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IBAtS - Image Based Attendance System: A Low Cost Solution to Record Student Attendance in a Classroom

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***Abstract*—Conventional practices for recording student attendance in a classroom, such as roll-call and sign-in-sheet, are proven to be inefficient in terms of time and staff-workload. In addition, they are also prone to human error and bogus attendance, which introduce inaccuracy in the recorded data. A number of studies have been conducted to improve the way we record class attendance. However, some of the proposed solutions are costly and impractical. Most solutions also fail to address bogus attendance. This paper presents a low cost solution in recording student attendance. Attendance is recorded on class photographs, students' faces are automatically located using a face detection technique, and students then registered their attendance by simply identifying their face on the records. Mobile applications were developed for both students and lecturers as the primary interfaces to interact with the system.**

***Keywords*-bogus attendance, educational data mining, face detection, computer vision, biometrics**

I. Introduction

Recording student attendance is a common practice in many schools and universities, especially for those who enforce compulsory attendance policy [1]–[3]. Some scholarship programs also demand a class attendance report of their awardee. Several studies have been conducted in investigating the correlation between students' attendance and their academic performance. Majority of the studies reported a positive correlation between these two factors [4]–[7]. Recent study also reported that student absenteeism could be used as an efficient predictor of student failing rate [8]. In contrast, other studies suggested that student attendance and academic performance are weakly correlated [9] or even non correlated [10]. Academic performance is a complex topic with multiple facets and should not be evaluated based on class attendance alone. Whether or not there exists a correlation between student attendance and their academic performance, their attendance is still worthwhile to be recorded as it is part of the academic process [1], [8], [11].

There are two conventional practices for recording student attendance in a classroom, namely roll-call and sign-in-sheet [1], [12], [13]. In roll-call, a lecturer calls out a list of students' name and records who are present in the class. With sign-in-sheet, each student needs to locate their name and sign the sheet to record their attendance in the class. The attendance sheet is circulated among students in the class as the lecture progresses.

These conventional practices are proven to be inefficient, especially in classes with large number of students [1]. Several issues are identified as follows:

a) Time inefficiency: Roll-call is a time consuming procedure as lecture time is wasted to call the name of each enrolled student and record their attendance. Sign-in-sheet is also considered time inefficient where attendance sheet needs to be circulated among students in the class, although it is not necessarily halting or stopping the ongoing lecture [14].

b) Labour intensiveness: In terms of staff-workload, both roll-call and sign-in-sheet require administrative staff to convert the attendance record from a printed (paper-based) format into a digital format by inputting the data into spreadsheets or a database management system. This procedure is necessary for further data processing such as calculating the attendance percentage for each student or for each course [15]. Such procedure is labour intensive and time inefficient, especially for institutions with large number of classes and students.

c) Human error: The increase in staff-workload may introduce mistakes and errors during the aforementioned data conversion procedure (i.e., from printed to digital format). In addition, attendance data recorded on a piece of paper is easy to be lost or damaged due to poor practices in document handling. Human error may also occur while the attendance is being recorded in the class. A lecturer may mistakenly register attendance of a student to other student while conducting

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a roll-call, which often happens among students who share similar names. In the sign-in-sheet, students may sign their attendance on other student's field, or a mistake in circulating the attendance sheet may result in some students being missed in the record because the sheet does not get to them. In addition, sign-in-sheet is also prone to bogus attendance [14]. Students may sign the attendance sheet for other students who are not actually present in the class. Such inaccuracy means the data no longer represents the actual student attendance in a class and fails to serve its purpose.

d) Distraction: Although it is not directly interrupting the lecture in progress, sign-in-sheet could be considered a distraction [16]. Students' attention in following and focusing on the lecture is cut from the moment they receive the attendance sheet. It requires a few moments for each student to locate their name on the sheet, sign in their attendance, and pass the sheet to other student. Some students may experience difficulty in re-engaging with the lecture. Such distraction causes valuable lecture time being lost.

