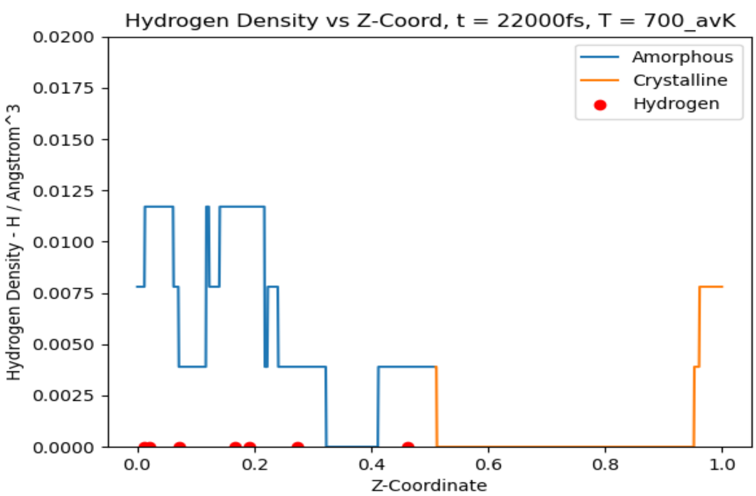

Figure 7: Coordination number as a function of z, at 500K. No hydrogen - silicon interactions were considered. We see nearly constant 4-fold coordination in the crystalline region, with a drop at the interfaces with the amorphous region.

Hydrogen densities remain fairly static in the z-coordinate across all three training temperatures, although there is variation in magnitude, figure 8. We observed no apparent re-crystallization in this time-frame. Finally, we see good convergence of both energy, and force error estimates with the actual error, figures 9 and 10. On average, a first principles training step took an average of 509.9 seconds of CPU time, whereas an ML step took 0.2505 seconds, for a speedup on the order of 2000 times.

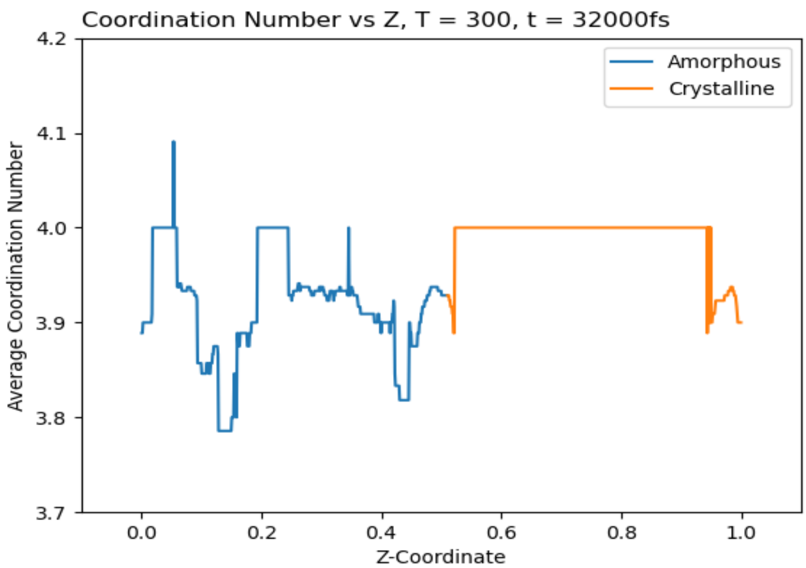

Figure 8: Hydrogen density within the model as a function of z. Hydrogen density fluctuated slightly through the trajectory, and no hydrogen entered the crystalline region.

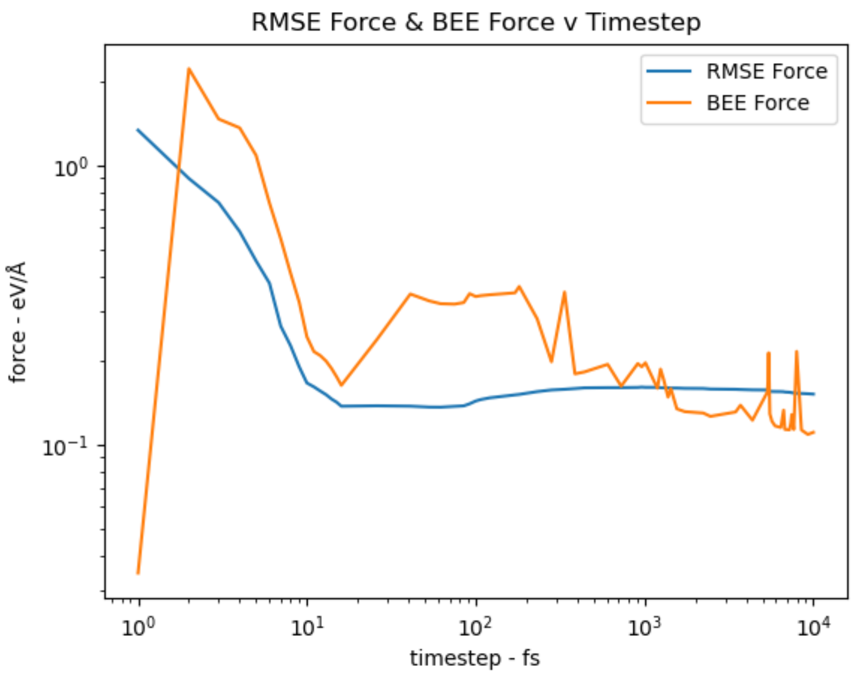

Figure 9: log-log plot of root mean square error and bayesian error estimate vs timestep. The difference in these values determines if first principles calculations are required.

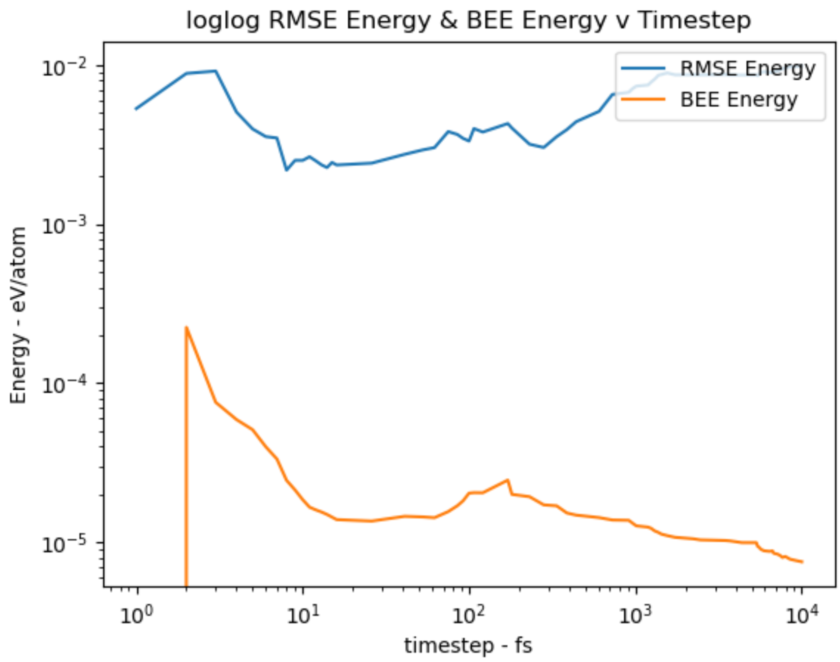

Figure 10: RMSE energy and BEE energy vs timestep. This convergence is not specifically required by the MLFF

In production runs, the relative coordination appears to be unchanging with respect to the three degrees of hydrogenation. We see a similar phenomenon to the training runs with the average coordination vs Z: a precipitous drop in coordination at the interface, with an opposite gain in coordination in the amorphous region. We observe a standing wave-like pattern at the higher 32 hydrogen count, as well as a slight penetration by the hydrogen into the crystalline region, see figures 11 and 12. Overall, 300 ps of production runs took 103,850.46 seconds, or 346.1682 seconds per ps, or 0.3462 seconds per timestep. We did not perform any first principles calculations for the production runs, but a single time step of FP calculations in the smaller training system took an average of 509.09 seconds, so we can expect the speedup to be on the order of 1000 times faster.

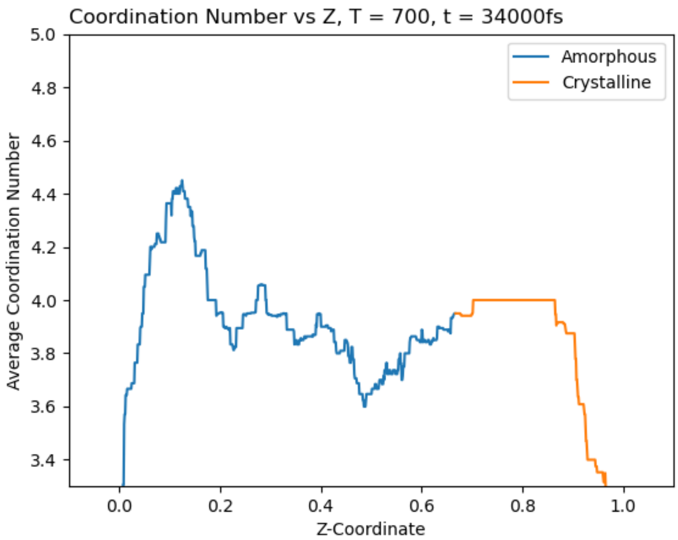

Figure 11: Coordination number vs z for the 32-hydrogen production run. We see a steep drop off in coordination at the interfaces.

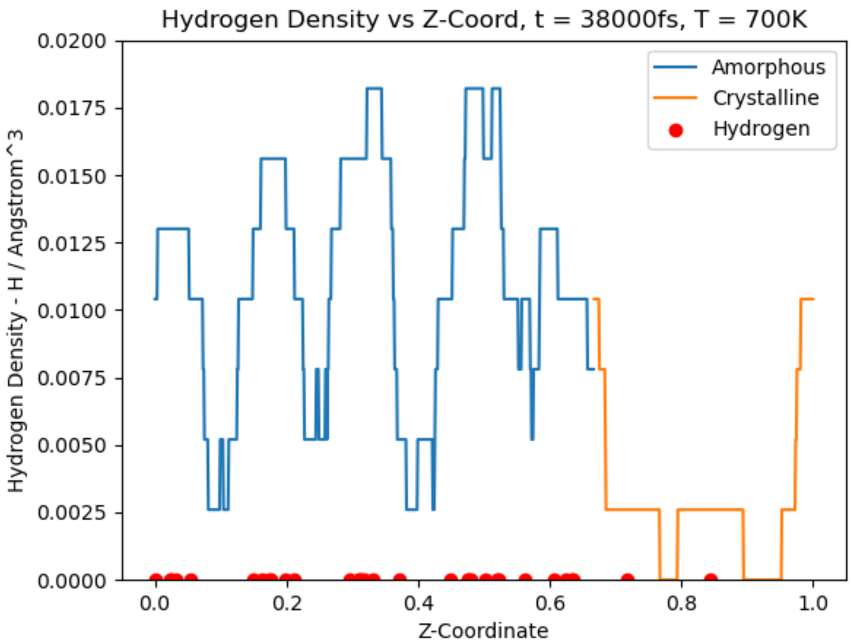

Figure 12: Hydrogen density vs Z for the 32 hydrogen production run. We see penetration into the crystalline region, and a consistent bias towards certain regions by the hydrogen.

DISCUSSION

As a test system for the MLFF, bulk crystalline silicon is a natural choice, as its dynamics are quite simple, and should allow for a quick training period for the MLFF. In addition, as a relatively small supercell is sufficient to get accurate results, such a small monoatomic system will allow for the simulation of first principles (FP) trajectories for the sake of comparison with the MLFF. The success of the machine learning approach is unsurprising, as significant atomic motion is not expected at any of the training temperatures. Overall, the MLFF was extremely successful in replicating the bulk silicon's behavior. The error's convergence was within a reasonable tolerance. The speedup on the order of 1000 times was comparable to other published works.

In the training of the interface, the mass of hydrogen was quadrupled. Since this model is being trained to replicate interactions between atoms, this modification seems to be a reasonable way to speed up the system's exploration of phase space. The added mass served to speed up training for rare events in which the hydrogen makes a significant jump to another nano-void within the amorphous silicon. So while the timescales presented within the figures will be faster than a real system, we believe the dynamics will be reasonable nonetheless.

The rightward skew found within the amorphous region's relative distribution is reasonable when considering the fixed density of the system. An individual silicon atom is very unlikely to find itself with less than 3-fold coordination, whereas fluctuations in density can momentarily increase coordination to 5, 6, or 7 for a short time.

It is less clear why an apparent rift forms at one or both interfaces of the models. A possible explanation could be in the preparation of the sample. We simply checked to make sure no atoms were too close (less than 1 angstrom). Experimentally, amorphous silicon is about 1.85% less dense than crystalline silicon at 300K, so the simulation cell could be a slightly inappropriate size. The data suggests the amorphous silicon draws itself away from the crystalline phase, leading to the 'rift' in coordination. Essentially, it appears there is a small gap between the two phases. A simulated annealing could fix this issue in future tests.

Finally, the hydrogen density plot reveals an apparent standing wave pattern at high density. Since it is very energetically unfavorable to enter the crystalline phase, the hydrogen is somewhat confined to the amorphous phase. The hydrogen are not able to easily pass by one another, so rather than random motion, this oscillatory pattern seems to be the most energetically favorable within the medium.

CONCLUSIONS

By the metrics tested: the bayesian error estimates, and the radial distribution, the MLFF performs within a small tolerance of FP methods. We trained a simple bulk crystal model, and a more complex interfacial model at a range of temperatures. We used this interfacial model to perform a simulation which would not be achievable within a reasonable timeframe by first principles methods, and by our analysis the results seem to be physically reasonable. Our analysis also revealed mechanistic insights into hydrogen movement, and interaction between the two phases at the interface. In the future we will refine our parameters, and give the MLFF more realistic inputs to give more realistic results. Some of the mechanisms observed could be artifacts of our methods. We also hope to add oxygen to the interface, as experimental results show oxygen can contaminate the interface during the annealing process, and we would like to capture this with our model.

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RECONSTRUCTING LOST BUILDINGS FROM HISTORICAL IMAGERY

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ABSTRACT

3D reconstruction from historical images requires special consideration due to the characteristics of the images. Such images often contain artifacts and are missing intrinsic camera parameters and the limited number of images available. With limited number of images, it is crucial to correctly match as many images as possible. Classical keypoint matching techniques are unable to find correspondences with large view-point or appearance changes. While state of the art, learned methods achieve high performance, they are lacking accurate keypoint localization which is important for 3d reconstruction.
We propose a method to increase the number of images matched and lower the mean reprojection error for structure from motion (SfM).

1. INTRODUCTION

Reconstructing 3D geometry from historical imagery is a difficult problem because of the image characteristics and limited number of remaining photos. Historic photos are often noisy, out of focus, or have other artifacts and the intrinsic parameters are unknown. Because of the limited number of photos available it is crucial to register as many as possible.

Classical, hand-crafted feature matchers such as SIFT [1] often fail on such images. Therefore, more recent, learning based methods has to be evaluated.

The latest methods in the field of image matching are *featureless* matchers. They don't start with keypoint extraction first but they utilize the whole images to form (semi-)dense matches and select sample matching points for each image pair. While achieving superior performance, the lack of repeatable keypoints across multiple images is not ideal for structure from motion (SfM).

In this work we investigate an ensemble of the state-of-the-art image matching methods, present a way to extract.

1. pipeline to match historical imagery
2. rematch extracted SuperPoint for use in SfM
3. compare to DISK, SuperGlue and SIFT

2. RELATED WORKS

Detector-based Feature Matching.

