Final Report – Human Computer Interaction

Team : S.A.S (Smart Attendance System)

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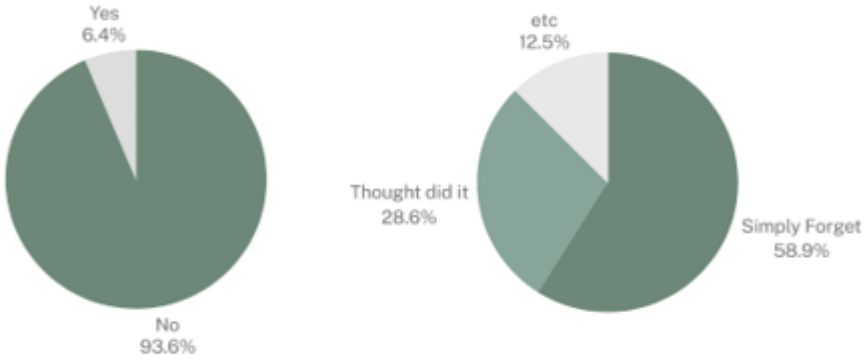
1. Introduction Report

1-1) Usability Problem

The attendance system of UNIST faces usability issues, with students often failing to check their attendance due to the lack of motivation and certainty, which directly affects grading. The main reason stems from the current system cannot give any help not to forget attendance checks.

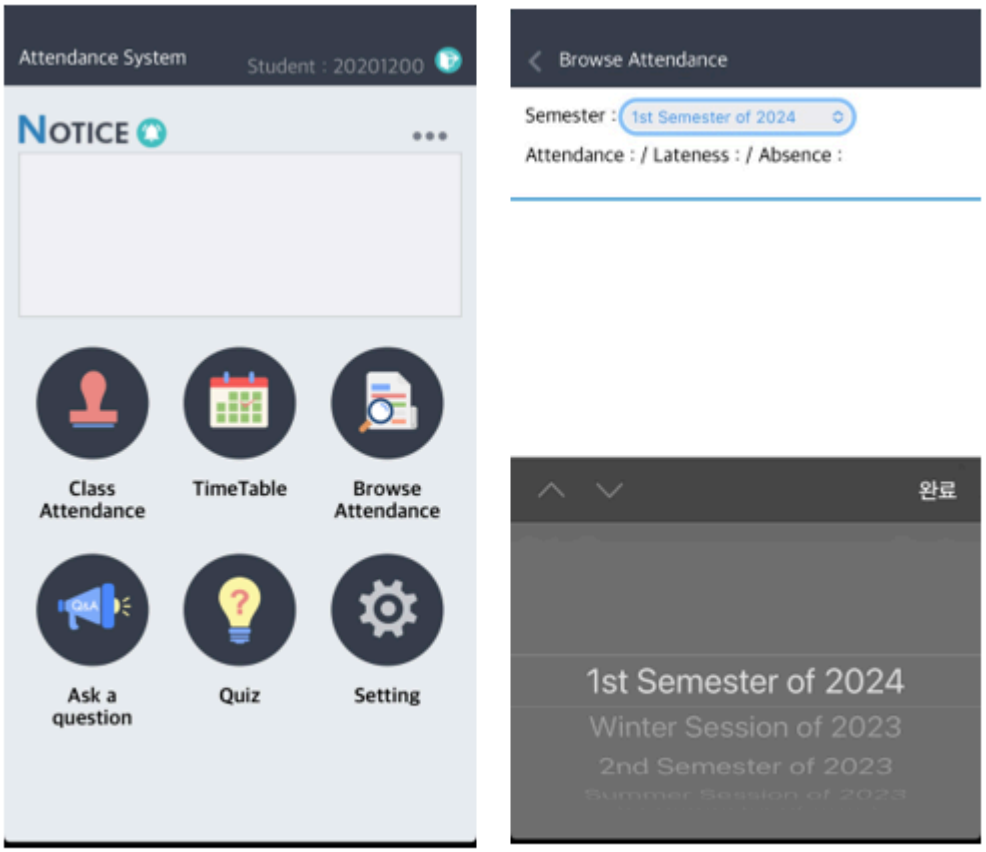


[Figure 1] Result of Survey

A survey of 47 students supports this perspective, with over 87% attributing attendance failures to forgetfulness and 93% stating that the current system does not help prevent forgotten check-ins. To effectively support students' memory, the system must be revised to implement strong motivations and reminders.