This paper aims to propose an efficient solution (in terms of time and staff-workload) by applying face detection technique to record student attendance in a class. Other issues found in the conventional practices, such as human error and distraction, are also considered in our study. For proof of concept, the proposed solution was applied to record student attendance over fourteen weeks in eleven different classes within our department (Faculty of Information Technology, Maranatha Christian University, Indonesia).

II. Related Work

From the literature, we identified a number of proposals to improve our practice in recording student attendance. In general the main focus of these proposals is to reduce the staff-workload while collecting and processing the student attendance data, which will also improve the time efficiency and the reliability of the data. We classified these proposals into two categories: token-based and biometrics-based attendance systems.

In token-based attendance system, each student is required to present a token to verify and register their attendance in a class. RFID/NFC tag is the most commonly adopted token for this purpose [12], [17]. The tag could be embedded in the form of a dongle, a student card, or a mobile phone. A concise review on the applications of RFID for attendance system is reported in [17]. The implementation of token-based attendance recording system using RFID/NFC requires at least a dedicated RFID/NFC reader to be installed in each classroom. This would introduce a fairly high investment cost, especially for institutions with a large number of classrooms. In addition, only one student can register their attendance at a given time (assuming there is only one reader installed in a classroom). For classes with large number of students, this could result in a long queue of students waiting to register their attendance.

Some studies in token-based attendance system try to make further improvement (to overcome the aforementioned issues) by automating the attendance registration procedure. The study reported in [18] utilised an indoor positioning system, based on students' smartphone WiFi connection [19], to track students attendance in each class. The study took advantage of the large scale deployment of WiFi infrastructure in their campus. In addition to the automated attendance tracking, their proposed method is also capable of tracking late arrival and early departure students in each class. A fairly similar approach was also reported in [20], although attendance record was not the primary focus of their study. A slightly different approach was proposed in [8], where Bluetooth connections among minimum number of eight nearby students' smartphones were utilised to estimate the class attended by those students.

When being compared to the conventional practices, the token-based attendance system has advantage of eliminating the staff-workload and minimising the potential human error in collecting and handling the student attendance data. However, in addition to a high investment cost, this solution also has an inherent limitation in handling bogus attendance. By presenting a legitimate token, any student can register an attendance on behalf of other student.

In biometrics-based attendance systems, human characteristics are utilised to identify whom is present at a given time and place; and their attendance is then recorded. By harnessing the unique human characteristics (if the system works properly), this solution is capable of handling bogus attendance, resulting in a more reliable attendance data. The application could use different techniques ranging from fingerprint recognition [21], voiceprint recognition [16], [22], or face recognition [13], [15].

Using fingerprint recognition, each student registers their attendance by scanning their finger (usually thumb) on a dedicated terminal (i.e., fingerprint scanner) deployed in each classroom [21]. The implementation is fairly similar to RFID solution, instead the role of RFID tag is replaced with the unique feature of human fingerprint. Although this approach could handle bogus attendance, it shares similar limitations as in RFID solution: high investment cost for fingerprint scanner and only one student can register their attendance at a given time (which potentially results in a long queue). Inaccuracy (i.e., failure in recognising fingerprint) is another common issue in this solution.

The study reported in [16] proposed a voiceprint-based attendance system where students can register their attendance by pronouncing a predefined word or phrase on their smartphone and send the recorded sound (via a mobile application) to a verification server. A real-time positioning system (e.g., geo-tagging) is utilised to prevent students from registering their attendance outside the classroom. However, limiting the attendance registration in a classroom (while lecture is in progress) may potentially distract the students and their classmates, interfering with the lecture. High background noise in a classroom and deviation in the recording caused by different microphone qualities could introduce inaccuracy in the voiceprint detection process.