SIFT [1] is arguably the most famous hand-crafted local feature descriptor. Interest points are extracted and described using a hand-designed algorithm computed on the local image patch. With the rise of deep learning these descriptors were replaced by learning based methods using convolution neural networks (CNNs), achieving high level of robustness of local features on large appearance, scale and viewpoint change. SuperPoint [7] is trained on synthetic data using a self-supervised training method through homographic adaptation which concentrate keypoints at corners, especially useful for outdoor urban reconstruction. DISK [9] learns the keypoint locations and descriptors together in a self-supervised manner using policy gradient where the reward is given based on correct and incorrect matches.

The above-mentioned local features use the nearest neighbor search in descriptor space to find matches between the extracted interest points. Recently, SuperGlue [8] proposes a learning based approach for local feature matching based on graph neural networks (GNN).

Detector-free Feature Matching. Detector-free methods remove the feature detector phase and directly produce dense descriptors or dense feature matches. This approach has recently received great attention with LoFTR [4] being a prominent example. These methods do not detect keypoints, but rather produce sparse correspondences by a global matching stage, followed by sparse refinement. However, due to the lack the keypoint makes it difficult to use the matches in 3D reconstruction. QuadTree [5] adds an attention mechanism to LoFTR [4].

Dense Feature Matching. Similar to detector-free methods, dense matching uses global information but instead of sparse refinement gives a vector field or optical flow for each pixel of the input image. DKM [6]

3. METHOD

3.1 ENSEMBLE MATCHING

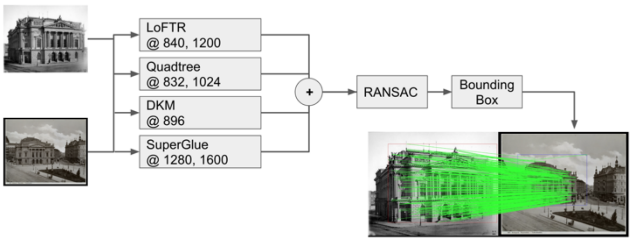

Figure 1 Pipeline of ensemble method

Matching historic images are difficult and each matching methods have different strengths and weaknesses. For example, large viewpoint or appearance change, different scales can cause the matching to fail. To combine the advantages of different matching techniques we make an ensemble of several state-of-the-art matching models. The pipeline is depicted in Fig 1.

The models used in this ensemble were selected based on the findings in the *Image Matching Challenge 2022*.

We downscale the images to different sizes because these techniques find different matches at different scales due to their training procedure and receptive fields. Additionally, we run the models both ways on each image pair and concatenate the results. The models are not symmetric and this way it is possible to extract more potential matches.

We run an exhaustive matching on each image pair for the selected models and configurations and save the extracted matches and confidence values.

In the next step, we normalize the confidence values and filter out the matches with confidence below *thres_conf*. Then the remaining matches are concatenated and run through MAGSAC [3], a type of RANSAC method to filter out the geometrically inconsistent matches. The results are saved along with bounding boxes of the matches and the number of inliers for rematching keypoints detailed in the following paragraph.

3.2 REMATCHING KEYPOINTS

Featureless matchers don't have reproducible keypoints which is important for SfM.

First, we extract SuperPoint [7] keypoints from all images at multiple scales (1600, 3200). Starting from the lower resolutions, we combine the keypoints if there is not already a keypoint in the neighborhood (*dist_kpt*). Using a KDTree can significantly increase the speed of neighborhood checks. SuperPoints at multiple scale make sure that even if the bounding boxes are small relative to the full image, the density of the keypoints remain high.

After having the matching image pairs and bounding boxes we can match the combined SuperPoints. This part consists of 3 steps:

I Matching the full images with all keypoints,

II Matching only the cropped part of the images and

III sampling a dense flow-based matches via the keypoints.

For steps I and II we use SuperGlue [8] since it's been trained on SuperPoint descriptors and shown to be work well.

In step III, we run the dense matches of choice (DKM) on the cropped regions. Then, sample the resulting flow field by the combined multi-level keypoints. After that, we find the closest keypoints on the target image within a threshold and declare them matches. In an optional step, we can make sure that the matches are cycle consistent, that is, a matching point from image A to B is the same as matching the closest point in B to A.

4. EXPERIMENTS

4.1 DATASET

In this paper we investigate the reconstruction of the *Hungarian National Theater* which was demolished in 1965. The dataset consists of the remaining photographs between 1875-1965. The dataset contains 344 images, including 81 images showing the façade and 127 images during demolition with partially intact building.

4.2 ENSEMBLE MATCHING

Out of the possible 58996 matches 8788 have more inliers than *min_inliers* 50. The histogram of the number of inliers is shown in Fig. 2.

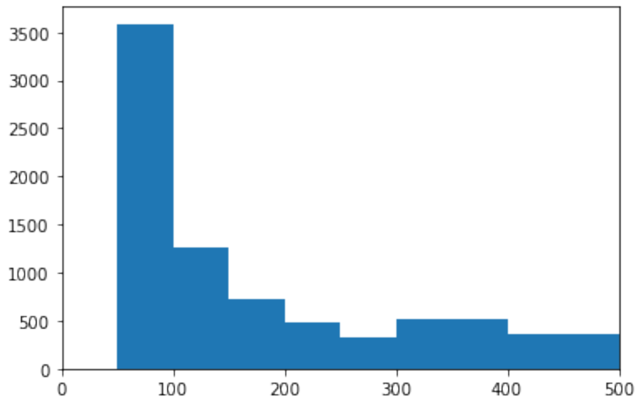

Figure 2 Histogram of number of matches between image pairs

The model often cannot match the façade but at the same time background building are matched correctly which would be challenging to a human annotator. Cherry picked failure cases can be seen in Fig 3. The most common failure case is matching symmetric structures e.g., the two sides of the theater building. Matching public transportation vehicles. To alleviate these problems a segmentation mask would be useful to ignore matches on vehicles, and people. Furthermore, disallowing matches between images depicting the two sides of the building for the lack of better algorithmic solution.

4.3 REMATCHING

To quantify the performance of our method, we run SfM in Colmap [2]. Table 1. shows the statistics of the sparse reconstruction.

Model name	Registered images ↑	Points /image↑	Mean track length ↑	Mean reprojection error ↓
Colmap SIFT*	119	318	3.29	1.12
DISK	191	299	3.48	1.35
SuperGlue	**198**	151	**3.67**	1.31
Ours	68	**350**	2.99	**1.02**

Table 1 Keypoint rematching statistics

SuperGlue achieves the highest number of images and the longest mean track length. Our method achieves the lowest number of images but at the same time the most reconstructed 3d points per image. Furthermore, our method achieves the lowest mean reprojection error.

To qualitatively evaluate the reconstruction, we plot the sparse point cloud and run the dense point generation in Colmap [2]. The results are shown in Fig 4. The color of the camera shows the image source, blue for Fortepan and red for the rest. While the sparse point cloud, for our method, shows the lack of surrounding area and back side of the theatre, the dense reconstruction shows that from even so few images a more accurate façade can be reconstructed, close to the SuperGlue model which uses the same feature points. (Disclaimer: dense DISK model might not be the best version possible)

5. CONCLUSION

The ensemble of state-of-the-art image matching methods achieve superior results to hand-crafted models on historical imagery.

Rematching keypoints using DKM achieves the lowest mean reprojection error and the most point for each registered image but it is a limiting factor for 3d reconstruction because of the low number of matches.

The experimental results suggest that with a lack of strong matches it is beneficial to keep only a small subset of images with precise matches.

While the ensemble model manages to increase the number of correct matches, filtering out the False Positives remain a challenge.

6. FUTURE WORK

Directly assign the matches to the closest SuperPoint to retain the advantage of the ensemble model.

Investigate COETR [10] model instead of DKM.

ACKNOWLEDGEMENTS

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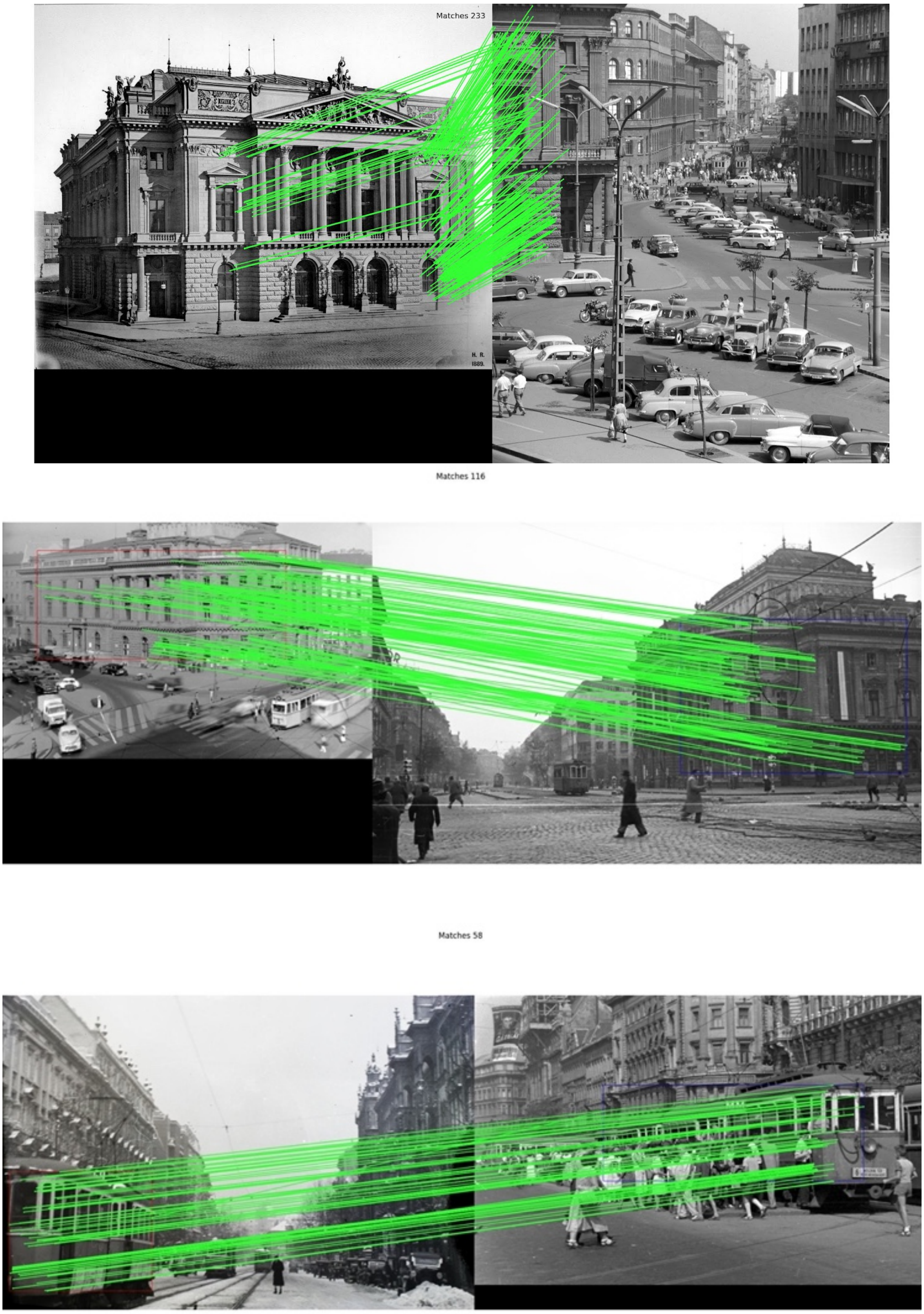
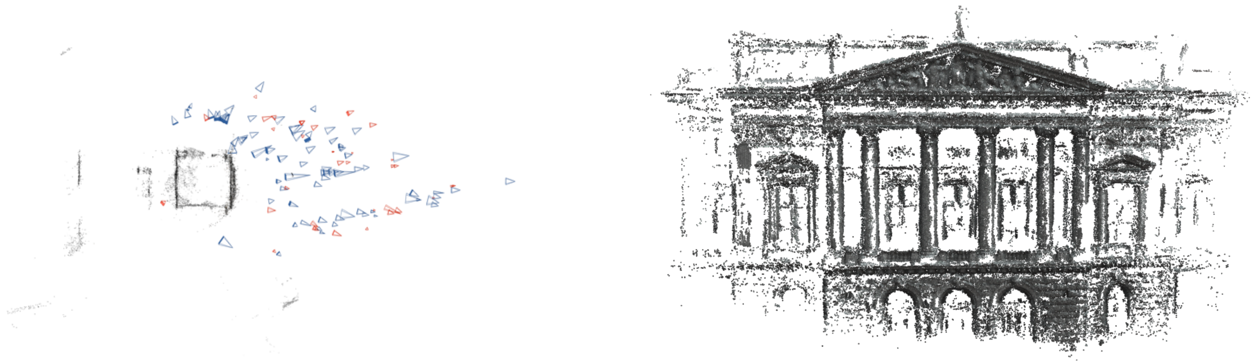


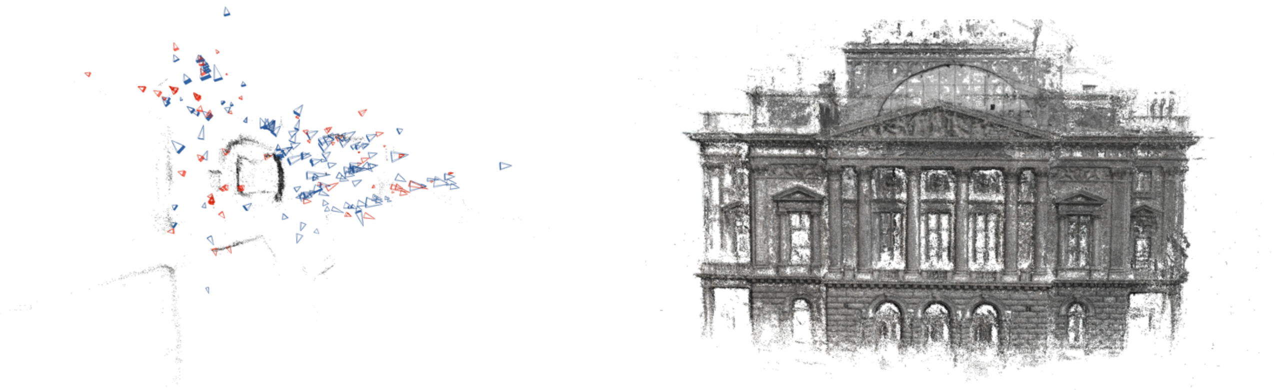
Figure 3: Failure cases

SIFT



DISK

SuperGlue



Ours (DKM+SuperPoint)

Figure 4 Top view of sparse reconstruction (left) and dense point cloud of facade (right)

INVESTIGATION OF THE EFFECT OF ARRANGEMENT OF MULTIPLE JETS BY COMPUTATIONAL FLUID DYNAMICS

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ABSTRACT

Turbulent jet has been implemented in many engineering applications. Air curtain is one of them. It takes advantages of the jet flow by separating two regions of air. Since Covid-19 is still quite rampant lately, air curtain plays a role to minimize the droplet of the virus entering sterilized place e.g., hospital. But in smaller scale, acrylic wall is often used in many places because of its convenient. It leads to other problem which is increasing the waste. Smaller scale of air curtain hopefully can manage reducing the use of acrylic wall. To achieve that, jet flow structure should be investigated to determine optimal arrangement of the jet inlet which can prevent air mixing of two region. Eight type of inlet arrangements are being investigated. Three arrangements can achieve less mixing process with two of them have similarity in shape. The one with no similarity with the other two should be investigated more to precisely determine which inlet arrangements achieve the least mixing process.