1-2) Existing Solutions

Several existing solutions have been employed. The current method is the mobile attendance system using bluetooth system, which has serious flaws with forgetness.



[Figure 2] Current Attendance System ↵

Another approach was using QR-codes, which did not significantly improve the users' ability to remember checking their attendance.

Fingerprint scanning is method to check attendance, but it faced limitations such as the inability to confirm whether users had checked in and its susceptibility to environmental factors.

Detecting users' locations via GPS was utilized, eliminating the need for manual reminders, but this solution suffered from poor precision.

1-3) Proposed Solution

Limitations of current solutions prompted the search for new ones. Displaying QR codes during class was rejected due to fake attendance risks. Improving GPS with Bluetooth recognition was rejected due to battery and privacy concerns. With mobile phones posing memory risks, alternative ID methods were sought. Student ID cards emerged as best. Previous entrance card

recognition was cumbersome and prone to fakes. Drawing from hotel key systems, proposed new ID card solution.

[Figure 3] Proposed solution model, and paper Prototype

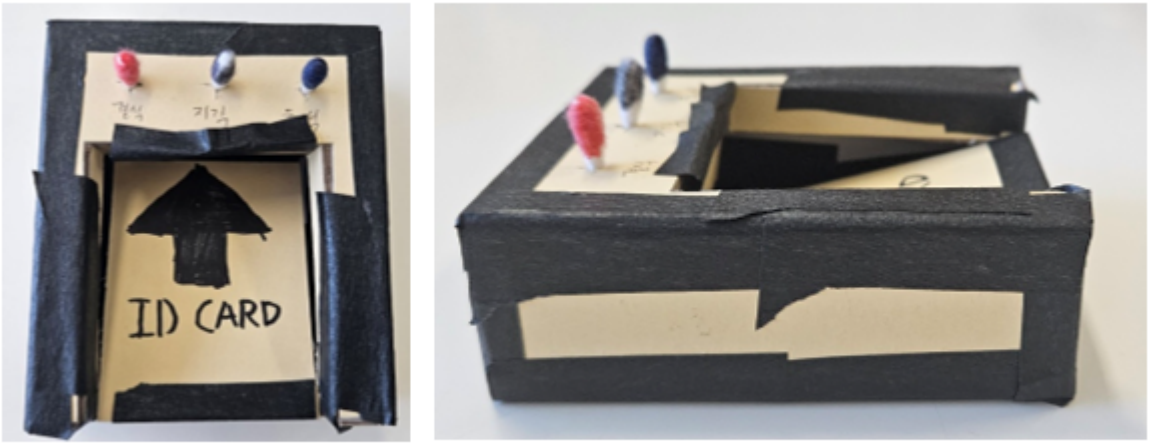
Our proposed solution is "student card slot attendance system" where each desk is equipped with card slot and LED lights. When student sits at a desk, they see a card slot with red LED, indicating that attendance has not been checked. The student inserts their student card into the slot, and the LED turns green, confirming that attendance has been successfully recorded. If the card is inserted 10 minutes after the class has started, yellow LED will turn on, indicating a late check-in.

The blinking LED and buzzing beeper serves as constant reminder until they check their attendance. It is enough to motivate users to check attendance. The LED provides continuous direct visual feedback, eliminating the need to recheck attendance. The article says that high degree of coherence of the color lights could result in new kinds of glares not considered in the current standards.[1] Additionally, there is no need to open a mobile app and wait for Bluetooth connection. While potential disadvantages include lost student cards and cost, our project primarily aims to solve usability problems rather than evaluating business feasibility.

[1] Ixtaina, P., Presso, M., Rosales, N. *et al.* Glare by Light Emitting Diode (LED) vehicle traffic signals. *Int J Mech Mater Eng* 10, 1 (2015).