Application of face recognition technique in student attendance system is gaining more popularity, a few good examples were reported in [15] and [13]. The implementation requires a dedicated camera to be installed in a classroom to capture images of students attending a lecture. Each image is then sent to a centralised server where each face of the students is identified and their attendance is registered. This solution is considerably fast and convenient as it is fully automated and non-intrusive toward the lecture in progress. However, face recognition technique is still far from perfect at present time. Face recognition algorithm also requires large training datasets of face images to produce classifier with high accuracy. In addition, there are many other factors that could introduce inaccuracy in face recognition, namely: poor light condition, different poses and facing angles, image resolution, quality of lens and camera. Such inaccuracy may demand more manual work to verify and correct the attendance record.

III. IBATS - IMAGE BASED ATTENDANCE SYSTEM

We propose a low cost solution in recording student attendance by employing face detection technique. Our solution consists of four stages: image acquisition, face detection, attendance registration, and attendance monitoring (see Fig. 1). We named our proposed solution IBAtS (Image Based Attendance System). The system is designed to improve the time efficiency and to reduce the staff-workload, which would ultimately improve the reliability of the attendance record.

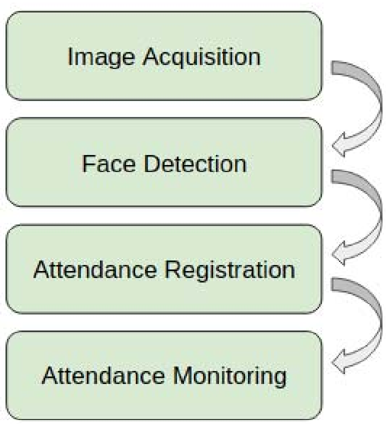
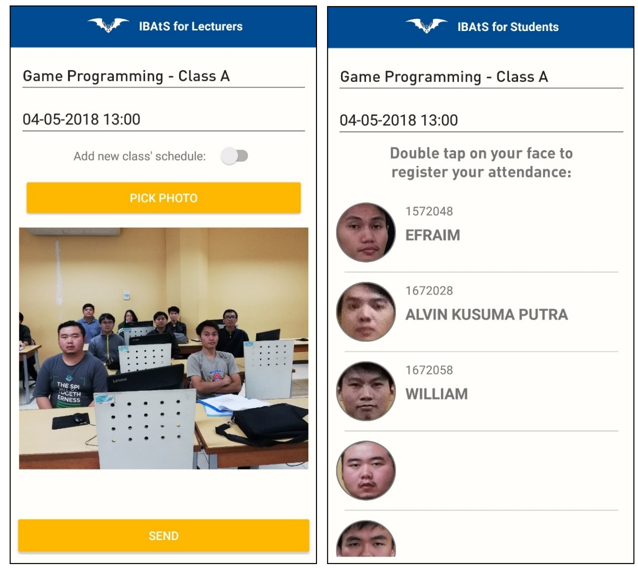


Fig. 1. Four stages in IBAtS. A lecturer initiates the procedure by taking class photographs which cover the entire class attendees. IBAtS then proceeds with face detection procedure to locate faces in each photo. Each detected face is sent back to the students and they can register their attendance by simply selecting their own face. As the academic semester progresses, interested parties (e.g., lecturers, students, and head of department) are able to monitor the attendance report in real-time.

A. Image Acquisition

In the image acquisition stage, images of students seating in a classroom are taken by a lecturer in charge. These images are captured using a smartphone/tablet camera and are uploaded to IBAtS server for further image processing. A dedicated mobile application (see Fig. 2a) was developed for this purpose. Depending on the classroom layout, for each lecture session, the lecturer may need to take several images to capture the entire class attendees. In our case, given the layout of our classrooms, we need to take up to four images for each lecture session (see Fig. 3). Anticipating the late attendance, it is prescribed to take images halfway through the lecture session or at the end of it. These images will serve as evidence for the class attendance.