UNDISCLODED

Analysis of Energy capture Efficiency of Bottom Hinged Oscillating Wave Surge Convertors

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Abstract:

This paper compares the efficiency of bottom hinged oscillating wave surge convertors (OWSC) in narrow water conditions and wide water conditions as well as in short period waves and long period waves. Using energy equations, it was found that the OWSC was more effective on average in wide water conditions than in narrow. The importance of resonance frequencies was confirmed when comparing efficiency across various periods as wave conditions with resonance had maximum energy capture efficiency and generation. Ideal C_{PTO} values were also found to decrease as average oscillation wave height increased.

1. Background:

There has been increased attention towards wave energy as a renewable source of energy. Recent studies have shown that wave energy has one of the highest energy densities as compared to other renewable sources such as solar and wind [1]. Although there are various mechanisms proposed for capturing wave energy, bottom hinged oscillating wave surge convertors (OWSC) have been shown to have significantly higher energy capture potential than their peers [2] [3]. Bottom hinged OWSCs capture wave energy by having a large flap that rotates around an axis or hinge when waves crash into it.

In this study, the performance of a bottom hinged OWSC will be compared in various water conditions. This includes three main factors: wide water regimes vs narrow water regimes, period, and wave height. Narrow water regimes are conditions where the width of the flume is equivalent to the width of the OWSC. This means that water is unable to flow around the sides of the OWSC and must flow over or under. In wide water regimes, this is not true and the width of the flume is significantly greater than the width of the OWSC. This allows for water flow around the OWSC and is closer to real life conditions. The period and wave height of the waves hitting the OWSC were controlled also. Periods of 1-3 seconds were studied with a step of 0.2 seconds. Wave heights of 9cm and 12cm were studied also.

2. Experimental set up:

Experiments were conducted by using a two-dimensional wave flume (30m x 0.7m) for narrow water regimes and a wide two dimensional wave flume (22m x 2.22m) for wide water regimes. A wavemaker was used to generate regular waves of selected period and wave height traveling down the length of the wave flumes. The bottom hinged OWSC was placed in the wave flume, with enough distance from the wave maker to allow the waves to be created and become steady. In front of the wavemaker two wave height meters were placed, staggered in their distance from the bottom hinged OWSC. These wave height meters recorded the changing water surface level and were staggered from one another so that effects from reflection of the waves from the far end of the flume could be recorded if they were present. These wave height meters gave insight into the actual wave height and shape of the waves as opposed to the assumed theoretical wave height inputted into the wave maker and the theoretical sinusoidal shape of waves. They were not however, used directly for the calculations and findings of this paper. An accelerometer was attached to the top of the bottom hinged OWSC to record the angle of the OWSC with respect to its natural, vertical position. This data is the main focus of the paper as the oscillations of the angle of the OWSC are the main indicators in which energy capture was measured.

3. Data analysis:

3.1 Calculating F_{max}:

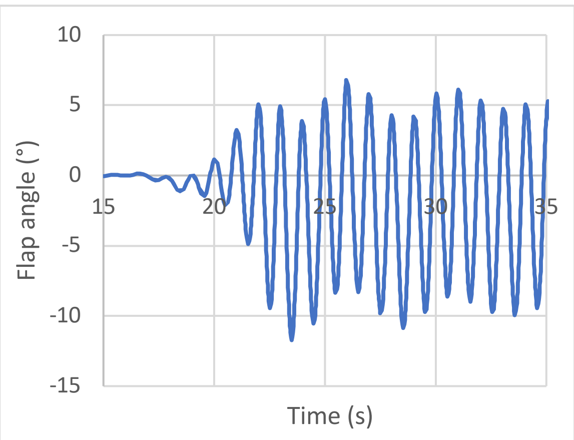

Fig. 1: The oscillations of the OWSC with waves with a period of 1s and wave height of 9cm.

The accelerometer data was first graphed using Microsoft Excel. By inspection of the graph, the period of 30-60s after the wavemaker had begun making waves was selected as the time range to analyze the accelerometer data. This range was well after the time it took for the waves to travel to the OWSC and for the OWSC to converge to a regular oscillatory movement. The accelerometer data of the range was then analyzed using python code. By taking the difference between the local maximum and minimum of every wave, the average wave height of the oscillations of the OWSC (φ_{amp}) over the 30 second interval was calculated.

Once φ_{amp} was known, F_{max} was calculated using equation 1.

$$\varphi_{amp} = \frac{F_{max}}{\sqrt{[K-(I+\mu)\omega^2]^2+[(C+C_{PTO})\omega]^2}} \quad (1)$$

Where K is the buoyancy of the OWSC in water, I the moment of inertia of the OWSC, μ the added mass, C the radiation dampening, ω the angular frequency, C_{PTO} the power take off moment and F_{max} the maximum force of the OWSC associated with 0 C_{PTO}. K, I, C, and μ are all physical properties of the OWSC itself, which were known beforehand or tabulated according to the period of the waves in question. ω is a property of the waves, inversely related to the period. C_{PTO} is the added resistance to the movement of the flap associated with the power take off system, the system absorbing wave energy and generating electricity [4]. If the C_{PTO} value is too high, the resistance in the hinge of the OWSC will be so strong that it will not effectively move when waves hit the OWSC. If the C_{PTO} value is too low, no significant electricity will be generated regardless of how much the OWSC oscillates. The ideal C_{PTO} value will be calculated for each wave condition further in the paper. C_{PTO} was set to 0 for this calculation as there was no actual electricity generation system attached to the OWSC and to calculate F_{max}. Once F_{max} was calculated, the change in φ_{amp} was able be predicted based on changing the C_{PTO} value.

3.2 Calculating Wave Energy:

The theoretical energy of each wave condition was calculated using its wave's characteristics: the period (T), wave height (H), and the wave flumes' neutral water depth (h). Using equation 2, the dispersion equation [5], the wave number (k) was calculated using an iterative technique.

$$\omega^2 = gk \tanh(kh) \qquad (2)$$

$$P_w = \frac{1}{16}\rho g H^2 \frac{L}{T}\left(1 + \frac{2kh}{\sinh(2kh)}\right) \qquad (3)$$

Where g is the acceleration due to gravity, 9.81 m/s^2 and ω is the angular frequency. k was then used in equation 3, to calculate the theoretical energy of the wave, P_w [5]. Where ρ is the density of water, L is the wavelength, and T is the period. The wavelength was able to be calculated through the definition of the wave number:

$$\omega = 2\pi/L$$

3.3 Calculating Efficiency:

The efficiency of the energy capture of the OWSC was calculated by simply dividing the theoretical energy yield of the OWSC (P_{out}) by the theoretical total energy of the wave (P_w), according to equation 4.

$$E = \frac{P_{out}}{P_w} = \frac{C_{PTO}{\varphi_{amp}}^2\omega^2}{2P_w W} \qquad (4)$$

As shown by inspection, P_{out} will equal 0 if C_{PTO} is 0. An ideal C_{PTO} value was calculated by iterating through a range of values. As C_{PTO} increases, P_{out} will not linearly increase towards infinity as C_{PTO} and φ_{amp} are inversely related as shown by equation 1. The C_{PTO} value associated with the highest efficiency was chosen for each wave condition. The relationship between C_{PTO} and P_{out} can be seen in figure 2, showing the curve representing the initial increase in efficiency and the eventual decrease.

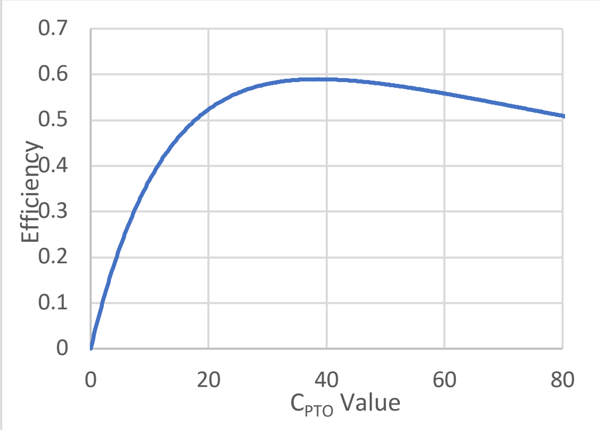

Fig. 2: The relationship between C_{PTO} and Efficiency measured for an OWSC with waves with a period of 1s and height of 9cm

4. Results and discussion

4.1 The relationship between Period and φ_{amp}:

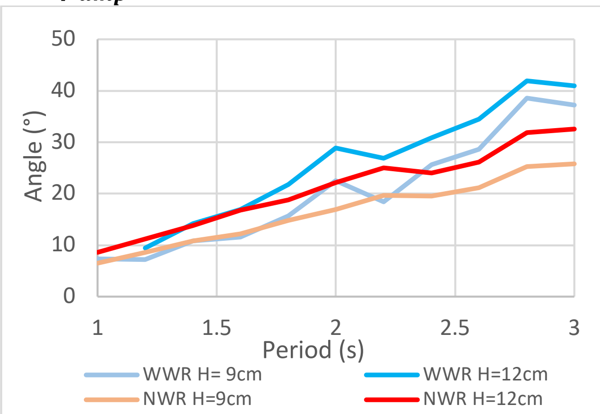

Fig. 3: The average oscillation wave height of OWSC in various wave conditions

As a general trend, the average oscillation wave height increased with period. However, this should not be thought of as a direct linear relationship. This correlation between period and φ_{amp} is most likely caused by the period of the waves approaching the natural frequency of the OWSC in water. This would also explain the slight increase in angle with waves with a period of 2 seconds in the wide water regime and 2.2 seconds in the narrow water regimes. It can be hypothesized that the natural period of the OWSC in water is around 4-4.5s. This would mean that wave conditions with a period of 2 and 2.2 seconds benefited from resonance effects with the wave period being half of the natural period of the OWSC. This would also mean that further deviations from these values would result in lower angle values.

4.2 Ideal C_{PTO} Trends:

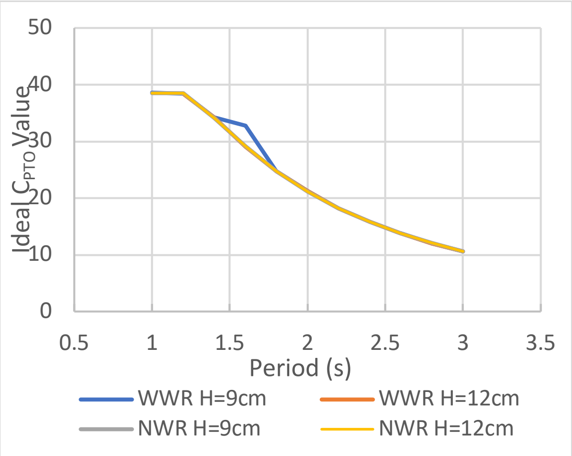

Fig. 4: The calculated ideal C_{PTO} value for various wave conditions. The values were similar enough for the lines to overlap on top of themselves

While φ_{amp} increased between the periods 1 to 3 seconds, the ideal C_{PTO} values calculated for each wave condition exclusively decreased. This can be explained by assuming that there is an inverse relationship between φ_{amp} and ideal C_{PTO}. When the OWSC oscillates with a smaller angle, it is the most efficient to maximize that smaller movement by having a higher C_{PTO} value to generate the most electricity. However, in cases with a larger φ_{amp} value, it is most efficient to utilize the full motion of the OWSC by not restricting its angle and having a lower C_{PTO} value.

4.3 Efficiency and Energy Output:

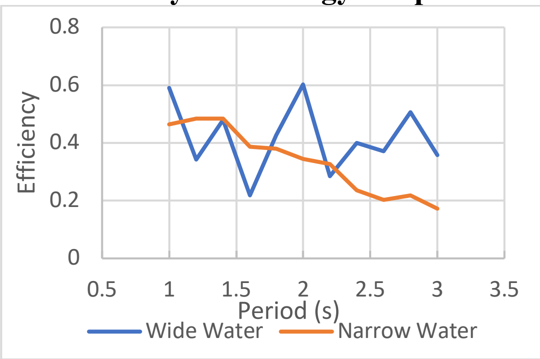

Fig. 5a: Wave height 9cm efficiency analysis

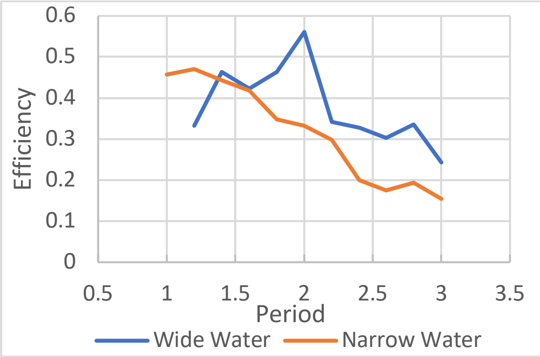

Fig. 5b: Wave Height 12cm efficiency analysis

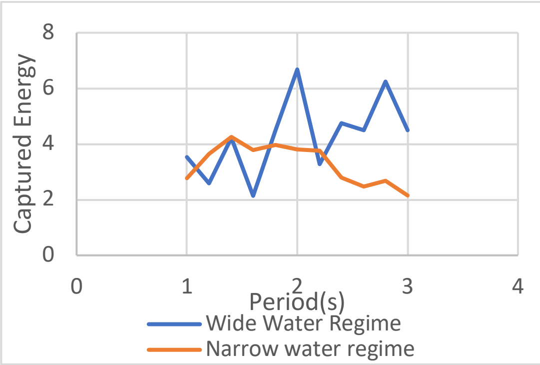

Fig. 6a: Wave Height 9cm Energy Capture

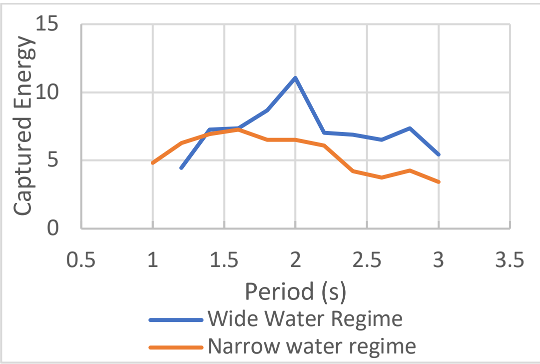

Fig. 6b: Wave Height 12cm Energy Capture

In narrow water regimes, efficiency of energy capture decreased as period increased. This was true for both water depths. There was not as clear of a relationship between period and energy production efficiency for wide water regimes however. Wide water regimes did, however, have on average higher energy capture than their narrow water regime counter parts. Energy capture peaked at a period of 2 seconds for wide water regimes.

5. Conclusion/Future works

In this research, the effectiveness of energy capture of a bottom hinged OWSC was compared in different water conditions: narrow and wide, short and long period waves. Wide water conditions were found to be overall more efficient in capturing wave energy. This is encouraging as wide water regimes are closer to real life conditions these OWSCs will have to perform in. This research also confirmed the importance of resonance in OWSCs. In wide water conditions, both efficiency and energy capture peaked at a period of 2 seconds, which is where resonance was believed to be occurring. Ideal C_{PTO} values were found to decrease with increasing average oscillating wave height values also.

There are many other factors left to consider and research in these systems. Most important is the scalability of these systems. The OWSC used in this research was around 50cm tall and 68cm wide. Much larger structures will need to be built to generate electricity at a profitable rate. The trends and effects discussed in this paper may not continue to be true at significantly larger scales and new considerations may arise.

Acknowledgments:

I would first and foremost like to thank Dr. Tomoaki Nakamura and Dr. Yonghwan Cho for supporting and educating me throughout this research. Huge thanks to Motosugi san, Harutaka san and other lab members for their support. I would also like to thank the JUACEP program for making this possible despite the COVID pandemic.