2. First Iteration

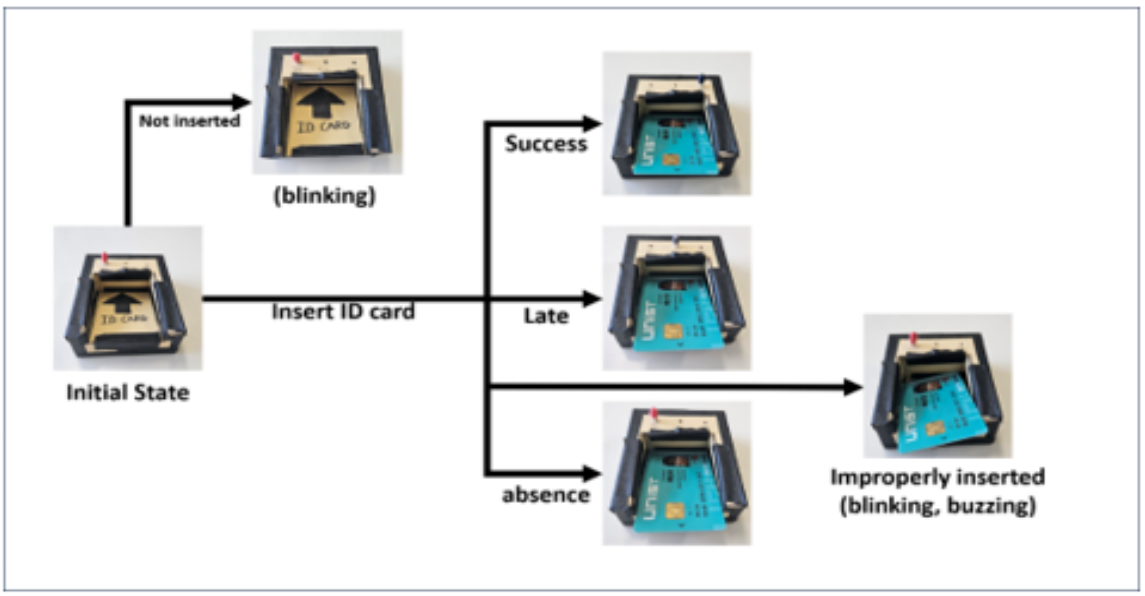
2.1) Design



[Figure 4] Prototype used in experiment

To implement how our model will work in all possible scenarios when attendance is taken with student ID cards, we created paper prototype. We use cardboard to make a physical body. And we implemented the LED lighting by inserting a cotton swab of the corresponding color into each LED. Moreover, we have designed the card holder with a slight tilt for smoother insertion of student ID cards. To help first-time users, we draw the arrows to navigate and use the system easily.

2.2) Design Justification



We designed the prototype's responses for five major scenarios. The above figure briefly shows how the prototype responds to each of the five scenarios. Our prototype's initial state is with the red LED lit. Depending on whether a student ID card is inserted and the time, it provides different feedback.

i. When attendance is successfully checked on time. Our prototype will light up a blue LED when the card is recognized.

ii. When a late attendance check is occurred. In this case, the prototype will light up a yellow LED.

iii. When an absence is checked due to being too late, the prototype keeps the red LED continuously lit.

iv. When there is no card inserted within the first 5 minutes after the class starts, the prototype blinks the red LED 5 times to remind the user.

v. When the card is incorrectly inserted and not properly recognized, the prototype also blinks the red LED to notify the user that the check has not been conducted properly.

2.3) User Study

i) Participants

The study involved 10 UNIST students from diverse majors.

Participants were consisted of researcher’s acquaintances, currently using the existing electronic attendance system.

ii) Tasks

The user study was conducted on May 15th, at 7:00 PM and 7:15 PM in Room 204 of the Business Administration Building, with participants divided into two groups of 5 for each session.

The day before experiment, each participant of each group was asked to perform exactly same task they do at the beginning of the class after entering the lecture room during experiment.