(a) IBAtS for lecturers (b) IBAtS for students

Fig. 2. Screen-captures of IBAtS mobile applications specifically developed for lecturers and students are presented in Fig. 2a and 2b respectively. IBAtS for lecturers facilitates the lecturer in charge to take class photographs and upload them to IBAtS server. Students then can register their attendance by identifying their face using IBAtS for students. The name and ID of the students who already completed their attendance registration are displayed next to their associated faces.

(a) classroom layout (b) class attendees

Fig. 3. A typical layout of our classroom environment is shown in Fig. 3a. In general, our classrooms consist of four row seats (a bigger classroom may have more rows and row seats). Given the layout, a lecturer needs to take one image per row seat to properly capture the entire class attendees. An example of a class attendance photograph taken in our classroom is presented in Fig. 3b.

B. Face Detection

Face detection is a procedure of locating and extracting face regions from an image [23]–[25]. In this stage, a face detection technique is applied to every image acquired. Each detected face is then cropped and grouped according to the class where the image was taken. We employed a pre-trained classifier provided by OpenCV library [26], [27] to locate students' faces in each image. The classifier was built based on HAAR Cascade, also known as Viola-Jones Detector [28]–[30].

C. Attendance Registration

A dedicated mobile application (see Fig. 2b) was developed to assist the students in registering their attendance. Using this application, students can obtain a list of attendees' faces for each lecture session they were enrolled in; attendance registration can simply be done by selecting their face from the list. This registration procedure is not necessary to be completed inside the classroom. It is up to the students' preference either to register their attendance during the lecture session or after the lecture ended, although students were encouraged to register their attendance after the lecture ended in order to avoid distraction.

As we discovered from our preliminary study, occasional false detections are expected during the face detection procedure; these could be in the form of false-positive detections (i.e., objects mistakenly detected as human faces) or false-negative detections (i.e., failures to detect human faces).

In general, false-positive detections are harmless toward the attendance registration, as long as no student makes any claim on the mis-detected objects as their face. However, it is suggested for the lecturer in charge to review the list of detected faces in each lecture session. For this purpose, each lecturer is equipped with both mobile and web applications specifically developed for the lecturers. Using these applications, the lecturer could obtain the list of detected faces for each lecture session, and remove any mistakenly detected objects.

False-negative detections, on the contrary, can interfere with the attendance registration process; as impacted students (whose faces were failed to be detected) are unable to register their attendance. In order to address this issue, the impacted students can notify the lecturer in charge via a mobile application (IBAtS for students). In response, the lecturer needs to manually locate the students' faces and complete the attendance registration. A web interface was developed for the lecturer to conduct such procedure.

D. Attendance Monitoring

As the academic semester progresses, lecturers can monitor the class attendance which they are in charge of. Depending on the details of the attendance report needed, a simple version of the report is accessible via a mobile application (IBAtS for lecturers) and a more complex report is presented on a dashboard accessible via a web interface. Students can also track their attendance records for every course they are enrolled in via their mobile application (IBAtS for students).

IV. Evaluation and Discussion

In order to evaluate our proposed solution, we implemented IBAtS to record student attendance in eleven different classes at Maranatha Christian University, each with the number of enrolled students ranging between 15 and 44 (see Table I). IBAtS was applied in semester 1 in 2018 over the period of fourteen weeks (i.e., one complete academic semester). There were 177 unique students involved as participants, as identified from the participant consent forms that we have collected. Students might enrolled in more than one class, since different courses were offered in those classes.

TABLE I
Number of enrolled students in each class

Observed Classes	A	B	C	D	E	F	G	H	I	J	K
Enrolled Students	26	16	23	27	15	16	16	23	21	28	44

Five factors were chosen in our evaluation: time efficiency, staff-workload, implementation cost, human error, and student acceptance. Each factor is observed as comparing factor to measure the performance of IBAtS toward the existing (conventional) attendance recording practices (e.g., roll-call and sign-in-sheet). Comparison with few other proposed solutions (see Section II) is also discussed as part of our evaluation.

