

THE APPLICATION OF IOT SMART ATTENDANCE BASED ON BLUETOOTH LOW ENERGY

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ABSTRACT

Internet of things (IoT) is a technology where any objects is connected to the internet. The IoT application currently being developed to support education system such as the implementation of smart campus including academics and administration field. In order to improve the learning efficiency between lecturers and students, we provide smart application to facilitate administration of attendance. This application able to provide the proof of presence for both lecturers and students by recording user presence automatically. In this paper we conduct experimental trial utilizing beacon BLE (Bluetooth Low Energy) as media communication at our proposed application. The application is called as UMY-Ipresence. The application is built by utilizing a cloud server as a backend services, beacon bluetooth low energy as an intermediary media and an android application as a smart application on an end device. The system is divided into two categories, namely backend services in the form of cloud servers and front-end applications. The application on the front end consists of admin side and user side where each part has a different privilege access. There are several features for users (students) and lecturers in their respective roles for the approach to implementing smart attendance.

Keywords: IoT, Smart Campus, Beacon, BLE, Ipresence

INTRODUCTION

Industry 4.0 era have encouraged educational institutions to implement technology to support proactive learning process in order to improve skillss and competence (Mourtzis et al., 2018). The young generation of the modern era has a high tendency to use electronic devices (gadgets) to obtain information and make it a medium of communication (<https://www.forbes.com>, 2018). Although the learning system using e-learning can be used as an alternative that can help distance

learning students, direct teaching involving the physical presence between lecturers and students is still needed in certain subjects so that the process of absorption of knowledge can be more optimal (Biškupić et al., 2015). College presence is one of the physical proofs of the presence of lecturers and students in a lecture that needs to be noted.

The presence of lecturers and students in lectures is still a matter that is taken into account in the learning system held at Muhammadiyah University of Yogyakarta. Attendance data of lecturers and students are recorded manually on paper or commonly referred to as attendance sheets. Conventional recording has several disadvantages including the opportunity for greater manipulative actions to fill data, and time efficiency. This time efficiency is related to the process of filling in data where students and lecturers fill the attendance sheet in each course attended, then the data will be recapitulated by the admin in the teaching section and uploaded to the academic information system. Therefore the research team intends to establish an automatic attendance recording process with internet of things technology-based in order to improve learning efficiency between lecturers and students.

The main problem behind this research is the initiation of the implementation of smart campus in the University of Muhammadiyah Yogyakarta with the introduction of smart attendance or the attendance of students and lecturers in each subject automatically by the system.

Therefore, the researcher intends to create and implement an Internet of Things based software by utilizing a cloud server as backend as services, beacon bluetooth low energy as an intermediary media and an android application as a smart attendance application on the end device.

The specific objective of this research is to make and test the implementation of smart attendance applications, which are named UMY-Ipresence. The system built is an Internet of Things based software by utilizing cloud servers as backend services, beacon bluetooth low energy as an intermediary media as well as android applications as smart applications on end devices. The existence of this application is expected to facilitate attendance during the lecture

period as well as automation of attendance data recording by a system that has better validity so that learning can be more effective.

THEORY AND RELATED WORK

A. Internet of Things

The Internet of Things (IoT) is a new revolution of the Internet. Objects that have sensors can easily be identified and can provide intelligence analysis that can make decisions in certain circumstances related to the quality desired from the facts. One device can access data that has been collected by other devices. The aim of the Internet of Things is to support "Ubiquity" which allows everything to be connected anytime, anywhere, with anything and anyone who is ideally connected to shared networks and services. The basic idea of IoT is not only about the connectivity of all machines, but how the data generated can be used to generate new knowledge (Suryanegara M. et al., 2016). The smart application perspective is finally associated with the concept of smart data. In principle, intelligent data offerings are associated with the utilization of large amounts of data information as a result of internet connections from machines, humans and other electronic related elements. Data will be considered "smart" after filtering is done to remove "noisy data" to get valuable data (<http://www.information-age.com/>, 2018).