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[1] Bradley E. Layton (2008) A Comparison of Energy Densities of Prevalent Energy Sources in Units of Joules Per Cubic Meter, International Journal of Green Energy, 5:6, 438-455, DOI: 10.1080/15435070802498036

[2] K. Budal & J. Falnes (1982) Wave power conversion by point

[3] A. Babarit, J. Hals, M.J. Muliawan, A. Kurniawan, T. Moan, J. Krokstad, Numerical benchmarking study of a selection of wave energy converters, Renewable Energy, Volume 41, 2012, Pages 44-63, ISSN 0960-1481, https://doi.org/10.1016/j.renene.2011.10.002

[4] Yao Liu, Norimi Mizutani, Yong-Hwan Cho, Tomoaki Nakamura, Nonlinear hydrodynamic analysis and optimization of oscillating wave surge converters under irregular waves, Ocean Engineering, Volume 250, 2022, 110888, ISSN 0029-8018,

[5] Dean, R. G., & Dalrymple, R. A. (2009). *Water wave mechanics for engineers and scientists*. World Scientific.

[6] Liu, Y.; Cho, Y.-H.; Mizutani, N.; Nakamura, T. Study on the Resonant Behaviors of a Bottom-Hinged Oscillating Wave Surge Converter. *J. Mar. Sci. Eng.* **2022**, *10*, 2. https://doi.org/10.3390/jmse10010002

2-2 Presentations

The 27th JUACEP Workshop

for the Students of 2021 Outbound Course and 2022 Summer Research Course

Date & time: 10:00~ on Friday, August 26, 2022

Venue: Lecture room IB013 (Ground floor, IB)

10:00 - 10:05 Opening address

10:05 - 10:20 **(1) KOYAMA, Hiromu** P.36-38
"Analysis of Energy Capture Efficiency of Bottom Hinged Oscillating Wave Surge Convertors" *Advisor: Assoc. Prof. Tomoaki Nakamura, Civil and Environmental Engineering*

10:20 - 10:35 **(2) MC KIBBIN, Jacob Patrick** P.39-42
"Molecular dynamics simulations of hydrogenated amorphous silicon using machine learning potential" *Advisor: Prof. Ryoji Asahi, Institute of Innovation for Future Society*

10:35 - 10:50 **(3) LI, George Peiyuan** P.43-45
"Performance Characterization of Half Flux Quantum and Single Flux Quantum-based Digital Logic" *Advisor: Prof. Akira Fujimaki, Electrical Engineering, Electronics, and Information Engineering*

10:50 - 11:00 Break

11:00 - 11:15 **(4) KOMOROWICZ, David Laszlo** P.46-48
"Reconstructing Lost Buildings from Historical Imagery" *Advisor: Prof. Toshiaki Fujii, Electrical Engineering, Electronics, and Information Engineering*

11:15 - 11:30 **(5) MUHAMMAD, Diksan** P.49 Undisclosed
"Investigation of the effect of arrangement of multiple jets by computational fluid dynamics" *Advisor: Prof. Yasumasa Ito, Electrical Engineering, Global 30 Automotive Engineering*

11:30 - 11:45 **(6) TERAI, Yusuke** *Outbound course of Nagoya student*
"Bio-sample droplet evaporation with LASER irradiation to induce salt precipitation aside and improve SERS throughput" *Advisor at NU: Prof. Noritsugu Umehara, Micro-NanoMechanical Science and Engineering*

11:45 - 12:00 Overall discussion and closing remarks

**10 minutes presentation + 4 minutes Q&A each*

Nagoya University

Analysis of Energy Capture Efficiency of Bottom Hinged Oscillating Wave Surge Convertors

By: Hiromu Koyama

1

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Background

- There has been increased attention on wave energy as a renewable resource
- significantly higher energy density than wind or solar.
- Allows for consistent power

2

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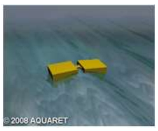
Background



- There are various mechanisms for capturing wave energy
- Attenuators
- Point absorbers

3

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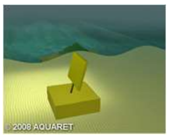
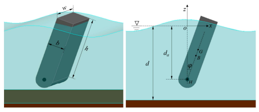
Background

- What is a bottom hinged oscillating wave surge convertor (OWSC)?
- Narrow water regime vs wide water regimes





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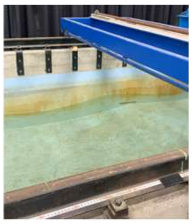
Experimental Setup



- A wave maker was used to generate regular waves with a determined period and wave height
- The bottom hinged flap was placed in the water
- Two water height meters were placed in front of the flap
- They were staggered so that it was possible to calculate reflected waves
- An accelerometer was attached on top of the flap to measure angle data

5

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Equations and Variables

$$\varphi_{amp} = \frac{F_{max}}{\sqrt{[K-(I+\mu)\omega^2]^2 + [(C+C_{PTO})\omega]^2}}$$

$$P_W = \frac{1}{16}\rho g H^2 \frac{L}{T}\left(1 + \frac{2kh}{\sinh 2kh}\right)$$

$$E = \frac{P_{out}}{P_W} = \frac{C_{PTO}{\varphi_{amp}}^2\omega^2}{2P_W W}$$

$$\sigma^2 = gk\tanh(\mathrm{kh})$$

Controlled/Known Variables:
T: Period
H: wave height. Vertical distance from crest to trough. Double the amplitude of wave
h: water depth (42.5cm)
K : buoyancy of the flap (Nm)
I: moment of inertia of flap (kgm^2)
μ: added mass (kg)
C: radiation dampening
C_{PTO} : Power take off dampening

Calculated Variables
F_{max}:The maximum force when C_{PTO} equals 0
φ_{amp}: average flap angle wave height
P_W: power of the wave (W/m)
P_{out} : mechanical power captured by the OWSC
σ or ω: angular frequency $2\pi/T$
k: wave number ($2\pi/L$)
h: water depth
W: width of the flap

6

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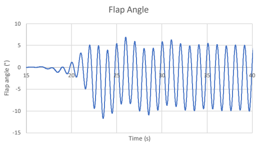
Data Analysis



- The angle of the flap was graphed with respect to time
- Python code was used to determine the average wave height
- This is φ_{amp}, the average flap angle wave height

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Data Analysis

$$\varphi_{amp} = \frac{F_{max}}{\sqrt{[K - (I + \mu)\omega^2]^2 + [(C + C_{PTO})\omega]^2}}$$

$$P_W = \frac{1}{16}\rho g H^2 \frac{L}{T}\left(1 + \frac{2kh}{\sinh 2kh}\right)$$

$$E = \frac{P_{out}}{P_W} = \frac{C_{PTO}{\varphi_{amp}}^2\omega^2}{2P_W W}$$

$$\sigma^2 = gk\tanh(\mathrm{kh})$$

Once φ_{amp} was known, it was possible to calculate Fmax using equation 1.

This allows us to calculate φ_{amp} when Cpto doesn't equal 0.

8

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Data Analysis

$$\varphi_{amp} = \frac{F_{max}}{\sqrt{[K - (I + \mu)\omega^2]^2 + [(C + C_{PTO})\omega]^2}}$$

$$P_W = \frac{1}{16}\rho g H^2 \frac{L}{T}\left(1 + \frac{2kh}{\sinh 2kh}\right)$$

$$E = \frac{P_{out}}{P_W} = \frac{C_{PTO}{\varphi_{amp}}^2\omega^2}{2P_W W}$$

$$\sigma^2 = gk\tanh(\mathrm{kh})$$

Equation 4, the dispersion equation was used to solve for the wave number (k).

Once the wave number was known, the theoretical power of the wave was calculated using equation 2.

9

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Data Analysis

$$\varphi_{amp} = \frac{F_{max}}{\sqrt{[K - (I + \mu)\omega^2]^2 + [(C + C_{PTO})\omega]^2}}$$

$$E = \frac{P_{out}}{P_W} = \frac{C_{PTO}{\varphi_{amp}}^2\omega^2}{2P_W W}$$

The efficiency of the flap was calculated by calculating the power captured by the flap.

This was done by varying the Cpto value, which changes φ_{amp}, in accordance to equation 1.

The maximum efficiency as well as the Cpto associated with maximum efficiency under these conditions was recorded.

10

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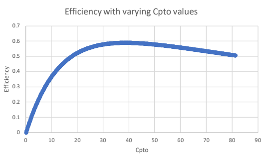
Data Analysis



The efficiency of the flap was calculated by calculating the power captured by the flap.

This was done by varying the Cpto value, which changes φ_{amp}, in accordance to equation 1.

The maximum efficiency as well as the Cpto associated with maximum efficiency under these conditions was recorded.

11

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Results

Depth: 42.5 cm Wave Height: 9cm				
Period (s)	Average Flap angle	Emax	Ideal Cpto	Energy Out
1	7.339878333	0.58954522	38.6	3.52016526
1.2	7.198016	0.34324799	38.4	2.58908476
1.4	10.82048571	0.47947911	34.2	4.22971863
1.6	11.61544444	0.21828857	32.8	2.13840199
1.8	15.68693438	0.42700667	24.8	4.49717206
2	22.47766	0.60230856	21.2	6.68070889
2.2	18.38076154	0.28501292	18.2	3.28454388
2.4	25.58316818	0.40041258	15.8	4.74982791
2.6	28.62836818	0.3707271	13.8	4.4978251
2.8	38.571	0.50531625	12	6.24094496
3	37.255995	0.35814462	10.6	4.48719092

Depth: 42.5 cm Wave Height: 12cm				
Period (s)	Average Flap angle	Emax	Ideal Cpto	Power Out
1.2	9.442854	0.33229732	38.4	4.45581553
1.4	14.17936	0.46314295	34.2	7.26325387
1.6	16.94015	0.42233074	29	7.35504519
1.8	21.78846563	0.46337684	24.8	8.675942
2	28.91949	0.56081629	21.2	11.0586372
2.2	26.85671154	0.34226756	18.2	7.01219098
2.4	30.83771667	0.3272548	15.8	6.90134361
2.6	34.47061364	0.30233032	13.8	6.52089798
2.8	41.92439	0.33581299	12	7.37330264
3	40.926545	0.24310774	10.6	5.41492419

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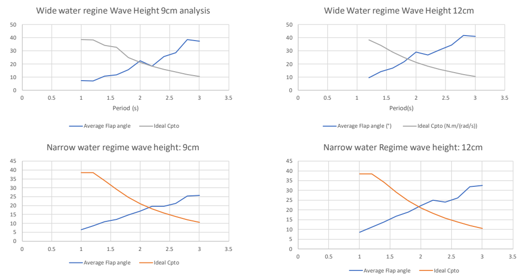
Results



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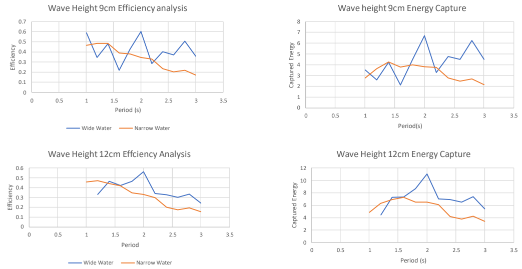
Results



14

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Future Works

- Many other factors to consider
  - Cross sectional shape of flap
  - Water filling for matching wave conditions
  - Scalability
  - Wave overtopping effects
- Effects on marine life and ecosystem

15

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Works Cited

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- http://www.aquaret.com/indexfca4.html
- Energy density of various renewables
- https://drexel.edu/~/media/Files/greatworks/pdf_sum10/WK8_Layton_EnergyDensities.ashx

16

Molecular Dynamics Simulations of Hydrogenated Amorphous Silicon Using Machine Learning Potential

Jacob McKibbin
Advisor: Prof. Ryoji Asahi

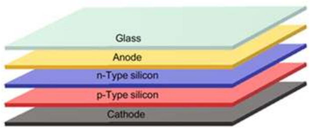
Nagoya university JUACEP

NC STATE UNIVERSITY CBE

1

Broad Motivations - Improving Solar Panel Efficiency

- Solar power is one of the lowest carbon footprint energy sources available to us today, by some measurements it emits 20 times less carbon than fossil fuels
- Solar Power is the fastest electricity source, with around 140 GW being added in 2020, for a total of 760GW globally, or around 3% of global electricity generation
- ... e fight against carbon emissions



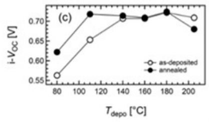
A typical first generation solar panel. First generation panels make up about 90% of all solar panels in use today.

Pavel M. Sokolov et al 2019 Russ. Chem. Rev. 88 370

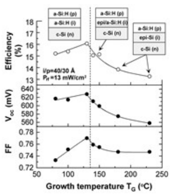
2

Amorphous Silicon Passivation Layer

- A limiting factor of these first generation solar cells are so-called interface recombination sites - a site where an electron is able to lower its energy without completing the circuit
- Thus we introduce a passivation layer - a thin film of hydrogenated, amorphous silicon placed between interfaces, which in turn reduces the number of recombination centers, increasing current



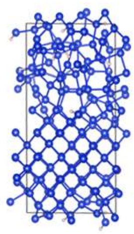
AIP Advances 9, 075115 (2019);



Appl. Phys. Lett. 90, 013503 (2007).

3

Simulation of the c-Si and a-Si:H Interface



c-Si and a-Si:H interface

- In order to better understand this interface, we have simulated at at a variety of temperatures, and hydrogen concentrations
- This is a challenging problem, in order to properly simulate an amorphous medium, a large number of atoms are required
- These calculations are extremely time consuming, so we've implemented a machine learning technique to greatly reduce calculation time

4

First Principles Methods - Density Function Theory (DFT)

- First principles (ab initio) methods are a family of techniques which can predict material properties without experimental input
- An important ab initio tool is DFT, which allows us to analyze the structural, magnetic, and electronic properties of a wide variety of materials
- DFT reformulates the n-body problem of a complex schrodinger equation into an equivalent, more easily soluble form.
- DFT scales as $O(N^3)$ with the number of electrons, which is **very** expensive

5

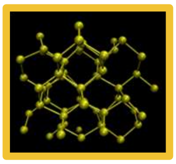
Methods 2 - Machine Learned Force Field (MLFF)

- To alleviate the problems of DFT, we employed a machine learned forcefield to our simulations
- The goal of the MLFF is achieve DFT-accuracy results, while greatly reducing the time required to complete the calculations
- The machine learned force-field employs a gaussian approximation potential (GAP)
- We rely on the MLFF predictions until the GAP determines they will accrue too much error, at which point DFT is performed, to further train the force field
- In a system of 216 atoms, traditional DFT took around 24 hours to advance the trajectory by around 70 fs
- Using the MLFF, in the same time around 70,000 fs, or a speedup on the order of 1000 times faster

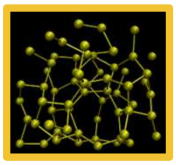
6

First Step: Bulk Models

- To build up to the full interfacial model, we began with bulk crystalline, and bulk amorphous silicon simulations



64 crystalline silicon



64 amorphous silicon

7

Training the Bulk Crystalline Silicon Model

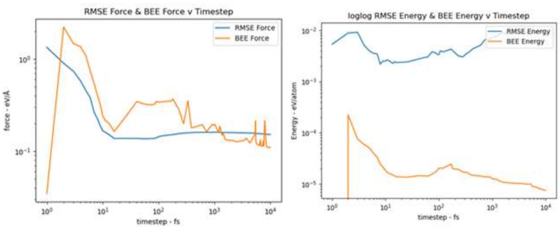
- Performed in the NVT ensemble, using the Nosé-Hoover thermostat
- With such a small system, I was able to simulate the system twice: once using purely *ab initio* methods, and once using the MLFF