A. Time Efficiency

Using IBAtS, there are two stages (among the four) which could take a considerable amount of time to proceed as human actions were involved. Those are image acquisition, which is required to be done during the lecture session, and attendance registration which could be completed after the lecture. This is fairly similar to the conventional practices (e.g., roll-call and sign-in-sheet), where printed (paper-based) attendance record is required to be collected during the lecture session and data conversion into a digital format needs to be done after the lecture. For simplicity purposes, we classify these activities into *in-class activity* and *after-class activity*.

An observation was conducted in week 10 and the time required to accomplish both activities in IBAtS was measured and compared to the conventional practices. Table II shows the number of attendees across the eleven observed classes. As the academic semester progressed, the number of attendees was dropping. There were several factors which might contribute to this phenomena, however, the discussion related to it is beyond the scope of this paper.

TABLE II
Number of class attendees in week 10

Observed Classed	A	B	C	D	E	F	G	H	I	J	K
Attendee	26	14	20	25	12	9	14	19	18	25	30

A simple time measuring was conducted in each observed session while lecturer was taking photographs. A similar time measurement was also applied while lecturer was calling out each student's name and while attendance sheet was being circulated. This measurement is used to capture the time spent for conducting *in-class activity* using IBAtS, roll-call, and sign-in-sheet. The result of our observation is presented in Fig. 4. From the figure, we can highlight that IBAtS outperformed both roll-call and sign-in-sheet approach consistently across all the eleven observed classes. Such result is not surprising, and it is expected, as taking class photographs is faster when compared to calling each student's name or circulating attendance sheet. Sign-in-sheet required the longest time to finish and was significantly outperformed by both IBAtS and roll-call. We identified two common issues in sign-in-sheet which resulted in extra time being spent: students forgot to pass the attendance sheet and students circulated the sheet in a wrong direction (i.e., the sheet was passed to the students who already signed in).

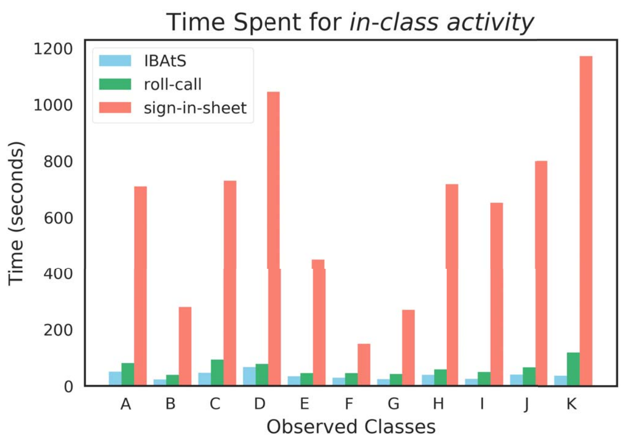


Fig. 4. Time required to collect attendance record within a lecture session (i.e., *in-class activity*) using IBAtS, roll-call, and sign-in-sheet. IBAtS outperformed roll-call and sign-in-sheet across all the eleven observed classes.

We kept track of the time required to conduct *after-class activity* in IBAtS by recording the longest time spent for students in each lecture session to register their attendance (by identifying their face via a mobile application). For the purpose of our evaluation, we asked the students to complete the registration within the lecture session, although in practice students might prefer to do it after the class. For roll-call and sign-in-sheet, since they both have the same data conversion procedure (from printed to digital format), we only recorded the time once for each observed class. Fig. 5 shows the result of our observation on the *after-class activity*; it is clearly shown that IBAtS performs better in most classes. There were four classes in our observation where IBAtS was outperformed by the conventional practices. Two factors were identified as the cause: technical issue due to the lag in students' smartphone and the inexperience in using the mobile application (as we latter found out that not all students in those classes were listed as participants and that was the first time they used the application to register their attendance).