Each participants enters the lecture room with research organizer and required to do the task.

iii) Research Method

We divided the participants into two groups: Group 1, without the prototype and Group 2, with the prototype. We used between-subjects design, since there could be order-effect. The session lasted about 5 minutes. We checked the percentage of attendance and the time it took until they check attendance. In both group, organizer sits next to participants. For group 1, organizer turn on the attendance checking application 2min before the end of session, to give clue for the participants. Also, in the group 2, the organizer give the sign that prototype was supposed to give. (For example, blinking LED when ID card is not inserted, etc..) After the research, a survey was conducted. We used quantitative evaluation for evaluating design principle. Additionally, we used qualitative evaluation to identify any disadvantages of the prototype from the participants perspectives.[2]

[Figure 5] Photo during the experiment

[2] Survey form is presented :
https://drive.google.com/file/d/1tPWfHEDx6zSaWusq9PtHRmlyuO5o-saB/view?usp=share_link

iv) Result

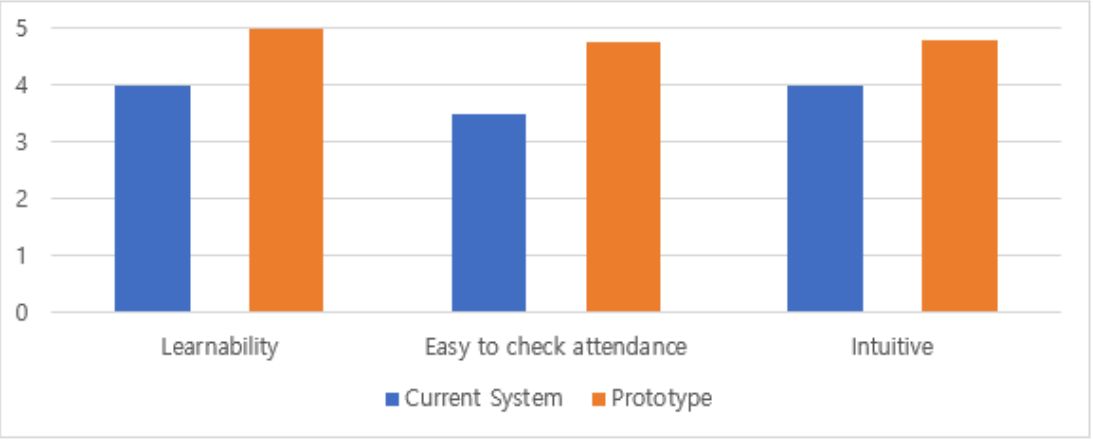
As a result, the 80% of the participants with prototype doesn't forget to check attendance, whereas only 50% of participants without prototype checked attendance. Also, average time for attendance with prototype is 61.25s, whereas 154.5 without prototype.

Also, We checked that participants feel prototype more easy to learn, easy to check attendance, and intuitive than current system. The graph above shows the average scores of participants on each attribute of the prototype and the current system.

At last, qualitative evaluation is conducted, to get the feedback from the participants.

Group 1 (W/O Prototype)	Attendance	Time (sec)	Group 2 (with Prototype)	Attendance	Time (sec)
Participant 1	X	-	Participant 1	O	145
Participant 2	O	141	Participant 2	O	21
Participant 3	O	168	Participant 3	O	47
Participant 4	X	-	Participant 4	O	52
			Participant 5	X	-
Average	50%	154.5	Average	80%	61.25

[Table 1] Attendance and Time data of each participants



[Figure 1] Answer comparison among design principle

2.4) Insights and Reflections

i) Feedback

The feedback for the prototype included the following points:

1. Lack of Clear Instructions for ID Insertion: Some participants did not think to insert their student ID upon seeing the prototype. This indicates that the "Insert ID" sign may not sufficiently reflect the "Learnability" or "Affordance" for certain user groups. Therefore, it is necessary to include a bilingual instruction that reads "Insert Student ID."

2. Enhanced Use of Audio (vibration) Feedback: Feedback regarding a "warning sound for potential absences" and "notification vibration to prevent card loss" suggests that more proactive use of audio feedback is needed. It is important to implement auditory and tactile alerts that remind students to remove their card at the end of class and to warn them of impending tardiness.

3. Desk Space Concerns for Large Devices: Participants who use laptops or large electronic devices expressed concerns about desk space becoming cramped. To address this, the prototype should minimize its height to allow for devices to be placed on top and consider a horizontal insertion design to accommodate laptop space.

ii) Discussion

The core hypothesis of our team, as mentioned in the introduction, was: "A check-in system utilizing visual disturbances in red, blue, and yellow, similar to traffic lights, will be more effective in reminding users to check the attendance in compared to the current system."

Based on the experimental results, which measured 'time spent on attendance (efficiency)' and 'success rate for attendance (effectiveness)', our proposed solution showed a significant improvement in preventing forgotten check-ins compared to the existing system. Therefore, the design direction of continuously providing 'visual information(LED and physical device)' is validated.