Simulation Parameters

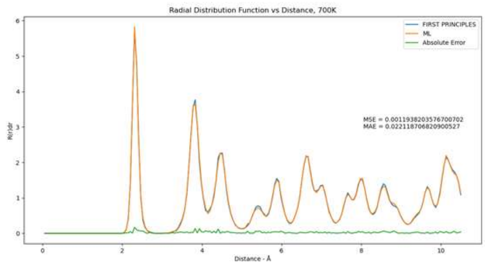
Timestep	1fs
Training Timesteps	160,000 (160ps)
Temperatures	300, 500, 700 K
# Atoms	64 Si

8

Convergence of Force and Energy Errors



9



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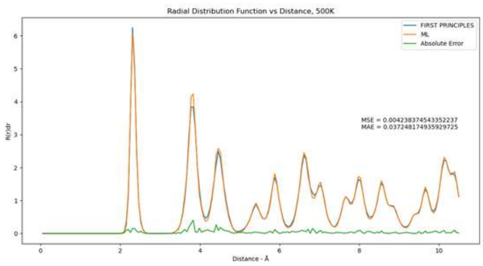

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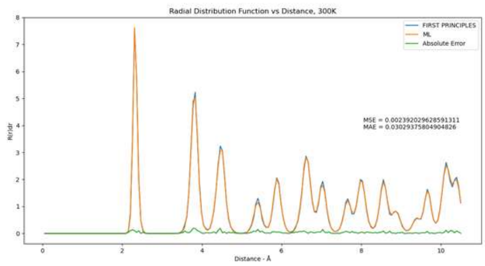


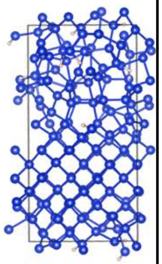
12

Training the Interface Model

- Moved to the a-Si:H, c-Si interface model
- As it is more complex, more FP steps are required
- It was also more difficult to prepare FP trajectories for comparison

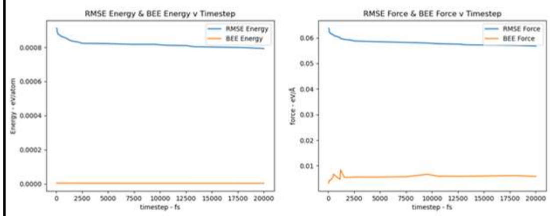
Simulation Parameters

Timestep	2fs
Training Timesteps	100,000 (100ps)
Temperatures	700 K
# Atoms	64 a-Si, 64 c-Si, 8 H (136)



13

Convergence of Errors



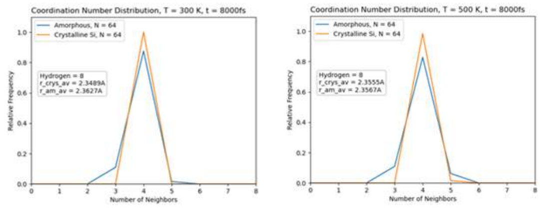
14

Continued Training - Varying Temperature

- We continued training, with the same parameters, varying the temperature to 500K, and then 300K
- Besides, we also paid close attention to hydrogen distributions, and coordination numbers

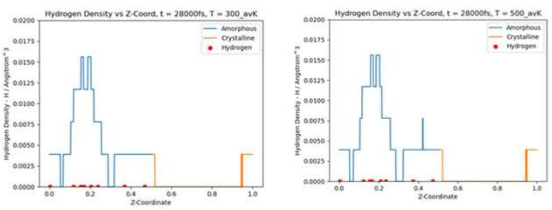
15

Coordination Relative Frequency



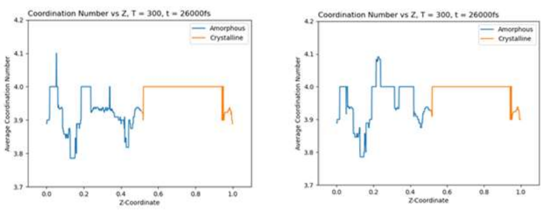
16

Average Hydrogen Density vs Z



17

Average Coordination vs Z



18

'Production Run' Interface at 700K

- Created a large supercell of 192 silicon atoms, with varying numbers of hydrogen
- Prepared an amorphous sample of silicon with 128 total atoms, and a crystalline sample with 64 atoms
- Hydrogen were placed from a uniform distribution throughout the amorphous region
- Unrealistic bond lengths were manually adjusted, and the whole cell was relaxed at 300K before the temperature was increased to 700K
- These runs are 'pure' machine learning, as such these systems can be trained for much longer, and with more atoms than typical methods

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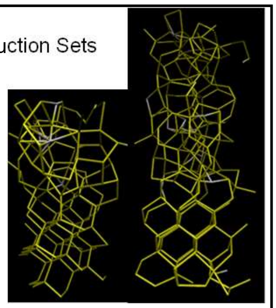
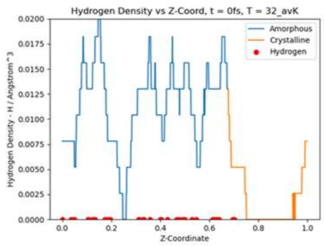
Comparison of Training and Production Sets

- On the left we see the training model
  - 64 c-Si
  - 64 a-Si
  - 8 H
- On the right we have a production set
  - 64 c-Si
  - 128 a-Si
  - 16 Hydrogen
- This set is far too large to be reasonably simulated for large time-scales, so we rely solely on the MLFF



20

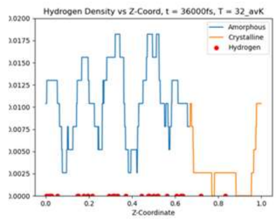
32 Hydrogen Production Run

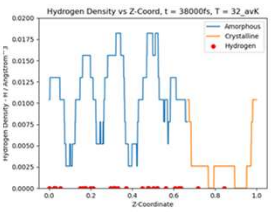


- Initially we see a uniform distribution of hydrogen atoms through the amorphous medium
- However, as time goes on we see a clear bias in distribution, instead of the initial uniform distribution

21

Standing Wave Pattern Among Hydrogen





22

Conclusions

- The machine learning model has greatly reduced calculation time, by around a factor of 1000
- This will allow us to study systems of unprecedented size
- There remains a challenging task ahead of sorting out 1) Is the MLFF producing accurate statistics, 2) Which results are artifacts of our simulation
- In the future we hope to further refine this simulation, and expand to more complex systems, such as one accounting for oxidation due to the annealing process.

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24

NAGOYA UNIVERSITY

NC STATE UNIVERSITY

Performance Characterization of Superconductor Single-Flux Quantum and Half-Flux Quantum Digital Logic

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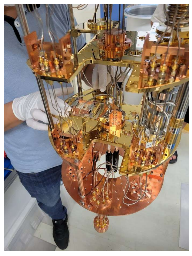
Advisor: Professor Akira Fujimaki, Assistant Professor Masamitsu Tanaka
Nagoya University School of Engineering
Electrical Engineering, Electronics, and Information Engineering

Nagoya university JUACEP

1

Background

Objective: Build a better quantum computer



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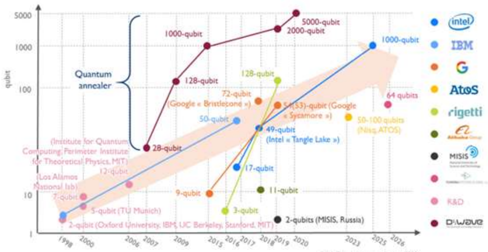
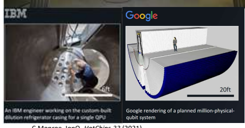
Projected Quantum Roadmap



https://www.i-micronews.com/products/quantum-technologies-2021/

3

Quantum Scaling Challenges



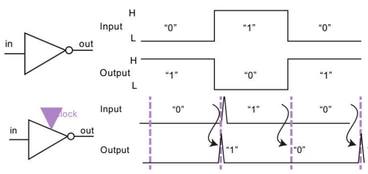
C Monroe, IonQ, *HotChips 33* (2021)

- Quantum computer qubits operate at mK temperatures, close to absolute zero.
- Scaling with classical computers requires more wires, larger refrigerators, and generates more thermal noise
- With classical computations operating inside the refrigerator, or ideally on the same chip as the qubits, quantum computers could scale much more easily

4

Superconductors vs CMOS

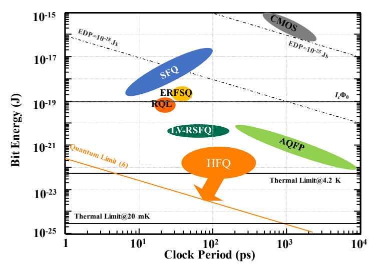
- Lower power, higher frequency
  - 4-5GHz with CMOS vs 60-80+ GHz
  - Pulses are sensitive to thermal noise at lower signal energy levels
- CMOS does not work well, or at all, at cryogenic temperatures
  - Superconductors do



Tanaka M, *SIMIT-NU Joint Workshop* (2018)

5

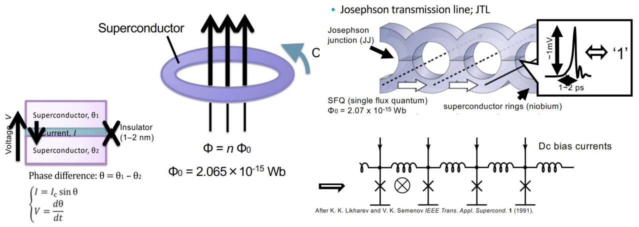
Device Power and Delay Comparisons



Li Feng et. al, *International Symposium on Superconductivity,* ISS34 (2021)

6

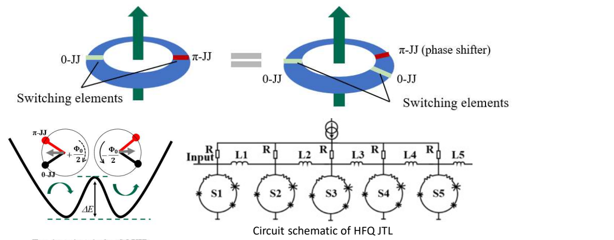
Single-Flux Quantum (SFQ)



Tanaka M, *SIMIT-NU Joint Workshop* (2018)

7

0-π junction – Half-Flux Quantum (HFQ SQUID)



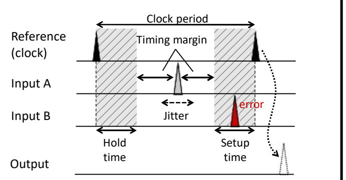
- Pi-zero junction allows for lower nominal critical current with the same junction sizes, which potentiates lower power consumption

Li Feng et. al, *International Symposium on Superconductivity* (ISS2021)

8

Research Motivation

- What is Jitter?
- Why is this important?
- HFQ vs SFQ jitter

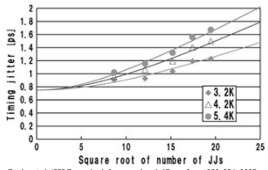


$$\langle I_n \rangle = \sqrt{\frac{4k_B T B}{R_s}}$$

k_B: Boltzmann constant
T: temperature
B: band width

σ = 0.065 ps/√JJ @ 4.2K (2.5 kA/cm² process)

Tanaka M et al., ACASC/Asian-ICMC/CSSJ Joint Conference (2020)



Terabe et al, *IEEE Trans. Appl. Supercond.*, vol. 17, no. 2, pp. 552–554, 2007.

9

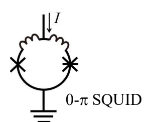
Circuit Timing Simulation Methodology

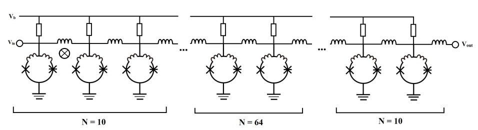
- Using JoSIM simulation tool, generate netlists to simulate 3 consecutive phase-switching input pulses in a Josephson Transmission Line (JTL)
- Use equivalent parameters for fabrication process, critical current, bias current, loop inductance, operating parameters, and circuit schematics between HFQ and SFQ JTLs
- Record switch timing delays between transitions
- Demonstrate correlation between standard deviation (σ), length of transmission line, and temperature

10

HFQ JTL Circuit Parameters

Parameter	Value
$I_{c,nominal}$	~13 µA
Loop Inductance	40 pH
SQUID Inductance L_1, L_2	1.75 pH
Bias Voltage	1 mV
Bias Resistor	95 Ω
0-junction, π-junction I_c	50 µA
Temperature	4.2 K



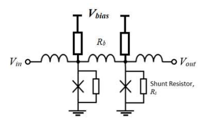


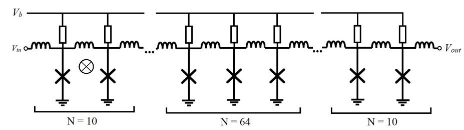
HFQ Josephson Transmission Line (JTL) circuit schematic

11

SFQ JTL Circuit Parameters

Parameter	Value
I_c	13 µA
0-junction area	0.13 µm²
Loop Inductance	80 pH
Bias Voltage	1 mV
Bias Resistor	108 Ω
Shunt Resistor	59 Ω
Temperature	4.2 K

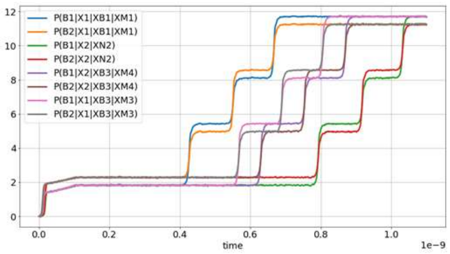




SFQ Josephson Transmission Line (JTL) circuit schematic

12

HFQ Device Output Waveforms



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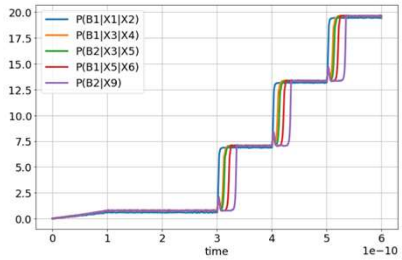
SFQ Device Output Waveforms



14

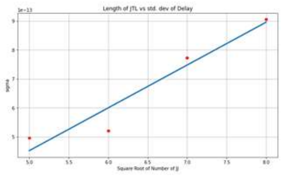
Timing Results

SFQ JTL	Mean delay time (μ)	Standard Deviation	Normalized std. dev. (σ)
N=64 JJ	29.54 ps	905.08 fs	113.14 fs
N=49 JJ	17.25 ps	773.25 fs	110.47 fs
N=36 JJ	9.524 ps	520.76 fs	86.792 fs
N=25 JJ	6.951 ps	497.03 fs	99.406 fs

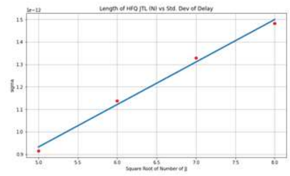
HFQ JTL	Mean delay time (μ)	Standard Deviation	Normalized st.d dev. (σ)
N=64 JJ	367.98 ps	1.481 ps	185.16 fs
N=49 JJ	280.41 ps	1.329 ps	189.82 fs
N=36 JJ	204.46 ps	1.137 ps	189.46 fs
N=25 JJ	140.16 ps	0.915 ps	183.04 fs

15

Plotted Timing Results



SFQ sqrt(N) vs σ



HFQ sqrt(N) vs σ

16

Concluding Statements and Final Analysis

- Learned and explored device physics and design flow of SFQ and HFQ based logic, and it's potential applications to quantum computing
- Successfully designed a framework for timing analysis of HFQ with comparison to a reference equivalent SFQ circuit at a given temperature
- Results demonstrate a first order relationship between circuit depth and jitter

17

Acknowledgements

- Many thanks to the JUACEP program for the opportunity and support to make this exchange possible
- Thank you to the faculty, students, and staff of the Fujimaki Lab for welcoming, supporting, and teaching me in this experience.