From our IBAtS implementation, we also noticed that some students preferred to register attendances for their classes once a week (e.g., at the end of the week). Thus, the time spent for

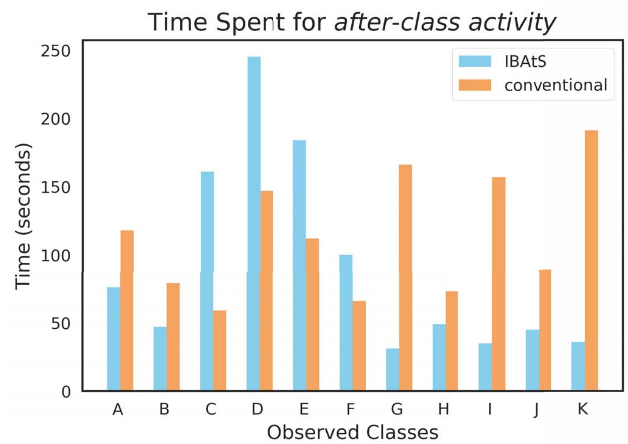


Fig. 5. Time required to complete attendance record outside a lecture session (i.e., *after-class activity*) using IBAtS and conventional practice (e.g., roll-call and sign-in-sheet). IBAtS outperformed the conventional practices in most classes.

attendance registration on regular basis would be relatively small.

In our evaluation, we did not have the environment setup to objectively measure the time efficiency in comparison to other proposals (see Section II). Instead, we tried to identify some time related issues which are commonly found in the proposals from the literature. Long queue introduced in RFID and fingerprint-based solution (as students have to scan their token/fingerprint one at a time) will not be found in IBAtS as class photographs are utilised as attendance record (where one image can capture multiple students). This results in a shorter time being spent to collect attendance record. However, IBAtS is outperformed when being compared to the automated attendance system (as proposed in [18] and [19]), considering human action is still involved in IBAtS to initiate and to complete the registration procedure.

B. Staff-workload

A dedicated administrative staff for data conversion (as found in the conventional practices) is no longer needed in IBAtS. The attendance footage taken in each lecture session is already recorded in a digital format and the task of completing the attendance registration is now distributed among the students. This results in a significant reduction in staff-workload. Our administrative staff can focus on more significant and productive tasks instead of spending time and effort on a repetitive task.

For the lecturer in charge, roll-call task is now replaced with a much simpler task (taking class photographs). This would enable the lecturer to focus more on delivering a better lecture experience to the students. However, IBAtS still introduces a slightly higher staff-workload for lecturers when compared to other proposals (e.g., token-based and biometrics-based attendance systems), where no lecturer involvement is required in the process.

C. Implementation Cost

There are at least two operational costs could be reduced by implementing IBAtS: printing and labour costs; as printing and dedicated administrative staff for data conversion procedure are no longer needed.

Although IBAtS introduces investment cost (mainly to build a centralised server), when compared to other proposals (e.g., RFID or fingerprint system) the cost is considerably small. In IBAtS, there is no dedicated terminal (e.g., RFID or fingerprint scanner) required to be deployed in each classroom. The attendance footage is taken via a smartphone's camera, which most lecturers would own.

D. Human Error

As data conversion procedure (from printed to digital format) is no longer required in IBAtS, potentials human errors introduced within the procedure will also be eliminated. In addition, missing data due to poor practices in handling the attendance documents is no longer an issue; considering the data is now recorded and stored in a digital format from the beginning.

IBAtS simplifies the procedure in registering attendance by allowing students to identify their own face as their attendance record in each lecture session. Such a simple task is distributed among the students and effectively avoid some common mistakes in recording attendance data (as found in the conventional practices) such as a lecturer or a student mistakenly marks an attendance to other student. IBAtS also provides flexibility for students to register their attendance, even after the lecture session is ended, ensuring no attendees being missed from the record.

Bogus attendance issue is effectively addressed in IBAtS, as photographs are used for the attendance record. An alarm will be triggered when there are two or more students make a claim on an identical face for their attendance record. We assume that nobody shares the same face, with the exception of identical siblings such as twins or triplets.

