**SDGs hackathon event focused on AI/IoT with M5Stack**

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**Abstract**

**In this presentation, we will discuss a hackathon event focused on Sustainable Development Goals (SDGs) as a social issue, which employed AI and IoT technologies using the M5Stack microcontroller series. The event was organized by faculty members from Kanazawa University, Kanazawa Institute of Technology, Hokuriku University, and National Institute of Technology (Ishikawa College), along with several local companies. The hackathon consisted of three stages. The first stage was a one-day ideation workshop, during which participants learned about Sustainable Development Goals (SDGs) and technology, chose the SDG topic they wanted to address, and engaged in team building. The second stage was an online training session, where each participant received hands-on training on how to use the M5Stack. In the third stage, lasting two days, participants worked on creating solutions to SDG-related problems. Throughout the hackathon, 27 participants worked on seven different projects. Although Raspberry Pi is a well-known hardware platform for learning AI/IoT, and many hackathons have used Raspberry Pi, this event utilized the M5Stack. The M5Stack is a compact microcontroller module that integrates peripherals such as an ESP32 with Wi-Fi and Bluetooth wireless communication capabilities, color LCD display, buttons, speaker, microSD card slot, and battery into a 5cm x 5cm square package. The M5Stack can be developed using UIFlow, a visual programming tool with a GUI, which allows even inexperienced programmers to learn from the documentation. There are numerous modules, such as sensors and actuators, that can be easily connected to the M5Stack. Additionally, a wide variety of libraries are available for using the sensors, making it accessible for those with no experience in electronics design to tackle the project. This presentation shows the prototypes created by the students and the feedback received from the event. According to the results of a questionnaire given to the participants, more than 80% of the respondents rated the event as excellent, while the rest considered it good. All participants answered feedback expressing their satisfaction with attending the event.**

**Keywords:** *AI/ IoT, SDGs, hackathon, M5Stack*

**Introduction**

As part of the Ministry of Internal Affairs and Communications (MIC) project to improve the literacy of young people developing new IoT devices and services, the Ishikawa District of the Web x IoT Makers Challenge, a skills development event for students and young engineers to enhance their understanding and proficiency in IoT, has been organized as a hackathon event since 2019. A hackathon is an event where individuals or teams come together to work on solving a problem or creating a project within a specific timeframe, usually ranging from a few hours to a few days.

**Materials : M5Stack**

In this event, the M5Stack was utilized. M5Stack is named after the initials of "Modular 5cm x 5cm Stackable." M5Stack is also the name of a technology company located in Shenzhen, China.

We selected the M5Stack as the most suitable option for IoT prototyping. The M5Stack is equipped with the ESP32, which is one of the most popular products with a communication module. The ESP32 within the M5Stack features built-in Wi-Fi and Bluetooth, enabling it to connect to the internet and communicate wirelessly with peripherals. This makes it easy to create applications that send and receive data to and from servers. Many existing microcontroller boards do not have a user-friendly output interface. The M5Stack has a built-in screen, making it easy to display information. This screen is also very useful for debugging during development. The M5Stack comes equipped with three buttons from the start. Most existing microcontroller boards have bare boards, which have disadvantages such as corners and terminals that can scratch hands and peripheral devices, and being easily broken by shocks when carried around. The M5Stack is enclosed in a case, making it durable and visually appealing. This case also adds durability, with all buttons and terminals located on the exterior. As the M5Stack has a built-in battery, it can be used without power supply wiring, expanding its range of applications. M5Stack can be developed using UIFlow, a visual programming tool with a GUI, allowing even inexperienced programmers to learn from the documentation. The product lineup includes numerous modules, such as sensors and actuators, which can be easily connected to the M5Stack. Additionally, a wide variety of libraries for using these sensors are available, enabling even those with no experience in electronic construction to tackle projects.

Raspberry Pi is well-known hardware for learning AI/IoT, and many hackathons have utilized Raspberry Pi. When comparing Raspberry Pi and M5Stack, there are several factors to consider. M5Stack is easier to use and more accessible for beginners, as it comes with built-in sensors, a touchscreen display, and a user-friendly programming environment. It also has a more compact design and can be easily integrated into wearable devices or other small-scale projects. Arduino is also a well-known electronic hardware, but it cannot be used for IoT without a communication module.

**Web x IoT Makers challenge, the first year**

In the first year's Hackathon event, we held a two-day hands-on session. One month later, we conducted a two-day hackathon. The event was sponsored by the Ministry of Internal Affairs and Communications and was organized by a steering committee consisting of staff from Ishikawa Prefecture, Kanazawa City, local companies, and faculty members from various universities and Ishikawa KOSEN.

In the first year, this hackathon focused on solving local and familiar problems. The 24 participants were divided into six teams based on the theme they wanted to explore. The Grand Prize went to Garbage Collector, a garbage collection robot that determines its route using information from a ceiling-mounted camera and moves around the desk, avoiding obstacles to collect garbage. All six teams were outstanding.