18

Reconstructing Lost Buildings from Historical Imagery

Dávid Komorowicz
@dawars00

Supervisor: Prof. Toshiaki Fujii

1

Dataset

- Hungarian National Theater
  - Demolished in 1965
  - ~350 photos remaining

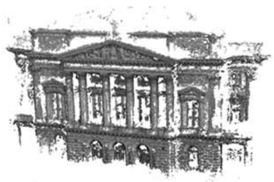
2

Motivation

Source: https://3dwarehouse.sketchup.com/model/456438acf00cb5ad6c4e174b0cf70299/FORUM-ROMANUM

3

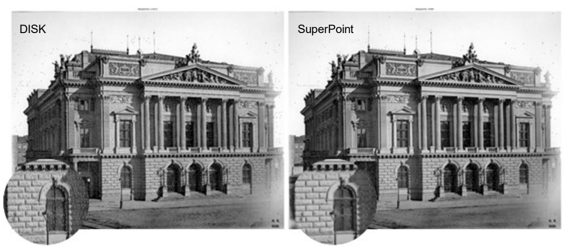
Dense Point Cloud using Colmap [1]



https://sketchfab.com/3d-m ... 68b3bd2f2f8bbec233

4

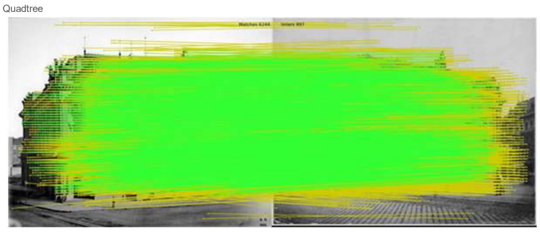
Keypoints



5

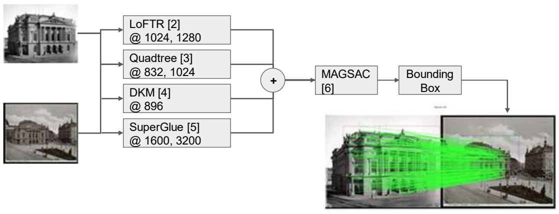
Featureless Matching

Quadtree



6

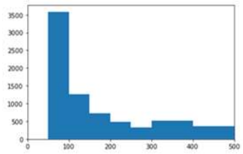
Ensemble Matching



7

Evaluation

8788 matching pairs out of 58996



Histogram of number of matches between image pairs

8

Dense Rematching via SuperPoint

- Dense vector field
- Uncertainty

9

Keypoint Rematching via SuperPoint

- Match BB crops via DKM (same scale
- Sample vector field at SuperPoints
- (Optional) Cycle consistency

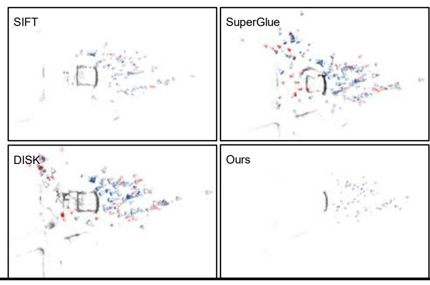
10

Quantitative Results

Model name	Registered images ↑	3D points ↑	Mean track length ↑	Mean reprojection error ↓
Colmap SIFT*	119	37872	3.29	1.12
DISK	191	**57139**	3.48	1.35
SuperGlue	**198**	29816	**3.67**	1.31
Ours	68	23783	2.99	**1.02**

11

Reconstructions



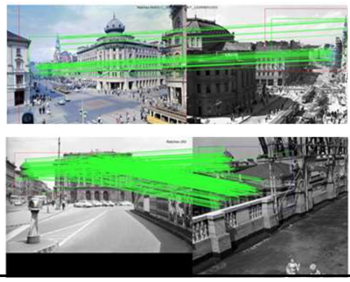
12

Dense Point Cloud

Old

13

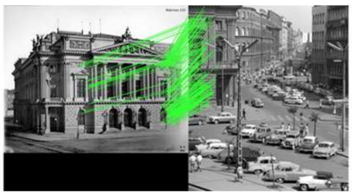
Cherry-picked Results



14

Failure Cases

Symmetry, large viewpoint change



15

Conclusion

- Ensemble matching is successful
- Keypoint Rematching achieves high accuracy
- Defeats the advantages of the ensemble

16

Future Work

- Non-maximum suppression when combining matches
- Find closest SuperPoint pair for all matches
- Evaluate COTR [7]

17

References

[1] https://github.com/colmap/colmap

[2] https://arxiv.org/abs/2104.00680

[3] https://arxiv.org/abs/2201.02767

[4] https://arxiv.org/abs/2202.00667

[5] https://arxiv.org/pdf/1911.11763v2

[6] https://openaccess.thecvf.com/content_CVPR_2019/html/Barath_MAGSAC_Marginalizing_Sample_Consensus_CVPR_2019_paper.html

[7] https://arxiv.org/abs/2103.14167

Images are from Fortepan, Metropolitan Ervin Szabo Library, MTVA Archive

18

Investigation of the effect of arrangement of multiple jets by computational fluid dynamics

Diksan Muhammad

Supervisor:

Prof. Yasumasa Ito

1

1

UNDISCLOSED

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<3> Classes and Events

3-1 JUACEP Summer Program 2022 Orientation Session

Friday, June 17, 2022

10:00 **Reception at ES Conference Room**

Check-in. Distribution of the student ID card and Handbook.

Confirmation of the documents

Payment of the admission fee, tuition, campus insurance and Japanese textbook.

10:30 **Orientation at ES Conference Room**

Welcome addresses from Prof. Ju, JUACEP Leader.

Introduction of Faculty, Staff and the Participants.

A) Schedule
B) Campus map
C) Japanese language class
D) Hands-on exercise
E) Excursion
F) Meet-up for JUACEP Students
G) JUACEP Seminar
H) Workshop
I) Reports and evaluation
J) Life information

a) Nagoya University ID and Campus WiFi
b) University's security department warning
c) Medical and health care: Medical services, Health precautions
d) Daily life: Dormitory, Refuse disposal, Public transportations, Accidents, Compliance of low, etc.

11:40 **Introduction of the Lab Mentors and TAs**

11:55 **Photo shooting**

12:00 **Welcome lunch at Chez Jiroud**

12:50 **Scholarship paperwork at JUACEP Office, 3F Room341, EB-2N**

13:00 Settlement at each laboratory

3-2 JUACEP Summer Program 2022 Japanese Course Syllabus

Course name	Japanese Language
Teaching staff	Ms. YASUI Sumie
Course period	June 20 - July 26, 2022
Weekly timetable	Monday 9:30 -12:00 Thursday 9:30 -12:00
Classroom	Engineering Building 3, Minami (EB-3S in the map) 5F Rm.572
Textbook	“GENKI An Integrated Course in Elementary Japanese” I (The Japan Times) This textbook is a comprehensive approach to developing the four basic language skills (listening, speaking, reading and writing) in order to cultivate overall Japanese-language ability. *Some teaching material will be given in class.
Course contents	**Course outline** The purpose of this course is to introduce the most essential Japanese words and expressions for everyday life. Students will learn writing system (Hiragana & Katakana), the basic grammar, expressions of Japanese. **Classroom activities** Basic communication skills required in everyday life will be taught by introducing new vocabulary, new grammar, and practicing listening, conversation and role-playings. **Homework and Quiz** You are expected to submit your homework by the deadline. Quizzes will be given every day in class. 1. Hiragana 2. Katakana 3. Dictation 4. Conjugation
Evaluation	1. Homework 20% 2. Quizzes 30% 3. Oral exam. 50% 100% More than 80% attendance is required. You will be officially awarded 1 credit of Nagoya University. A^+=100-95 A =94-80 B =79-70 C =69-65 C^-=64-60 F (fail) =59-0

Course schedule	1. 6/20(Mon) Greeting Expressions, Hiragana 1 Introducing yourself, Noun sentences 1, Occupation, Nationality, Age, Numbers 1-100 2. 6/23(Thr) Classroom expressions, Hiragana 2 Shopping, Noun sentences 2, Price, Numbers 101-1,000,000 3. 6/27(Mon) Hiragana 3 Describing where things are, Locations Placing an order at a restaurant 4. 6/30(Thr) Hiragana 4 Talking about your daily life Verbal sentences 1, Time reference, Adverbs 5. 7/4(Mon) Hiragana 5 Invitations, Suggestions, Desires Verbal sentences 2, Days/Weeks/Months/Years, Counting 6. 7/7(Thr) Katakana 1 Talking about your family Adjectives, Likes or Dislikes, Degree expressions, Family terms 7. 7/11(Mon) Katakana 2 Talking about your week-end, Past tense, Time words 8. 7/14(Thr) Katakana 3 Making a request (Verb-Te-form), Progressive actions, Describing your status 9. 7/21(Thr) Asking permission, Prohibition, Negative request Describing two things Talking about your interests Plain form 10. 7/25(Mon) The Final Examination (speaking)

3-3 Meet-up for JUACEP Participants and NU students

3-4

JUACEP Hands-on Workshop

"Disassembly and Assembly of Internal Combustion Engine"

July 8th, 2022

Date: 13:00 – 16:30, July 8th, 2022

Place: Creation Plaza, 10th floor of IB-North

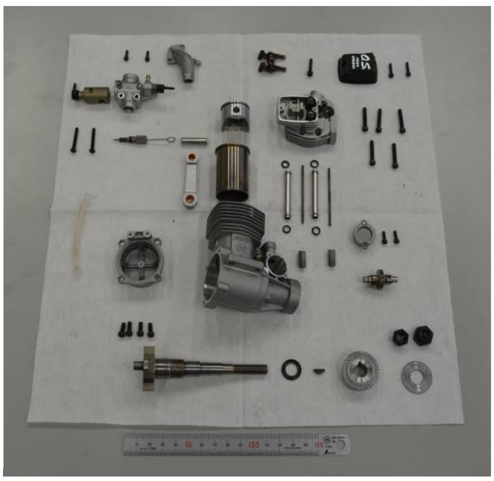
Staff: Prof. Tsuyoshi Inoue, Director of Creation Plaza

Technical staff… Nakakimura, Goto, Saito, Isogai, Adachi and Yamamoto

TA… Kenjiro Oba, Takayuki Senba, Teito Uemura, Muyang Wang, Kei Suzuki

Contents:

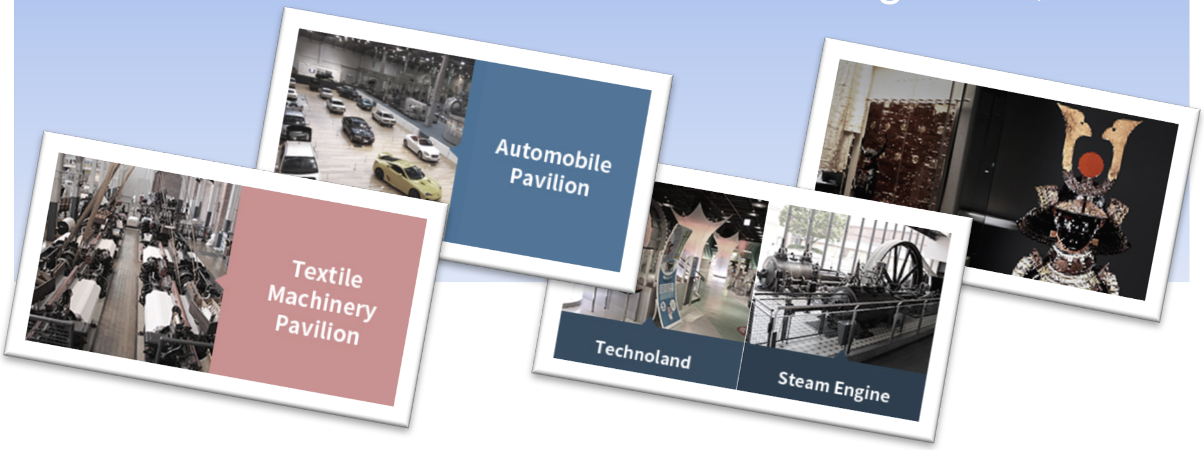
1. Opening remarks
2. Introduction to the basis of the Internal Combustion Engine and other engines (History, Characteristics, Operation principle, Demonstration of engines)
3. Disassembling → Assembling → Adjustment
4. Performance test
5. Jet engine demonstration
6. Discussion, questionnaire



3-5

JUACEP Excursion

August 4th, 2022



Date: Thursday, August 4th, 2022

Fee: 2,000 yen

Schedule:

Time	Visiting spots	Transportation
9:00	Meeting at Toyoda Auditorium	
9:10	Departure from Nagoya University	Hired bus
10:00	Aichi Museum of Flight https://aichi-mof.com/	
11:00	Leaving Aichi Museum of Flight	Hired bus
11:30	Inuyama Castle, nearby attractions & lunch https://inuyamajo.jp/	
13:00	Leaving Inuyama Castle	Hired bus
14:00	Toyota Commemorative Museum of Industry and Technology https://www.tcmit.org/english/	
16:00	Leaving the museum	5 mins. on foot
16:10	Noritake Garden https://www.noritake.co.jp/eng/mori/	
17:00	Dinner at Noritake Garden	
19:30	Adjournment	Subway

*Schedule above is tentative and may be changed.
*Wear sports shoes for safety of the tour.

<4> Participation Essays and Questionnaires

4-1 Finding through JUACEP

A Reflection on my Internship Experience with JUACEP

Name: George Li
Affiliation: Electrical and Computer Engineering, NCSU
Participated program: JUACEP Summer 2022

Research theme: Superconducting Quantum Logic Circuits
Advisor at Nagoya Univ: Prof. Akira Fujimaki
Affiliation: Electrical and Electronics Engineering, Graduate School of Engineering

The JUACEP program experience was one that I would recommend to anyone interested in and willing to conduct research work in any capacity, regardless of one's curiosity towards cultural exchange or travel. The compelling amount of knowledge I gained and relevance of the work I was pursued during my internship was a truly fantastic – it proves to be useful in my continuing studies and research work each day. The cutting-edge research topics I was exposed to and valuable connections I made will be treasured for the rest of my career.

With the professional aspects of relevance covered, however, there was so much more to the time spent I will cherish, which were directly enabled by the JUACEP internship. From even before arriving in Japan, making pre-departure accommodations and paperwork, the international office staff worked tirelessly through hurdle after hurdle to make sure our arrivals were guaranteed and painless. Due to pandemic restrictions, this commendable feat was rewarded with a successful program. After arriving in Japan, the dormitory staff, JUACEP staff, and my research lab faculty and lab mates were all welcoming and genuinely helpful in more ways than I could possibly ask for. They, along with my fellow cohort of international exchange students, helped me feel secure and confident enough to explore things I wanted while feeling connected to a larger community. Collaborating with a foreign laboratory and research advisor, discussing technical details and topics, and being integrated into a research team in a foreign country were genuinely eye-opening experiences. I have gained many new perspectives on research environments and workflows which could not be learned any other way. Taking the subway to the lab every day and eating lunch in the cafeteria, simple moments of the mundane, are things that have left a strong imprint on my memories.

There is so much more to my time which I could share about, but there is one fundamental message to it all: I had a wonderful time during my internship. This was made possible through the support of the JUACEP program and all the faculty and staff who helped. I was able to learn and work to further my career, form new networks, connections and friendships, travel to beautiful destinations, eat delicious food, gain novel perspectives and communication skills, and enjoy an unforgettable summer abroad experience in Japan.