However, it is crucial to consider in future user tests that this system, while effective at preventing forgotten check-ins, might increase the probability of students leaving their cards after class.

3. Second Iteration

In the initial iteration, we received feedback regarding concerns about the device occupying desk space. Specifically, having the device on the desk was considered disruptive during class. To address this, we propose a new design where the device is placed under the desk. Additionally, based on feedback that the LED indicator is insufficient for notifications, we have designed it with an LED strip on the desk for attendance notifications. In this iteration, our goal is to gather feedback on the prototype with the device positioned under the desk.

3-1) Design of Prototype

Attendance Status

Usage

The prototype was designed to secure space on the desk by locating the card holder under the desk, accepting the user feedback from the first iteration. Although the ID card holder becomes invisible, we designed a large LED using an LED-strip to ensure that attendance status could be easily checked. We placed the LED close to the user to be visible to them without disturbing others.

The prototype was made of paper, with the card holder folded to allow insertion of a student ID card. LED was represented by using colored paper to represent different attendance status.

3-2) Design Justification

1) **Location of the card holder:** Feedback from our first prototype included lack of space on the desk. To solve this problem, we placed the card holder under the desk.

2) **Location and size of the LED:** The main idea of our solution was to prevent forgetting to check attendance by making the card holder immediately visible. But, the card holder becomes invisible by placing it under the desk. Instead, we make the size of LED bigger to do this role instead. If the LED is located in front of the desk, it can be disturbed to the person in the back seat.

3) **ID card insertion guide:** To ensure that first-time users can easily understand how to use our prototype, we draw arrows indicating where to insert the ID card.

4) **Attendance check feedback:** Based on the time the ID card is inserted, the LED changes its color to indicate the attendance status. Green indicates success, yellow indicates lateness, and red indicates absence.

5) **Attendance check reminder:** If the attendance is not checked until 5 minutes after the class starts, the LED blinks and a short vibration reminds the user to check attendance.

6) **Take ID card reminder:** To prevent students from forgetting their ID cards, the LED blinks at the end of the class, reminding them to take their cards.

3-3) User study

1) Participants

   The study involved 4 UNIST students from diverse majors. The four participants who are acquaintances of the researcher using the current attendance system, included two from the first prototype test and two new participants.

2) Tasks

   The user study was conducted on May 24th, at 6:00 PM and 6:15 PM in each member's dormitory room. Each participant entered the dormitory room with the research organizer and was required to do the task, testing the prototype.

3) Research Method

The study conducted field testing to evaluate the prototype's performance. For the two participants from the first prototype test, We provided the participants with a comprehensive explanation of how the prototype changed and which features have been implemented from feedback of the first prototype. Then, participants were asked to use the prototype. It took three minutes. For the two new participants, we gave only information that it will be used as a replacement for the traditional attendance system. Then, participants were asked to infer how the prototype works as an attendance checking device, and do the attendance check based on the prototype's appearance. It took five minutes. After the research, a survey was conducted. We used quantitative evaluation for evaluating design principles. Additionally, we used qualitative evaluation to identify any disadvantages of the second prototype from the participants perspectives.

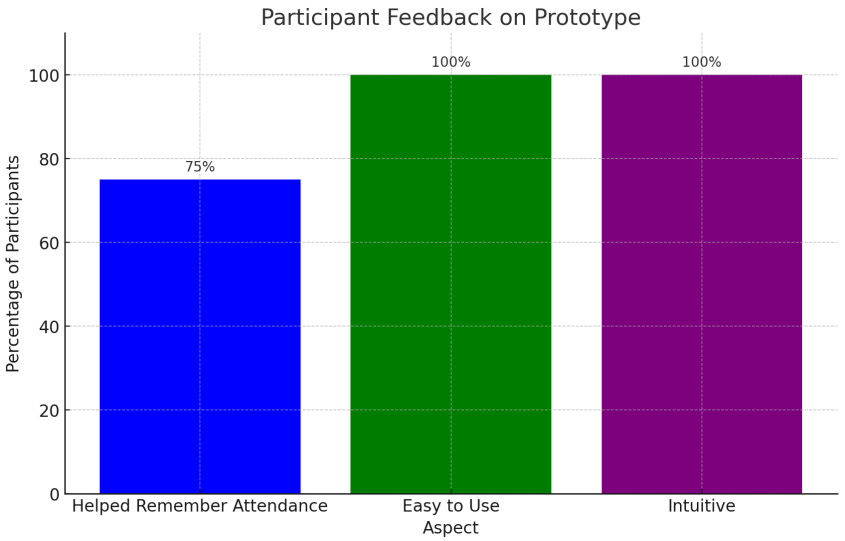
4) Results[3]