The Internet of Things is a structure in which objects and humans have an exclusive identity and the ability to move data through networks without requiring two ways handshaking between sources namely from human to human for purposes or human interaction-to-computer (Anup W. et Al, 2016). The Internet of Things has a wider range of connectivity than communication between electronic devices such as desktops, laptops and smartphones. The reach of the Internet of Things comes to the connection between various devices that have sensors that are embedded as a tool to communicate and interact with the outside environment through the internet. The basic premise of Internet of Things is the collaboration ability of smart sensors that directly without involving humans in the exchange of data in an application (Ala Al-Fuqaha et al., 2015). The existence of this capability makes IoT a disruptive technology business opportunity, with standards that arise primarily for wireless communication between sensors, actuators and gadgets i

everyday human life. Mohsen Hallaj Asghar et al. (Mohsen Hallaj Asghar et al., 2015) introduced the application concept for the Internet of Things and a discussion of social issues and governance that emerged as a vision of the future of the Internet of Things.

B. Beacon – Bluetooth Low Energy

This research (K. E. Jeon et al., 2018) stated that IoT has the potential to change human lifestyles to be more effective and efficient. In the research carried out, Jeon et al. said that beacon technology in which there is use of Bluetooth Low Energy (BLE) is one of the media that can project IoT. The features of beacons in support of IoT are the ability to detect localization, proximity and sensing activities. K. E. Jeon et al. found that localization applied to beacons was a solution to the shortcomings found in GPS, Wi-Fi Access points, and RFID. In this study stated that BLE beacon technology has a better level of accuracy than Wi-Fi Access Point. Besides localization, BLE beacons have a better proximity detection rate than other technologies. Output produced by proximity detection is something that can spur a command at a predetermined distance when the user interacts with the object. The current technology that has this function is Narrow Field Communication (NFC).

In line with the utilization of Bluetooth Low energy, (T. Okamoto, et al., 2017) has conducted research on changing advertising methods that previously used image processing to BLE. T. Okamoto, et al. proposed an advertising method using BLE beacons in an effort to improve advertising effectiveness through better accuracy of customer attributes.

C. Backend as a Service

Backend as a Service (BaaS) is one of the cloud computing platforms that functions as a middleware between media servers and mobile applications for cloud services through Interface Programming Application (API) and software developers' kits (SDK). This service is a new form of cloud computing where BaaS is also known as Mobile Backend as a service (MBaaS). BaaS also provides general features such as user management, push notification, social networking integration, and other features needed by application users from smartphones. Some Baas

features are similar to other cloud computing service models such as SaaS, IaaS and PaaS, but Baas is unique in that it has a special ability to handle Web and mobile application needs. The service on BaaS has its own API, making it possible to integrate it into other applications relatively easily. BaaS has a way of managing backend data that is constant so that one type of backend can be duplicated and then modified as a server for different applications.

RESEARCH METHOD

1.) The Design of UMY-Ipresence Application System

The UMY-Ipresence application has several parameters for the manufacturing process. In the identification process the research team determined that the proposed application had support for the Android operating system with the lowest OS (Operating System) version was Android 4.3 Jelly Bean (API 18). The smart attendance application installed on a smartphone with an Android OS acts as an end device on the side of the prospective user. Presence system works when the smartphone activates Bluetooth to get a trigger of information from the sensor and then the user's smartphone will be connected to the cloud server via internet media via both cellular and Wi-fi to upload attendance data to the system. Overall the system topology proposed in this study is shown in Figure 1 below.

Communication media that connects the end device with the sensor is Bluetooth Low Energy version 4.0, where the sensor used is a sensor that has the ability to detect distance or proximity. The protocol used in this proximity sensor is a beacon. Beacon is a BLE module that can provide notifications in the form of proximity with more efficient and economical energy use. Beacons are considered better than GPS because the accuracy level is more accurate to 2-100 meters. Meanwhile, the communication media between smartphones and the backend system or cloud server uses wireless both Wi-Fi and cellular networks.