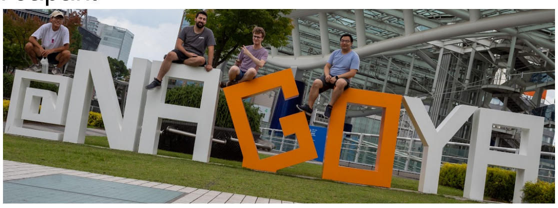


Photo time with fellow JUACEP exchange students

Sunrise view from Mount Fuji. You can see Lake Yamanakako, Lake Kawaguchiko, and Kanagawa.

Findings Through JUACEP

Name: Jacob McKibbin
Affiliation: Department of Chemical Engineering, NCSU
Participated Program: JUACEP Summer 2022

Research Theme: Molecular dynamics simulations using machine learning potential
Advisor at Nagoya University: Prof. Ryoji Asahi
Affiliation: Graduate School of Engineering

I'm confident that participating in JUACEP is one of the best decisions I've ever made. I've been fascinated with Japan all my life, and always interested in spending an extended period of time living there. As an undergraduate I had been accepted into a semester-long study abroad program in Japan, but it was canceled due to Covid-19. After finishing my degree and beginning graduate school, it was difficult to imagine I would be able to live in Japan in a similar capacity. JUACEP really made my dream possible. I gained valuable research experience, and was able to immerse myself in Japanese culture.

Working Prof. Asahi and my labmates, we trained a machine learning forcefield for silicon and hydrogen. We applied this machine-learned potential to a crystalline - hydrogenated amorphous silicon interface. This is a challenging problem, long simulation times and a large number of atoms are needed to get accurate statistics from the simulation. A large number of atoms leads to excessive calculation times under normal conditions. The machine-learned potential can solve this problem, and we were able to achieve over 1000-times faster simulations. Of course, much work remains to be done, and I'm happy to say I am going to continue to collaborate with the Asahi lab remotely, and we will work towards writing a publication. I was very happy to be given the opportunity to work with machine learning methods, and I think this experience will be very valuable moving forward in future projects. I was also given the opportunity to take a five week Japanese course. I had studied Japanese on my own, but nothing could compare to the opportunity to speak often, and freely with native speakers. I will continue studying Japanese at NC state.

While my research was extremely engaging, I also found time to explore Japan. In my time there, I summited three major mountains, and narrowly avoided summiting Mt. Fuji due to inclement weather. Japan's incredible public transport system made it all very convenient. My lack of a driver's license didn't set me back. I visited Tokyo, Osaka, and Sapporo as well. All of the cities I went to had a unique feel to them, and two activities I particularly enjoyed were their unique food cultures, and visiting shrines and temples. It would be impossible to summarize everything here, but everything exceeded my wildest expectations.

Finally I made lifelong friends from all over the world, and valuable connections which I'm sure will influence my career for the better. As I said before, I will continue to work with the Asahi lab to publish a paper, which I hope will be the first of many fruitful collaborations.

Exploring Japan through JUACEP

Name: David Komorowicz
Affiliation at home country: Department of Informatics, Technische Universitaet Munich
Participated program: Summer Course 2022

Research theme: Reconstructing Lost Building from Historical Imagery
Advisor at Nagoya Univ: Prof. Toshiaki Fujii
Affiliation at Nagoya Univ.: Department of Information and Communication Engineering

The JUACEP program allowed me to contact my own research which wasn't possible at my home university. I was able to finish a large portion of my project and I got valuable feedback. It helped me get a better idea for my future career direction.

I experienced everyday life in Japan as opposed to a short tourist trip. I was able to explore the country side surrounding Nagoya on bike: Toyota, Tokoname and Tajimi. I took lots of photos of the beautiful nature and learned about regional specialties.

I joined the art club to practice drawing and get to know Japanese students. We went on a BBQ trip to Gifu which was a lot of fun.



An important goal for me was to learn playing the koto (琴), a traditional Japanese music instrument. During my three months of learning I got to a level that I was able to perform at a concert at the end. https://www.youtube.com/watch?v=flUMvnp_HUA

Findings through JUACEP

Name: Diksan Muhammad
Affiliation at home country: Aerospace Engineering, Bandung Institute of Technology
Participated program: Summer Course 2022

Research theme: Investigation of the effect of arrangement of multiple jets by computational fluid dynamics
Advisor at Nagoya Univ: Prof. Yasumasa Ito
Affiliation at Nagoya Univ.: Statistical Fluid Engineering

Studying in Japan is always one of my goals. Fortunately, I had given an opportunity to do research in Japan in Summer 2022 by participating NUPACE. Initially, I got accepted to NUPACE program only without any scholarship but thanks to my advisor, Prof. Yasumasa Ito, to give me the information about JUACEP.

This was a great experience for me to live aboard even though it was only for a short period time. I have been interested in Japanese work culture for a very long time because at some point I want to work for Japanese company. I slightly got insight about work culture from my lab mates and based how I felt when I was doing my research. Doing research in Japan was very rough for me. It was not because the research topic I chose, but because I also had to do my thesis research for graduation from my home university. The research I was doing was quite interesting. I am familiar with the topic, but the tools are new. This research is also helpful for me because I also got so many insights for my thesis.

First time I came to Japan, I was shocked especially for the food. Since, I am a Muslim, I found it difficult to find halal food especially in Nagoya. But my friend who already lived in Japan to work was always helping me to show me which store is selling halal food. Because of that, I always made my own food with halal ingredient. Apparently, he is one of my close friends from my home university, so I did not hesitate to ask any help from him.

I like the subway system in Nagoya because in Indonesia especially in my city we do not have that. It is easy (for me at least) to go anywhere. I happened to be in Japan at the right time since most of Matsuri I like to travel by walk and train and find any interesting place by myself. Apparently, I did not have time much to travel but I only took a short trip to Kyoto and Osaka before I am leaving Japan. It was a unique experience, being a foreigner in Japan with only a little knowledge about Japanese language and travelling quite far all by myself.

I almost forgot about the excursion. We went to Inuyama Castle, Aichi Museum of Flight, and Toyota Commemorative Museum. Honestly, I am not the type who like historical places (I prefer going to park, forest, mountain, etc.) but at least since we visited the Museum of Flight, I was slightly enjoying the tour. But overall, it is nice to know that how the Nagoya before was, the aerospace history in Japan, and how Toyota company was.

In the and, I would like to thank you to all JUACEP committee not only to provide me a scholarship (of course) but also providing me with a very great experience in its research program, field trip, the workshop, etc.

Name: Hiromu Koyama
Affiliation at home country: Department of Civil, Construction and Environmental Engineering, NCSU
Participated program: Summer Course 2022

Research theme: Energy Capture of Waves
Advisor at Nagoya Univ: Prof. Tomoaki Nakamura
Affiliation at Nagoya Univ.: Department of Civil and Environmental Engineering

Although saying goodbye to the friends I made in Japan was difficult, I am extremely grateful I was able to participate in this program. I am a child of two fully Japanese parents, but I moved to America when I was just two years old. This left me grappling with a complex cultural identity for most of my life, one where I was told to be Japanese at home but was expected to act American everywhere else. Over time, it felt as though my Japanese identity was being eroded away by all the time I spent in America. If I were to decide that I were purely American, that I was only interested in living in America and studying here, surely no one could have blamed me. However, I couldn't seem to give up my Japanese identity. I watched anime and listened to Japanese music. I found myself wishing my Japanese was better. Then I had the opportunity to live in Japan for two months while forwarding my career in academia. Living in Japan made me more comfortable with the idea of being Japanese. Being Japanese wasn't some mythical thing that was impossible to achieve, it was something I was already capable of. I could talk with workers, order food, and make friends in Japan. By any metric, the me living in Japan was Japanese. It was a great realization, to realize that I am equally valid as an American and a Japanese person.

The exposure to academia in Japan was a great addition also. Not only was the research engaging and great for my career; it taught me a lot about how academia works in Japan. What the culture is like, how the system differs from America, and what the graduate students are like. It has increased my interest in attending graduate school in Japan.

Of course, traveling in a new country was amazing too! Here are some of my favorite photos from all the various destinations I was able to visit during my short stay here.

4-2 Questionnaires

For Q1-4, we asked the same questions BEFORE and AFTER the program.

Q.1: Are you interested in studying at a Japanese university for PhD?

Q.2: Are you interested in working at a Japanese company in USA?

Q.3: Are you interested in working at a Japanese company in Japan?

Q.4: Are you interested in working at a non-Japanese company in Japan?

Q.5: Which activity did you like? ('Research internship', 'Field trip', 'Engine assembly', 'Japanese course', others)

All students answered they liked every activity they participated.

Q.6: In what did you find difficulty? What could be improved? (Excerpts)

- I personally found some difficulty in sharing more of my own ongoing research at my home university with my visiting research group, simply because our lab had a relatively rigid and pre-scheduled system in place for student updates/seminars, so timing did not work out. I honestly have no complaints or comments for how the program could be improved, because on behalf of JUACEP I don't have any critiques for any of their responsibilities and how they conducted them.

- I very much enjoyed the program. I think any more activities, and it would have drawn me away from my research. Maybe another field trip could have been fun, as I truly enjoyed Inuyama and the Toyota Museum, but overall I was extremely satisfied with the program.

- I found it difficult to interact with my lab mates because of the language barrier but my advisor was very kind and helpful.

- I do not find any difficulty/dislikes at all.

- A difficult aspect of the program for me was the social aspect. I think I am naturally an outgoing guy, unafraid to talk to strangers and joke around. Because I am familiar with the language, I was excited to make Japanese friends that I have never had the opportunity to make. However, I quickly realized that even for me, a child of two Japanese parents who has visited Japan before, the cultural gap was steeper than I had thought. I was comfortable with casual Japanese but I quickly realized the limits of my vocabulary as I paused during conversation to search for a word that had not just the right meaning but also the right connotation and nuance. On top of this, I was utterly uninformed on Japanese slang that the lab mates used, leaving me confused on more than one occasion. Eventually, this barrier was overcome as I spent more time with the lab mates, going on excursions with them on the weekends and talking to them more. This led me to the most difficult aspect of the program: saying goodbye after a short two months. It felt like I had just started to get to know the lab mates and get friendly with them, but I was forced to go back halfway across the world where I was likely to never see the most of them again. This was also true for the non-Japanese friends I made during this program. The cool Italian guy I met because he lived in the same dorm floor as me and the group of German people who happened to be doing a similar program at the same time. Although our time was short, it doesn't invalidate the great memories I made with them all and how this experience impacted my life.

Q.7: Write comments freely.

- This program has left a lasting impression on a glimpse of what research and laboratory life in Japan could feel like. It would be interesting if a of corporate or professional ambassador could reflect or share on ways to relocate to Japan as either a researcher or for a corporate job. JUACEP acting as an international liaison to US universities and inviting participant professors from foreign universities to talk and exchange more in the future could also be very valuable and increase their reach. I know that this has been done in the past and the pandemic has disrupted it, but this could be an incredibly useful tool to add to the program capacities.

- I had an amazing time in Japan, and I wouldn't trade the experience I had for anything. I truly think it changed me for the better, I'm a more outgoing, and confident person now. Initially I was very reluctant to speak Japanese, and I would get all my meals from the convenience store because I was embarrassed when I would get confused by a native speaker, or when I was unable to find the words I needed. I've learned much better how to think on my feet, and communicate in different ways, and work with my limited vocabulary, and I quickly got over my embarrassment, so for that I'm extremely grateful. I had some really amazing experiences in Japan, I think it's the best thing I've ever done.

<5> Appendices

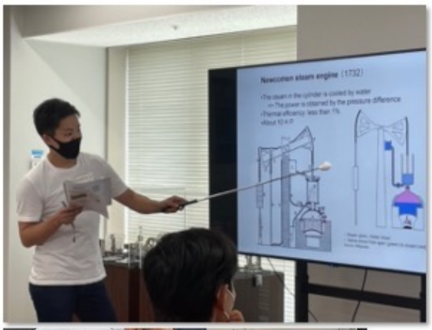
5-1 Photo Collection

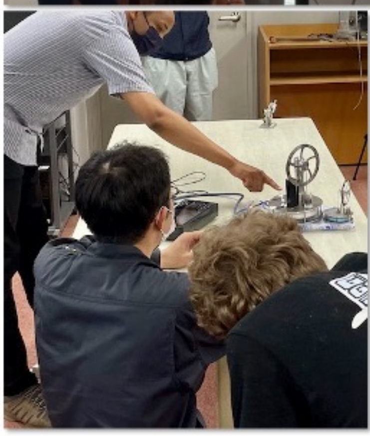
Orientation （June 17）

Japanese Language course

Meet-up（July 1）

Hand-on Workshop at Creation Plaza (July 8)

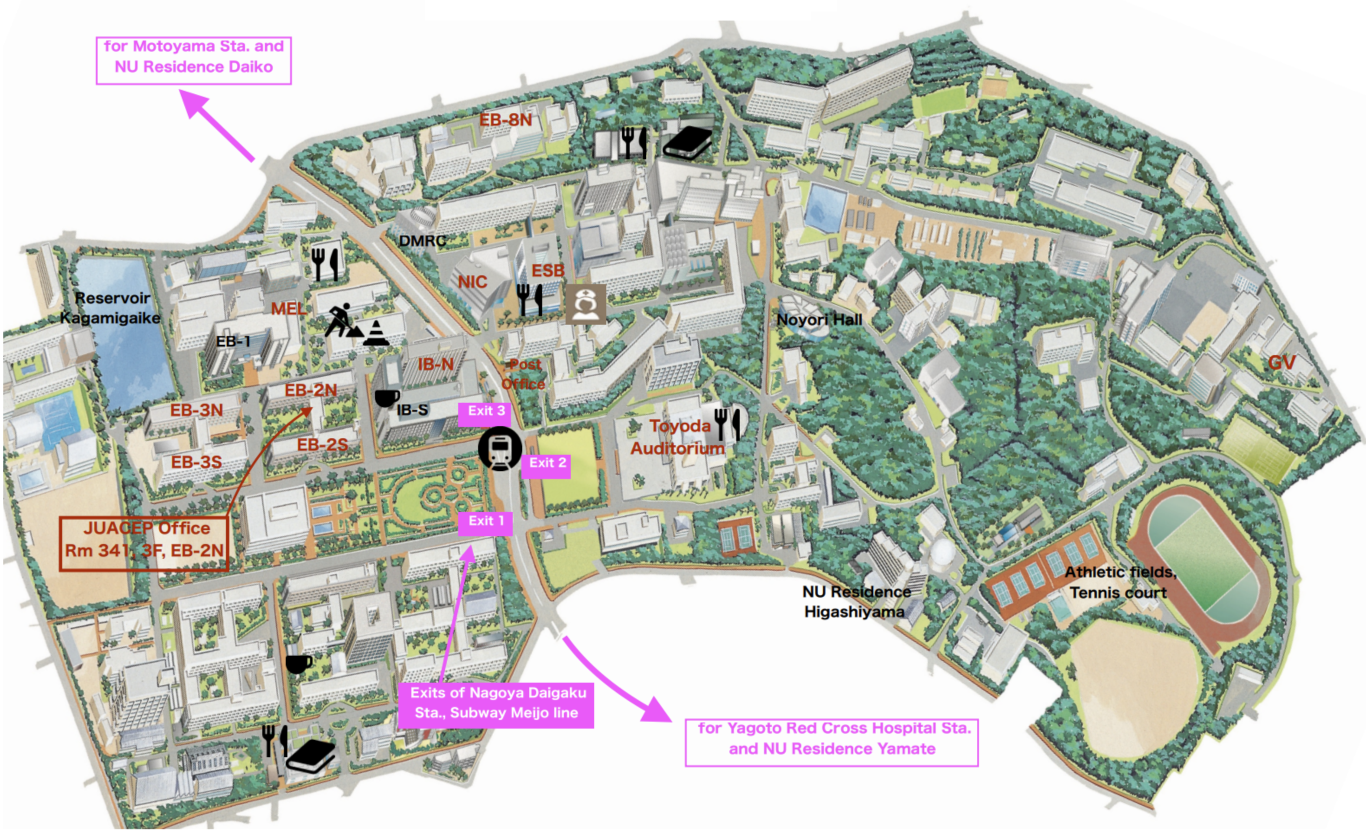




Field Trip（August 4）

The 27th JUACEP Workshop (August 26)