Moreover, as the students do not have to carry any dedicated token to register their attendance in the class, the issue of forgetting to bring the token (as commonly found in token-based attendance system) is avoided in IBAtS.

E. Student acceptance

In our evaluation, we were also interested to have students' perspective on IBAtS. A questionnaire consisting of six survey questions was prepared for this purpose (see Table III). The first five questions (Q1-Q5) aimed to identify whether the students agreed on some key improvements offered in IBAtS; each question required respondents to scale their preferences from 1 to 4 (respectively represents strong disagreement to strong agreement). The last question (Q6) aimed to capture the students' preference toward the class attendance system; respondents were asked to choose their most preferable attendance recording system (IBAtS, sign-in-sheet, or roll-call).

TABLE III
SURVEY QUESTIONS

ID	Question
Q1	Is IBAtS more time efficient when compared to sign-in-sheet?
Q2	Is IBAtS more time efficient when compared to roll-call?
Q3	Does IBAtS introduce less distraction for students in the class?
Q4	Does IBAtS prevent students from being missed in the class attendance record?
Q5	Does IBAtS reduce staff-workload in handling and managing the class attendance record?
Q6	Choose your most preferable attendance system (IBAtS, sign-in-sheet, or roll-call). Supporting argument is appreciated.

The questionnaire was released in week 10 as an online survey and was opened for two weeks to all IBAtS participants. There were 75 respondents participating in the survey. Responses toward the first five survey questions are presented in Fig. 6. Most of the respondents either agreed or strongly agreed to these questions. From the responses, we could conclude that our participants in general appreciated some of the key improvements offered in IBAtS.

Fig. 7 presents the respondents' responses on question Q6. It is clearly shown that most respondents preferred IBAtS to the conventional practices. We further investigated their supporting arguments regarding their preferences. We identified at least five key arguments provided by the respondents:

1) IBAtS keeps the precious lecture time intact since class photographs are used as attendance records (result in less lecture time being wasted).
2) IBAtS relieves the students of the necessity of pay full attention in order to not being missed in the attendance

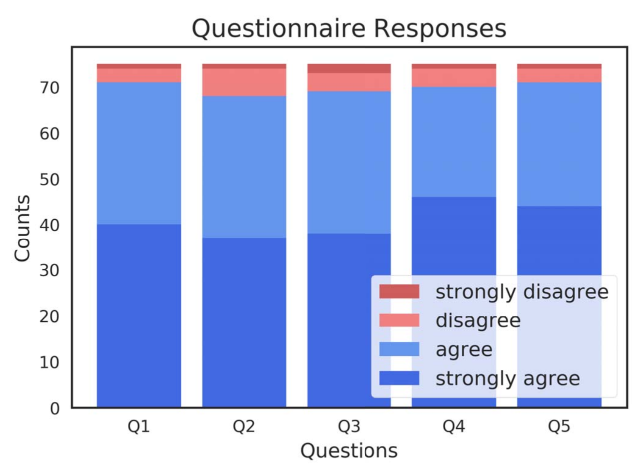


Fig. 6. This figure presents the responses from our respondents toward the first five survey questions (see Table III). The aim of these questions was to identify whether the students were aware and agree on some key improvements offered in IBAtS. There were 75 respondents participating in the questionnaire and majority of the respondents were either agree or strongly agree on the improvements offered in IBAtS.

record, as it often happens in roll-call.

3) IBAtS offers more flexibility and control to the students toward their attendance records, as they can complete the attendance registration at any time (even after the lecture session).
4) IBAtS eliminates potential human errors in handling and managing attendance record (including data conversion procedure), which often results in some attendance records being lost.
5) IBAtS is easy to use, as students can complete the attendance registration by simply identifying their own face.