The proposed application system consists of integration of a front end and a back end. The front end section is divided into three types of users, namely students, lecturers and administrators. The front end application on the three user classifications is designed with privilege access that is not the same as each.

The lecturer application has planned additional features that can provide broadcast information to students according to the established procedure. While administrators have the right to carry out administrative actions related to academic speeding. On the back end side of the system that was built, there is one server with smart dashboard display as a web-based desktop application that will be used to process data, and create data visualization, as well as data entry and data management that has been generated from smartphones connected via beacon devices with Bluetooth Low Energy transmission media.

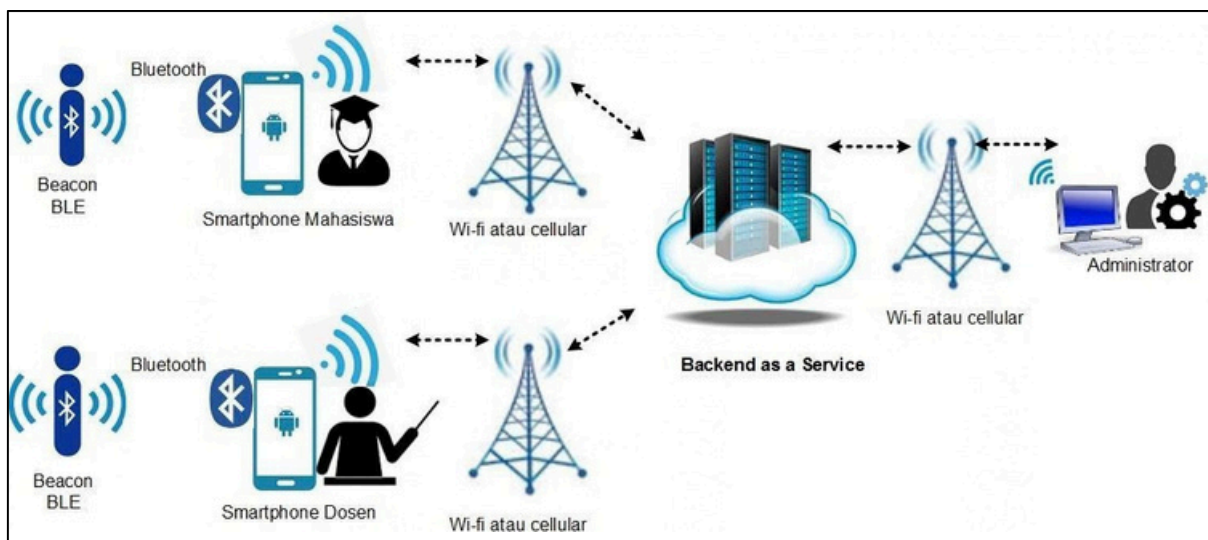


Figure 1. The System Design of UMY-Ipresence

2.) The Implementation of UMY-Ipresence

Previously, student attendance services are collected manually, as well as information sent to students is broadcast by each lecturer manually. All students enrolled in lectures taught by related lecturers will be able to automatically attend the prescribed class and receive information that is evenly distributed.

By implementing the application system, students get information directly with the pop-up message received by their smartphone. The information submitted can be in the form of updating lecture material, grades, student activities, research and other notifications that are considered important for students to know. The radius between smartphones and maximum beacons is 100 meters. So that in the

trial phase, several beacons will be installed in different locations to test the reliability of the system.

RESEARCH RESULTS AND DISCUSSIONS

The result of implementation of the system design is divided into two sides, namely from the side of the mobile device (android) and the database device. The design of the android system has 3 user modes, namely, lecturers, students, and admins. But there are features found in all modes, namely pages for displaying profiles and class schedules. Before entering each mode, there are several systems that will be run by an Android device. The first display when the application is opened is the Splash display. The activity that will be run is the `SplashActivity.java` class with `activity_splash` as the display. The `SplashActivity` class will check the session whether the user has logged in before. If not, the system will call the `IntroActivity` class which will display the `activity_intro` display as the intro page. But if the user has logged in before, the system will check the user's status, whether the lecturer, student, or admin. The Display of `IntroActivity` and its piece of code are shown in Figure 2.