5-2 Building Locations



Bldg. icon on the map	Building name (in Japanese)	Important places for JUACEP	Lab locations for JUACEP students
EB-2N	Engineering Building 2 North (Kougakubu ni-gou-kan, Kita)	JUACEP Office, Room 341, 3F for Stipend on July 6 & Aug. 5 Round-table discussion on June 24 at Room 347, 3F	
EB-3N	Engineering Building 3 North (Kougakubu san-gou-kan, Kita)		Fujimaki Lab, 3F for George
EB-3S	Engineering Building 3 South (Kougakubu san-gou-kan, Minami)	Japanese class at Room 572, 5F	
EB-8N	Engineering Building 8 North (Kougakubu hachi-gou-kan, Kita)		Nakamura Lab, 4F for Hiromu
MAL	Mechanical Engineering Lab. (Kikai jikkentou)		Ito Lab, 2F for Diksan
ESB	Engineering & Science Building (E-S kan)	Orientation of June 17 at ES Meeting Room, 1F	
NIC	National Innovation Complex (Nic)	27th Workshop, Aug. 19 at Idea Stoa, 1F	
IB-N	Integrated Building North (IB Kita-kan)	Hands-on Execises, July 7&13, Creation Plaza, 10F	Fujii Lab, 8F for David
GV	Green Vehicle		Asahi Lab, for Jacob
Toyoda Auditorium	(Toyoda koudou)	Meeting point for the Field Trip, Aug. 4, 9:00am	
Post Office		Money change, Money withdrawal, Postal affairs	
	Cafeteria/Convenience Shop		
	Café		
	Book Store		
	Subway Station	Nagoya Univ.: Nagoya Daigaku Sta. Dormitory Daiko: Sunadabashi Sta.	
	Health Administration Office	Open hours: 9:00-12:00, 13:00-17:00, Mon.-Fri. (052)789-3970	

5-3 Mandatory Deliverables

★ All of following templates can be downloadable at
https://www.juacep.engg.nagoya-u.ac.jp/downloads/index.html

1. JUACEP Independent research report
See *Appendix-1.*
Deadline: **August 26, 2022**
Send to… office@juacep.engg.nagoya-u.ac.jp

2. JUACEP Research presentation slides
We will collect your PowerPoint/PDF slides at the workshop site on **August 19, 2022**. Also, we would appreciate you sending us a backup copy beforehand.

Evaluation: your final score is calculated by the points of the research report (1~50pts.) and the presentation at the workshop (1~50pts.) evaluated by your Nagoya Supervisor.

A^+=100-95
A =94-80
B =79-70
C =69-65
C^-=64-60
F(fail)=59-0

You will be officially awarded credits from Nagoya University and the transcript to be airmailed to your home university in September 2022.

Important:
(a) JUACEP will publish the participants' research reports and the presentation slides in the website and booklet. Please let us know if your supervisor permits the publication by August 26.
(b) If you are planning to transfer the credits, kindly discuss it with your home university office and submit the transcript to JUACEP Office.

3. Findings through JUACEP
See *Appendix-2.*
Deadline: **August 26, 2022**
Send to… office@juacep.engg.nagoya-u.ac.jp
Please write freely about your experience in Japan inserting pictures.

4. JASSO Scholarship obligatory questionnaires, H-1
See *Appendix-3.* There are "Pre-arrival" part which you already submitted and "After the program" part which you have to submit until **August 26, 2022.**
Send to… office@juacep.engg.nagoya-u.ac.jp

5-4 Campus Life Information

[Housing]

International Residence Daiko (on Daiko campus)

Address: 1-1-18, Daiko Minami, Higashi-ku, Nagoya 461-0047, Japan
Office Phone: (052)737-8470
Resident Assistant office: rm. 228
WiFi is available.
Please follow the residential guidelines.

[NU ID & information security]

Student ID Card

A student ID card is issued. You can use the university libraries with it. The card lets you get student discounts at museums, theatres and so on. This card is delivered at the orientation.

Internet on Campus

Wireless Internet connection (NUWNET) is available on campus as far as your Nagoya University ID is valid. To connect, at the beginning you have to access to 'Information and Communications Headquarters' <*https://ist.nagoya-u.ac.jp/portal* > using your ID and a default password that are shown in a sealed card delivered at the orientation, then take the online "Information Security Training" and "Information Security Check". To pass the check, you must score at least 80% or repeat the test until you clear 80%. Please do all of required steps described in the web like changing password, otherwise acquired wireless connection will be expired in a week.
See: *https://ist.nagoya-u.ac.jp/*

University Security Department Warning

Copyright infringement using P2P software is prohibited. University has been strongly warning to all of faculty, staff and students not to use P2P software like Gntella, Share, Winny, WinMX, Xunlei, and so on. It can be easily detected and reflects discredit on University and oneself who used it.
Please never use P2P in University, nor PC in which P2P is installed accessing to University network. You will be detected and warned.

[Everyday Life]

Refuse Disposal at Nagoya University

A sorting system for refuse disposal is used at Nagoya University. There are trash bins for "combustible refuse", "incombustible refuse", and recycle bins for "empty bottles", "empty cans", and "PET bottles" all over campus. Recycle companies collect papers and magazines. Used paper products such as used copy paper are collected and recycled. Students are kindly requested to be mindful when they throw away their rubbish and to use the correct bins to help waste reduction and the reuse of recyclable materials.
Also please follow the manners ruled in each laboratory.

Public Transportation of Nagoya City

(1) MANACA マナカ is a pre-paid IC card that can be used for subway/ city bus/ most of train companies through Japan. It is also used at many shops, vending machines, restaurants, and so on.

(2) The Student/Commuter Railway Pass allows you to take unlimited rides between stations on the specified route. (Only the person registered on the card may use this pass.)
We recommend to purchase it or add it to your Manaca at a subway station counter by filling out a form and presenting your Student ID Card.
A 3-month Student Railway pass between *Nagoya Daigaku* station and *Sunada-Bashi* or *Nagoya Dome-mae Yada* station will cost you JPY 15,680 (for your reference, round trip will cost you JPY 480 daily.)

(3) ONE-DAY TICKETS allow for unlimited rides of city traffic for a day. One-day tickets for all bus, subway, and bus & subway routes are available. Ticket, Donichi-Eco-Kippu, that can be used on Saturdays, Sundays, holidays and the 8th of every month can be also purchased. These tickets include a discounted admission fee for some tourist facilities in Nagoya city such as Nagoya Castle or the Tokugawa Museum.
They can be purchased at any subway station. For further information, refer to the website: *http://www.kotsu.city.nagoya.jp/*
(3) Besides the city-running transportation, trains and buses of JR, Meitetsu, Kintetsu, Aonami-sen will make your passage easier in/around Nagoya City.

Useful Links:
The following websites provide information on available transport services, time-tables, etc.
HYPERDIA: *http://www.hyperdia.com/en/*

If involved in a Traffic Accident.

If you are involved in a traffic accident, remain calm and do the following:

1. Dial 119 for an ambulance.
2. Move any dangerous including vehicles, off the road to prevent other accidents.
3. Report the accident immediately, even if it is small, to a nearby police station and obtain a report of the accident.
4. Write down the license plate number of the car concerned as well as the name, address and age of the driver, after requesting to see his/her driver's license.
5. If there are witnesses, write down their names, addresses and telephone numbers.
6. Make detailed notes of the accident and take photographs, if possible.
7. See a doctor, even if you think that you are all right, because sometimes symptoms can take time to occur.
8. Consult your insurance company as soon as possible.

Smartphone zombies often cause accidents. Many cases are especially happened between bikers and walkers and some come fatal. Refrain from using mobile during walking.

Compliance with Japanese Law

During your stay in Japan, anyone who commits a crime, misdemeanor or any other illegal act, will be subject to legal procedures according to Japanese Law. Nagoya University also takes strict disciplinary measures against such person, and may expel the person from university.

(1) Prohibition of Narcotics
In Japan, the possession and sale, for personal use or otherwise, of all narcotics and any illegal substances are strictly prohibited. If offered, refuse them. If leaving Japan temporarily, never agree to look after a stranger's luggage at the airport.

(2) Drinking and Smoking Restrictions
In Japan, people aged under 20 are not allowed to drink or smoke. Smoking is not allowed in many places, including stations, public facilities and within the campus. Nagoya city has special zones where smoking on the street is banned. If found smoking there, you will be fined.
Driving a car, riding a motorcycle or bicycle after drinking any amount of alcohol is a serious offence in Japan, and can also cause accidents. Never drive after drinking. Those who accept a ride in a car that is driven by a drunk driver or those who offer alcohol to a driver are all subject to punishment under Japanese law.

(3) Others
Whilst inside a shop, removing product wrapper and price tag or putting product into the pocket or the bag before actually paying for them are easily treated as a shoplift in Japan. Talking loudly on the street in the midnight should be refrain.

Safety Guide

Japan is not as safe as most people think. There is the risk of crime anywhere in the world, including Japan. Please pay attention to safety and security for yourself and your belongings in any scenes as you do in the US.

Culture Shock

Although "culture shock" is generally understood as a temporary shock felt when confronted by different cultural customs, ways of thinking and behavior patterns, it actually refers to a psychological state of depression caused by a succession of failure experiences in unfamiliar social situations.

Culture shock is temporary and everybody goes through it to some extent in the process of cultural adaptation. General symptoms of culture shock include negative feelings such as: losing self confidence, feeling depressed, attributing all failure to yourself, feeling that nobody understands you, feeling inadequate, etc. Accordingly, you may lose all motivation to talk with Japanese people or to attend classes. Most of these psychological reactions are, again, very natural in the process of cultural adaptation. Please take time to cope with each single event in your life and to talk with friends, teammates and supervisor, and you will be able to overcome these emotions sooner or later.

Differences in "Academic Culture"

It is widely accepted that different values, behavioral and communication patterns exist from culture to culture. However, we often fail to realize that there are also differences in "academic culture", such as expected roles of academic advisers and students, classroom communication, evaluation criteria, etc. Such differences can also be a major cause of your stress. For example, the relationship between academic adviser and advisee is considered particularly important at the graduate level education in Japan. Some knowledge of the Japanese academic culture will help you achieve your goal more smoothly.

Cope with Stress

If you feel pressured by stress or lose confidence in your ability to study, you should think about releasing yourself from these negative emotions. Achieving good results in your studies may take a certain amount of time, and ought to be views as accumulative process. Sometimes, you will need to take a break. If you feel tired, do not push yourself too hard and try to enjoy some of your favorite foods, recreation, and physical exercise. It is also recommended that you talk with your friends, academic adviser, or international students advisors/counselors. Moreover, please do not consider the process of cultural adaptation solely as a cause of stress; you can learn tremendously about various cultures, including your own, from this process.
< Visit the Global Engagement Center Support Team (Advising & Counseling Services)>
If you feel that you cannot deal with stress or feel a sense of isolation or frustration, do not hesitate to ask for help from international counselors at the Global Engagement Center Support Team. There is an international student counselor who will support your personal and psychological concerns. A discussion with an international student counselor can help achieve a useful perspective on culture shock and insights into Japanese culture.
Global Engagement Center Support Team (7th floor, West Wing of IB Bldg.)
https://acs.iee.nagoya-u.ac.jp

Harassment

Nagoya University has set up a Harassment Consultation Center to prevent and eliminate the occurrence of any kinds of harassment, such as sexual harassment and academic harassment. Professional counselors deal with inquiries with utmost respect for their clients' feelings and wishes. For English language consultation, you may visit the representative at the Education Center for International Students (ECIS). All consultation will be kept confidential.
Nagoya University Harassment Consultation Center (Appointments by fax or E-mail)
Tel: (052) 789-5806 (9:30-16:00)
Fax: (052) 789-5968
sh-help@adm.nagoya-u.ac.jp
http://www.sh-help.provost.nagoya-u.ac.jp/english.html
Contact person at each School (including ECIS)

[Medical & Health Care]

About COVID-19

Please check out the Nagoya University response to the Novel Coronavirus (COVID-19) Pandemic and Guidelines for Activities here: https://en.nagoya-u.ac.jp/news/covid-19.html

Medical Services

If you suffer from continuous headaches, a loss of appetite, or you cannot sleep well, etc., you should seek the advice of a doctor before the condition gets serious. These symptoms may be signs of fatigue or exhaustion. They may also be psychological or psychosomatic symptoms, which are treatable by specialist doctors. In addition to taking care of your own health, please pay attention to your friends' health and encourage them to see a doctor, if they are feeling unwell.

(1) The Health Administration Office See Building Location map.
Students can undergo physical examinations, receive health advice, first-aid and arrange psychiatric counseling at this facility. There is no charge for using any of these services.
Appointments are necessary for psychiatric counseling services. Please call the office,
Tel: (052) 789-3970 or email to hokekan@htc.nagoya-u.ac.jp
[Office Hours for Health Services]

Treatment	Time	Mon	Tue	Wed	Thu	Fri
Physical Examinations & First-Aid	10:00 - 11:30	○	○	○	○	○
	13:30 - 16:30	○	○	○	○	○
Psychiatric Counseling	10:00 - 12:00	○	○	○	○	○
	13:30 - 16:30	○	○	-	○	○

(2) Calling an Ambulance

Telephone 119 or press the RED button on a public phone for connection. Free of charge.
This number is also used for requesting fire engine.

Precautions for Food Poisoning and Infectious Diseases

Great care should be taken with regard to eating habits during the extreme summer weather in Japan. To avoid food spoilage, check the expiration date before buying food, apply heat to raw foods and be careful not to keep food in the refrigerator for an excessive amount of time. To guard against food poisoning, always wash culinary items with hot water.
Also follow the basic hygienic rules to avoid being infected.
World Health organization: http://www.who.int/en/

[Hospitals around Nagoya University]

Nagoya Daini Red Cross Hospial (Yagoto Nisseki)	Address: 2-9 Myoken-cho, Showa-ku, Nagoya Tel: (052) 832-1121 Mon-Fri: 8:00-11:00 Closed on Sat, Sun, holidays
Watanabe Clinic [Internal medicine]	Address: 2F Nihonchouzai Yamate-dori Bldg, 3-8-1 Yamate-dori, Showa-ku, Nagoya Tel: (052) 861-3450 Mon-Sat: 9:00-12:00 Mon, Wed-Fri: 16:00-18:00 Closed on Sun, holidays
Kai Clinic [Internal medicine, Urology]	Address: 32-2 Myoken-cho, Shouwa-ku, Nagoya Tel: (052) 836-9136 Mon-Sat: 9:00-12:00 Mon-Wed, Fri: 18:00-20:30 Closed on Sun, holidays
Yamate Dermatologist	Address: 2F Habitacion Yamate, 2-9-1 Yamate-dori, Showa-ku Tel: (052) 836-4115 Mon, Tue, Thu-Sat: 9:30-12:30 Mon, Tue, Thu, Fri: 16:30-19:30 Sat: 14:30-17:30 Closed on Wed, Sun, holidays
Fujimi Dentist	Address: 139 Yagotohujimi, Showa-ku, Nagoya Tel: (052) 835-3200 Mon-Wed, Fri, Sat: 9:30-12:30 Mon-Wed, Fri, Sat: 14:00-19:00 Closed on Thu, Sun, holidays

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