After testing the prototype, 75% of the participants responded that it helped them remember to check their attendance. Additionally, all users found the prototype easy to use, believed it made checking attendance easier to remember, and considered its usage intuitive.

The two participants who tested the first prototype mentioned that it was inconvenient due to its excessive desk space usage. However, the new prototype received positive feedback for being placed under the desk, resolving the inconvenience of taking up too much space. Moreover, the addition of clear instructions for inserting the ID card made it much easier for users to understand the prototype. As a result, we were able to significantly improve the prototype's 'Learnability' and 'Affordance'.

[3] Survey form : https://forms.gle/fccsfwSDKdVmNCNi9

The two new participants provided feedback that inserting the card was inconvenient and unnecessary. They suggested adopting a touch-based system instead of the card insertion



method.

3-4) Insights and Reflection

i) Feedback

The feedback for the prototype included the following points:

1. **Alternative type / Using necklace of ID card :** We received feedback that some students bring different types of IDs, not in card form. For example, some students only carry RFID chips to enter the lecture room. In such cases, our card-insertion prototype cannot verify attendance. Additionally, students who wear their ID cards in necklaces also cannot use our prototype to check attendance.
2. **Card insertion method is cumbersome** : Feedback indicated that the card insertion method is cumbersome and less convenient than the card tagging method. Therefore, it is recommended to design the prototype using the card tagging method. Additionally, there was feedback that inserting the card throughout the entire class seems unnecessary.

ii) Discussion

The survey results indicate that the LED strip is effective as an attendance indicator. About 75% of users reported that the prototype helped them remember to check in, and feedback suggested that the LED strip provided a crucial reminder, significantly enhancing attendance memorability. However, there is a need to discuss the necessity of the card-insertion method. This method

received negative feedback and has critical drawbacks, such as being incompatible with alternative forms of ID like necklaces and RFID chips. Additionally, we observed that the main drawback of the card-tagging method is its similarity to the original solution, which lacks originality. However, card-tagging method is regarded to give more memorability of attendance to the users.

After our discussion, we concluded that our card-tagging method differs from the original solution because it incorporates an LED strip as an attendance indicator, which the original solution lacks. We identified lack of memorability as a usability issue with the current and existing solution. Therefore, our proposed card-tagging method offers originality compared to the existing solution. Consequently, we have decided to implement the card-tagging method in the further hard-prototype design.

4. Final Iteration

4-1) Design of Prototype

In the current iteration, the prototype implementation level higher than paper prototype to a stage where actual test is feasible. Compared to the prototype from the previous iteration, the most significant modification is the transition from inserting cards to tagging them. The placement for tagging the cards still has been positioned at the lower part of the desk. Additionally, features such as LED indicators for attendance status and haptic feedback for users have been retained.

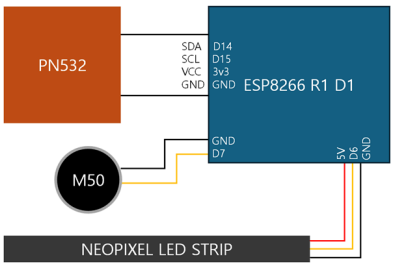
4-2) Design Justification

1. design requirements
    a. Card Tagging： A rectangular box-shaped prototype is located at the bottom of the desk, where users can tag their cards on its underside.
    b. LED Notification System
        The default brightness of the LED is set to 30, and it flashes to a brightness of 255 only for attendance reminders。
        In cases of lateness, a yellow light will appear and then change to green after five seconds. This lateness indicator is intended to be visible only to the user, as there is no need for others to be aware。
    c. Other aspects: Identical to the second iteration。