Figure 2. The Display of UMY-Ipresence application and its part of source code

Each user has a status that is presented from 0-2. Value 0 is admin status, 1 is lecturer status, while 2 is student status. If the system finds status 0, the system will call the `MainAdminActivity.java` class with `activity_admin.xml` as it looks. If

the status is detected 1, the class that is called is MainDosenActivity.java and activity_main_dosen.xml. Then when the status is 2, the class called is MainMahasiswaActivity and mhs_activity_main.xml as the display. If it turns out that no user has logged in, then the class that is called is IntroActivity.java, where there is an intro display in the form of a brief introduction to the application, then the login option and then login according to their respective status.

Figure 3 shows the intro page when no user has logged in. After the intro page, the application will point to the user option display. The class called on this page is OptionActivity.java with all_activity_opsi.xml as it looks. The user option on the page must be selected according to the user's status. Because if it doesn't match the status, a dialog will appear which informs the user that the user has chosen the wrong mode. As shown in Figure 3, that displays an error message because the login is not in accordance with the user's status.

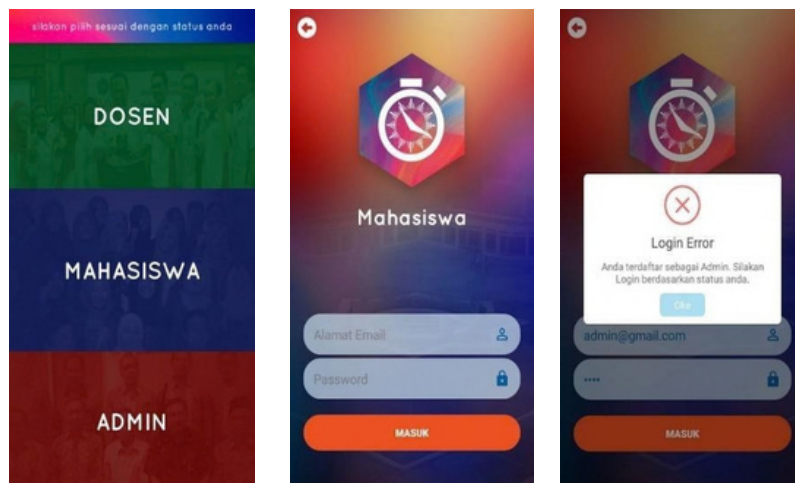


Figure 3. The Application Display: Option Role, Student Login, and Login Error Notification's Example

1) Administrator Mode

On the Admin main page, there are four main admin features in running lecture activities, consisting of the User Input menu, Viewing Database, Input Schedule, and Reset Menu. In addition, when pressing the menu button on the upper left side, a Navigation Drawer will appear which serves to display a brief profile along with photos and several choices. The Navigation Drawer can also be opened by swiping to the left. The appearance of the NMain page for administrator and it's

navigation Drawer are shown in Figure 4. The detail of the detailed application function that includes admin tasks can be explained as follows.