**Web x IoT Makers challenge, the second year**

In the second year, 2020, we conducted the event entirely online to prevent the spread of COVID-19. Since the previous event was successful, participants invited others to join them, and the number of participants reached as high as 36. In mid-November, M5Stack lecture materials were posted online, allowing participants to study at their own convenience. Although there were times when participants were unable to follow the lectures due to differences in their PCs and internet environments, they were able to ask questions frankly in the online message group, in which both the lecturers and all participants participated, and the lecturers were able to provide appropriate support. We provided the new M5Stack Core2 instead of the M5GO IoT Starter Kit. We also provided some sensors, such as environmental sensors (temperature, humidity, and barometric pressure sensor unit), ToF distance measurement sensor unit, optical sensor unit, digital RGB LED Strip, servo motors, and a conversion board. M5Stack also provided the new AI Camera "M5StickV" and "UnitV" with a dual-core 64-bit RISC-V CPU and an advanced neural network processor. The main difference between UnitV and M5StickV is that the LCD, battery, and gyro sensor are no longer included, making it smaller and lighter.

We also provided tutorials. If participants didn't understand something, our staff members were always available to answer questions on Discord.

The 36 participants were divided into 6 teams with different affiliations to create their works online. Zoom, Slack, and Miro were used as online communication tools. The event kickoff and idea workshop were held via video conference on Zoom. Associate Professor Sekiya of Hokuriku University served as the facilitator. The morning session was spent introducing themselves and practicing the functions of the videoconferencing and whiteboard-sharing applications (Miro), setting the stage for the discussion that followed. The theme of the discussion was the free exchange of opinions on troubling experiences around us. Participants voiced a variety of opinions, not limited to those related to COVID-19, and the repeated discussions with different members allowed participants to think about the issues in depth. In the end, six teams of three to seven members were formed to discuss and organize ideas for a hackathon project. After the ideation workshop, the teams continued to discuss and prepare for the hackathon three weeks later in their online groups.

The Grand Prize went to a multifunctional device for online communication that enables users to check the availability of the caller, provide topics of conversation, and read the facial expressions of others even when the video is off, and was recognized for its use and implementation of M5Stack.

The other team developed a bear notification system. With bear sightings and reports of bear damage increasing in the prefecture, a system was developed to prevent damage before it occurs. The system detects bears using AI cameras installed in the city, plays music from M5Stack to repel bears, and sends GPS information to Ambient to alert residents of the location of bears. The location of bear appearances can be stored in Ambient and displayed as a graph. Cameras and M5Stacks will be installed under streetlights where people are likely to be present, and in areas where there are power sources for farming. The other five teams also demonstrated a good understanding and use of M5Stack, and after discussion among the judges, all teams were awarded special prizes.

**SDGs Hackathon, the third year**

This Web x IoT makers challenge event has been held for two years by the Ministry of Internal Affairs and Communications since 2019. However, the Ministry of Internal Affairs and Communications (MIC) decided not to provide a budget for this event in 2021. Despite this, we believe the event is worth continuing, so we received funding from the Shibuya Science Culture and Sports Foundation, a company in Ishikawa, and held it independently under the name of SDGs Hackathon.

The hackathon was divided into three events. The first event was a one-day idea workshop, where participants learned about the Sustainable Development Goals (SDGs) and technology, decided on the SDG theme they wanted to address, and engaged in team building. The second event was an online training session, where each participant received hands-on training on how to use the M5Stack. In the third event, which lasted two days, participants worked on creating solutions to SDG issues.

The SDGs, Sustainable Development Goals, were unanimously adopted by 193 member countries, including Japan, at a summit held at UN headquarters in 2015 as common global goals, setting forth visions and tasks aimed to be achieved by 2030.

The hybrid format was a good combination of what we had done online last year and offline two years ago.

The hybrid format of online and in-person participation was used, and everyone seemed to be able to use Miro very well. I felt that this kind of hybrid approach is becoming more effective in idea-making and communication than the usual online-only or face-to-face approach. At first, I was worried about whether the students would be able to use these tools, but they were all able to use them without any confusion at all.

27 people participated in the event, which consisted of 7 teams. Since all the students who participated in the program made great achievements and put in a great effort, we did not give out awards for the best or ranked awards, but created one certificate for each participant and presented them to them. Our staff members came up with names for the awards based on their ingenuity, and at the awards ceremony, they all commented on good points of their works.

**Results and Discussion**

From the results of a questionnaire (Table 1) given to the participants who attended the event, more than 80% answered that the event was excellent, and the rest responded with good. Additionally, all the participants gave feedback that they were glad to have attended the event.

Table 1. Results of a questionnaire

|  |  |
| --- | --- |
|  | **%** |
| **Excellent** | 82.4% |
| **good** | 17.6% |
| **fair** | 0 |
| **poor** | 0 |
| **very poor** | 0 |

The following is a list of the reasons given in the free response.