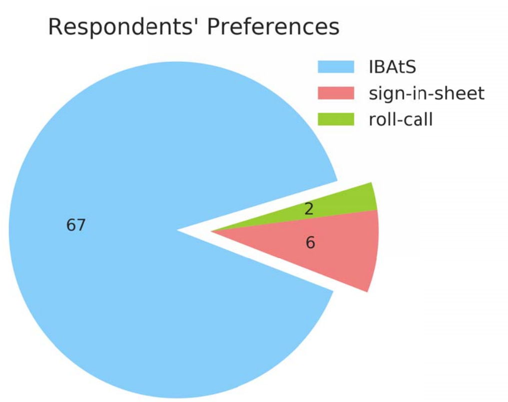


Fig. 7. This figure presents the preferences of our respondents toward the options for students attendance recording practices (e.g., IBAtS, sign-in-sheet, roll-call). IBAtS was the most preferable one among the three. There were 75 respondents participating in the survey.

There were eight respondents who preferred the conventional practices to IBAtS. Some of them argued that the flexibility offered by IBAtS (which allowed students to complete the attendance registration after the lecture session) may result in some students forgetting to register their attendance. Other respondents argued that they were already comfortable with the existing recording routine and were reluctant to adapt with the new procedure offered in IBAtS.

Since all the lecturers who were participating in the IBAtS implementation were also involved in IBAtS development, we were unable to conduct a similar survey for the lecturers as the responses would be bias.

V. Conclusion and Future Works

Recording class attendance is a common practice in many educational institutions; particularly for those who enforce compulsory attendance policy. Roll-call and sign-in-sheet are widely accepted as the conventional practices for recording student attendance in a classroom. However, there are number of issues introduced in these conventional practices, such as time inefficiency, labour intensiveness, human error, and distraction.

In this paper, we proposed IBAtS (Image Based Attendance System) as a low cost solution in recording student attendance by utilising face detection technique. Using our proposed solution, attendance was recorded on class photographs, students' faces were automatically located, and students then registered their attendance by simply identifying their face on the records. Mobile applications were developed for both students and lecturers as the primary interfaces to interact with the system.

Five factors were used to evaluate IBAtS: time efficiency, staff-workload, implementation cost, human error, and student acceptance. From the evaluation, we found that IBAtS outperformed the conventional practices and relatively more cost-efficient when compared to other proposals (as described in Section II). IBAtS also effectively handled bogus attendance, which most attendance systems failed to address.

Apart from the improvements and benefits offered in IBAtS, the system still has few limitations as we discovered during our implementation. Since the class attendance is recorded on photographs, it requires all attendees to be sitting in the classroom when images are taken by the lecturer. This can be problematic in the case of late attendance since their attendance will not be recorded. In order to deal with this issue, we advise the lecturer in charge to take class photographs half-way through the lecture session. Early departure students and students who take toilet break during the lecture session (when the photographs are taken) will also be missed from the attendance record. Similar limitations are also found in both roll-call and sign-in-sheet. Furthermore, in order to capture the entire attendees, it requires the lecturer to take multiple photos in the class. This may result in some students to be captured on multiple photographs, which can confuse the students while completing the attendance registration as they will find redundant faces. For this case, we also encourage the lecturer in charge to conduct a quick review on the list of detected faces and drop any duplicate face.

At the time of this manuscript writing, we are still developing and completing other functionalities of IBAtS (particularly for attendance monitoring dashboard application). We also plan to keep implementing and evaluating the system in several other classes for the upcoming academic semesters. This would benefit us to better understand the limitations of the system and start to formulate some possible solutions. While refining the system, we are also taking advantage on the collected class photographs. These images (with participants' consent) will contribute to the FACE (Face At Classroom Environment) dataset [31], a publicly accessible image dataset for face detection/recognition study. This image dataset would also enable us to start incorporating face recognition technique in IBAtS for face recommendation feature in the next version of the system. We are also interested to extract seating position information from the class images. This could enable us to better understand the correlation between students seating position and their their academic performance.

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