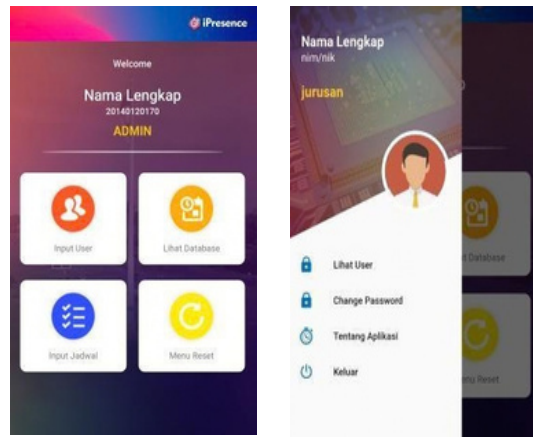


Figure 4. The Dashboard of Administrator Role

a. Input user data

User input is a menu that functions to input user data. The application dashboard is shown in Figure 5. There are two user input modes, namely input in a number of units and in large quantities. When the unit input is selected, the display will appear as shown in 4.8. In the system, the unit input will call the `InputSatuan.java` class with `admin_activity_input_satuan.xml` as the interface. This class serves to register 1 user, both students, lecturers, and admin. The identity that must be filled in is the initial name, last name, user ID, email, password, and user status. User status is available in the form of an Option Box with a choice of admin, lecturer, and students.

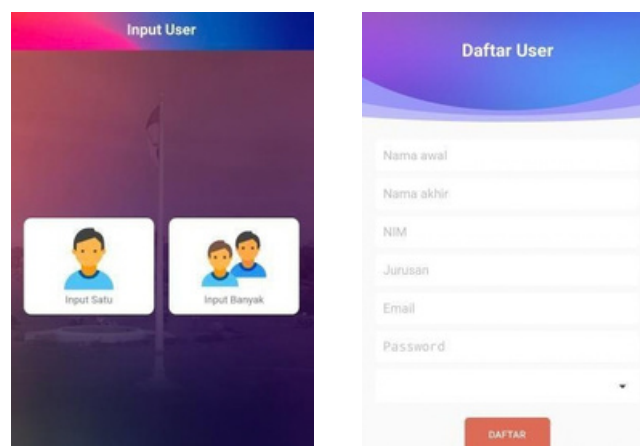
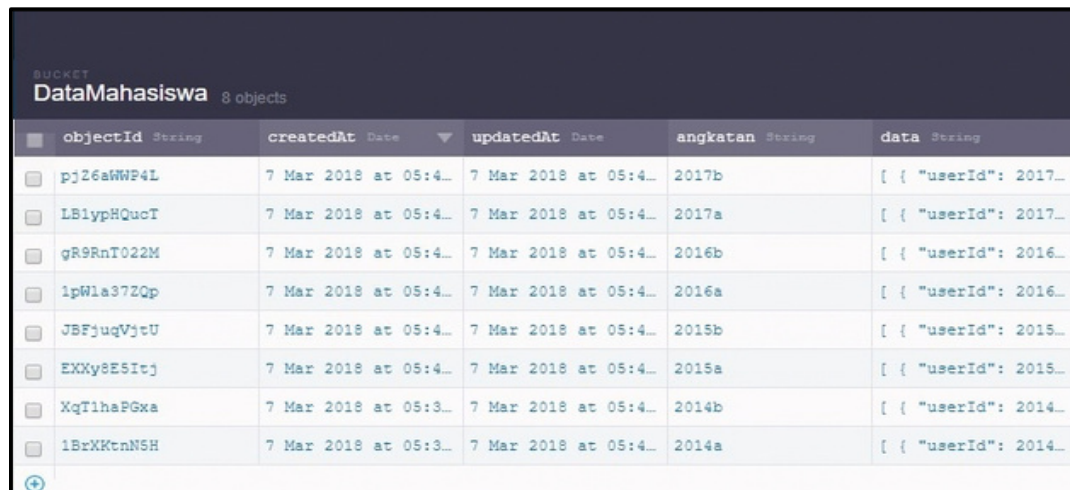


Figure 5. The Application Dashboard of Administrator Role: Input User Data

After all data is filled in, then when the user presses the Register button, the system will save the data to the user database in the mesosphere. The storage uses a method that is already available in the Mesosphere SDK, namely Register Callback. In addition to entering 1 user, the admin can also enter a large number of users. Data on electrical engineering students are classified into two groups in each generation. This is done because the mesosphere database is capable of recording as many as 100 users at a time. The available data is from the class of 2014 to 2017. The student data is made in one column in the form of Java Script Object Notation or JSON contained in the Student Data Database. Database table for Student Data can be seen in table 1.