* Because I had a lot of fun making things with people from other schools. Also, I was able to make new discoveries by discussing my ideas with various people.
* I have not had many opportunities to speak in front of people recently, so I was glad to be able to give a presentation in front of so many people.
* I enjoyed talking with people I had never met before.
* It had been a while since I had created my own work, and I enjoyed it because I was able to do so.
* It was good to talk with people from other universities and technical colleges that I don't usually talk to, and to be stimulated by them.
* Because I gained experience in solving problems related to the SDGs with IT.
* It was a good stimulus and increased my motivation.
* I was able to meet students from other universities and working people.
* I could understand the program even as a beginner.
* Seeing and hearing about various works was a good stimulus.
* I was able to understand how to use programming techniques, which I had only studied and did not know how to use, and how fun it is to create things with programming.
* The people around me were excellent, and it was very stimulating to exchange opinions and create things together.
* Because I acquired programming skills.
* Because I was able to experience the setup of a team to create a product in a short period of time.
* Because I was able to experience development with multiple people.
* Because I was able to create something by programming in earnest.
* Because I was able to gain new skills and knowledge.
* Because I could cooperate with people I had never met before and develop communication skills.
* I was able to take on a big challenge with strong support.
* The experience of thinking about social issues from a new perspective of manufacturing was very stimulating.
* I was able to think about solving issues together with my team members, and we were able to create ideas that had never existed before.
* Because there were many people from different fields that I have been involved with, and I got a lot of new stimulation.
* Also, I felt that we had a good relationship where we could honestly ask each other about things we didn't understand and teach each other.

Table 2 shows the results of the questions asked about what they learned from the hackathon.

Talbe 2. "What do you think you learned from participating in the hackathon."

|  |  |
| --- | --- |
| **Questionnaire item** | **# of People (%)** |
| **Experience developing with a team** | 14（82.4%） |
| **Experience in bringing ideas to life** | 12（70.6%） |
| **Control skills with M5Stack, sensors, etc.** | 12（70.6%） |
| **Experience with prototyping in short timeframes** | 11（64.7%） |
| **Communication skills** | 8（47.1%） |
| **Programming skills** | 7（41.2%） |

Table 3 shows the good points about the content of this hackathon.

Table 3. Good points about the content of this hackathon.

|  |  |
| --- | --- |
| **Questionnaire item** | **# of People (%)** |
| **Staff Response** | 15（88.2%） |
| **Theme, subject matter** | 14（82.4%） |
| **Assistance with material costs** | 14（82.4%） |
| **Actual equipment used (M5Stack)** | 11（64.7%） |
| **Style of presentation** | 11（64.7%） |

Table 4 shows the result of a question about the direction participants would like to take in the future. Although small in number, it was surprising to see that about 30% of the participants indicated that they would like to start their own businesses.

Table 4. The direction you would like to take in the future

|  |  |
| --- | --- |
| **Questionnaire item** | **# of People (%)** |
| **I want to work on IoT in my private life** | 13（76.5%） |
| **I want to become an engineer who can handle IoT as a job.** | 10（58.8%） |
| **I want to plan services using IoT as my job.** | 6（35.3%） |
| **I want to start my own business.** | 5（29.4%） |

The following are the responses to the question asking if there is anything you would like to learn or improve your skills in the future.

* Python, Ruby on Rails, HTML & CSS
* I would like to be able to do hardware (circuit design) as well as software.
* Communication technology (UDP, etc.)
* I would like to participate in any workshops on stm microcontrollers, RX microcontrollers, etc.
* I would like to get used to it by creating and executing some programs only by myself.
* I would like to make an effort to grow in terms of knowledge, such as technical terms and techniques.
* I want to learn further programming knowledge.
* I want to improve my programming skills using Python
* How to handle AI in Python About databases
* Machine learning systems
* I would like to try many things while I am a college student in a field that I usually don't have access to like this one.
* Programming techniques

The following is a summary of the feedback throughout the event.

* It was so much fun! Thank you!
* The staff provided positive encouragement and support during the event, which helped me to finish the whole thing.
* It was great, thank you very much.
* I enjoyed learning programming very much.
* The experience of creating and presenting a work in a short period of two days will help me to grow.
* It was nice to interact with people from other schools.
* The staff was very accommodating, the environment conducive to doing our best, and it was a very meaningful event!
* It was very good.
* I learned how to make the most of IT at this event.
* I have never had the opportunity to work with people who have different experiences and abilities in programming and computers, so I think it was meaningful to cultivate group activity experience in such a context.
* It was a very good experience. Thank you very much for creating such a place.
* I really received a lot of wonderful stimulation. Thank you very much. I'd love to participate again when you hold another one!
* Thank you so much to all the teachers who allowed me to attend the event and supported me. I was able to experience many things I have never done before and had a lot of fun.

**Conclusions**

lthough the 'Monozukuri' Hackathon 2023 was held after the deadline for abstract submissions and hence could not be included in the abstract, it took place at Hokuriku University in Ishikawa, Japan from March 18-19, 2023. This was the fourth annual event, with a total of 25 participants. The event, sponsored by Ricoh IT Solutions Co., continues to be well received, becoming increasingly established each year. It offers a valuable opportunity for students to learn about AI/IoT technologies in collaboration with various universities and regional companies.

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