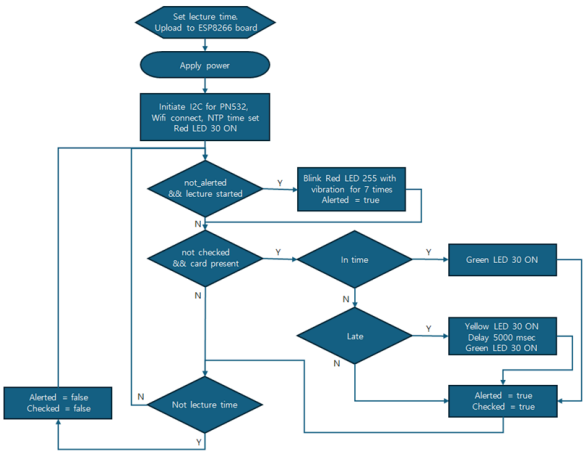
2. Implementation details
    a. Circuit configuration
        Component

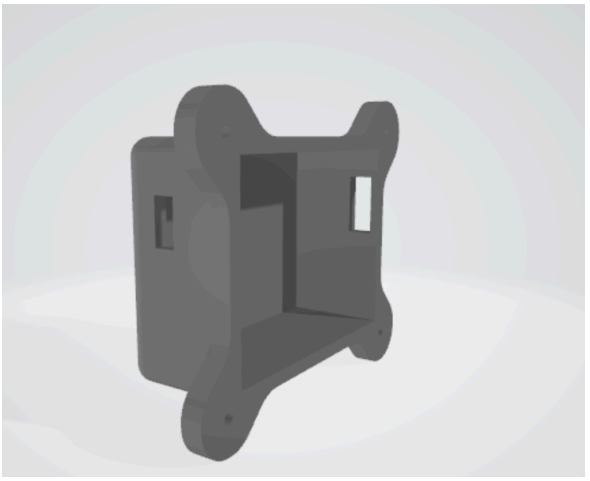
        1. ESP88266 R1 D1: MCU Wifi board
        2. PN532: RFID module, 13.56MHZ (NFC) support
        3. NEOPIXEL GRB led strip 5 units: 3 colored led
        4. M50 vibration motor: Electric parts from Samsung Galaxy Note 10

        diagram

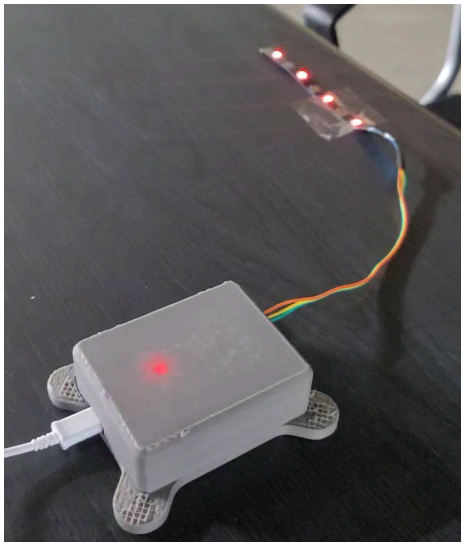


b. operating logic & modeling





c. Actual Prototype



Full code for hard-prototype is described in the Github[4].

4-3) User study

(1) Participants

The study involved 5 UNIST students from diverse majors. The five participants who are acquaintances of the researcher using the current attendance system, included one who

[4] https://github.com/suri7897/HCI/blob/1d9d1fe5d5738f88e0284379a2cfea850088b6d9/Hard_Prototype

conducted both the first and second prototype test, one conducted only first, one conducted only second, and two new participants.

(2) Tasks

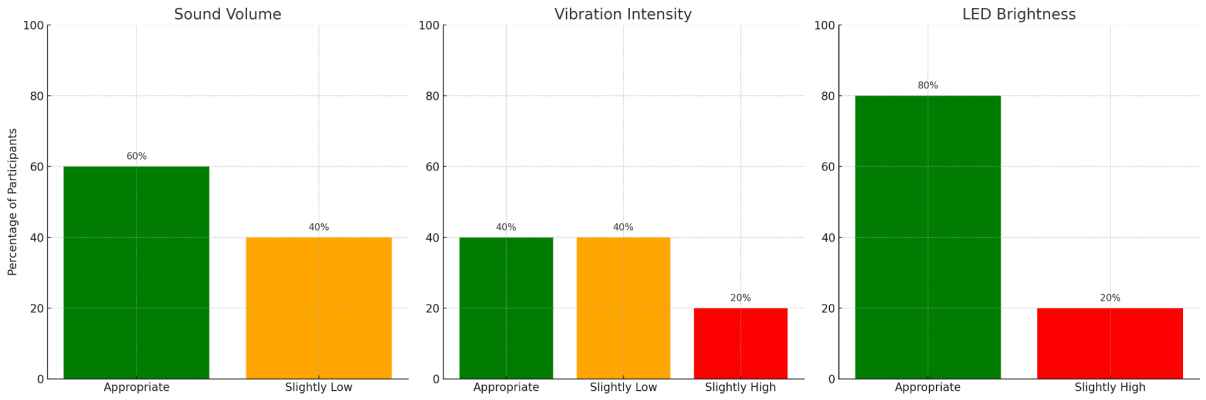
The user study was conducted on June 1st, at 2:00 PM and 2:20 PM, 2:30 PM and 2:50 PM, 3:00 PM and 3:20 PM, 3:30 PM and 3:50 PM, 4:00 PM and 4:20 PM each, at the UNISPARK. Each participant entered the discussion room with the research organizer and was required to do the task, testing the prototype.

(3) Research Method

In this experiment, for three participants who had experienced prior experiments, we explained the insertion method replaced to touch method by feedback. For the two new participants, we explained the attendance check process as similar to the entry system at the UNIST buildings. Then, we asked all participants to use the hard prototype. In the next phase of the experiment, we asked participants to study for final exams in front of the prototype. After 2 minutes, we triggered a 'Late' notification and observed their reactions. After the research, a survey was conducted. We used quantitative evaluation for evaluating design principles. Additionally, we used qualitative evaluation to identify any disadvantages of the final prototype from the participants perspectives.

(4) Results[5]

The final prototype test results showed that all participants considered the prototype significantly helpful in remembering to check attendance (scoring 4 or higher), and they considered it easy to use and intuitive.



[5] survey form : https://forms.gle/pcURBSP9qB5ZqP8g6

When asked about the appropriateness of the prototype's sound volume, 60% of participants felt it was appropriate, while 40% thought it was slightly low. Regarding the vibration intensity, 40% found it suitable, 20% considered it slightly high, and 40% felt it was slightly low. As for the LED brightness, 80% of participants thought it was appropriate, and 20% found it slightly bright.

During the observation, when red light started blinking after 2 minutes, one participant recognized ID card within 10 seconds. However, three participants were initially confused, but after realizing the need, they recognized ID card within 30 seconds. One participant, who was studying, didn't notice red light for 2 minutes and only observed continuous red blinking when checking his phone, prompting him to recognize ID card.

Participants provided feedback suggesting other options for sound, vibration, and brightness levels. They noted that each class might have different sensitivities to LED brightness, sound volume, and vibration intensity.

4-4) Insights and Reflection

i) Feedback

The feedback for the prototype included two points.

1. **Notification of the lateness was not done well:** Several participants can't notice the late notification and many participants give feedback for the volume of the alarm and the intensity of the vibration.
2. **Brightness of LED can distract their concentration:** Some participants thought the brightness of the LED was slightly high. Additionally, there is some feedback that LED is disturbed to their concentration.

ii) Discussion

We observed that 1 out of 5 participants missed the "Late notification" and did not complete attendance until 2 minutes after the lecture started. We attribute this to the low brightness and infrequent blinking of the LED. So, increasing brightness and frequency of blinking is needed for enhanced visibility.

According to the survey, users perceive the brightness of the LED as too intense, which distracts their concentration during class. While this brightness is advantageous for notifying late attendance, we have decided that the LED does not need to remain bright after attendance checking is completed. Therefore, we will reduce the LED brightness.

There was significant debate about the weak sound and vibration. Opinions were divided between worries about the possibility of disrupting lectures, and need to be effective to make

users recognized. Since LED-strip exists, sound and vibration are just secondary feedback. Thus, we decided to maintain weakness. Also, we recognized follow-up user study is needed. It should involve multiple participants to figure out the threshold at which vibration and sound from a left-side user's attendance check begin to disrupt studying. At this moment, sound and vibration should remain secondary features.