Table 1. Database of Student



objectId	createdAt	updatedAt	angkatan	data
pj26aWNP4L	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2017b	[{ "userId": 2017...
LB1ypHQuoT	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2017a	[{ "userId": 2017...
gR9RnT022M	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2016b	[{ "userId": 2016...
lpW1a37ZQp	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2016a	[{ "userId": 2016...
JBFjuqVjtU	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2015b	[{ "userId": 2015...
EXXy8E5Itj	7 Mar 2018 at 05:4...	7 Mar 2018 at 05:4...	2015a	[{ "userId": 2015...
XqTlhaPGxa	7 Mar 2018 at 05:3...	7 Mar 2018 at 05:4...	2014b	[{ "userId": 2014...
1BrXKtnN5H	7 Mar 2018 at 05:3...	7 Mar 2018 at 05:4...	2014a	[{ "userId": 2014...

Data in the form of JSON is in the data column. The JSON data contains a complete identity which will then be parsed and entered into the User database. When a user selects many input options, the system will call the InputBanyakUserActivity.java class with admin_activity_input_user.xml as the display. In this class, a list of groups of forces can be entered into the user. When a user selects one user group as above, the user group data will be processed into data that can be entered into the user database. The outline is that data in the form of JSON will be inputted one by one with the looping for command. If there are 100 student data in one group, then the data input command will be done 100 times using looping for. The program will parse JSON data, then each variable will be

declared. After that, the data will be stored with the `MesosferUser.createUser ()` command.

b. View the database

Each database or database needs to be monitored so that there are no errors in the input and output data. Therefore, the admin menu is equipped with a database view menu that serves as a page to monitor all databases in the Mesosphere. The java class used for this menu is `MenuDatabase.java` with `admin_activity_database.xml` as an interface. Display view database can be seen in figure 6. In this menu there are four choices, namely see user, see attendance, see schedule, see space.

On the user view menu, this menu has two menu options, namely a database of student and lecturer users. If you choose the student option, the application will go to the student database display with the `Student Database`. Java as class and `admin_activity_user.xml` as a display. This student database menu will ask the user to select the group of groups that will display the data. After the user selects a class, the list of student users will appear. In addition to the student database, the admin can also view the database from the lecturer. If the admin database menu displays the Lecturer option, the display that appears is a list of lecturer users as shown in Figure 6.

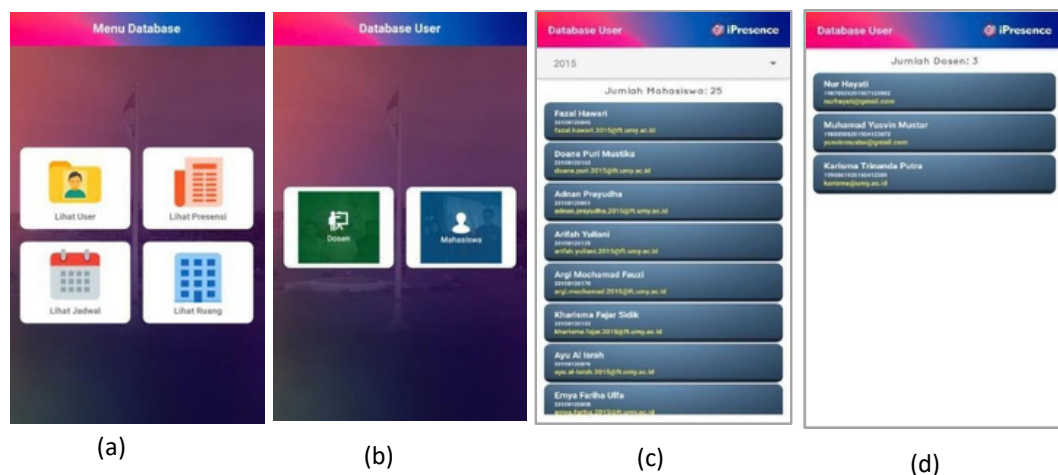


Figure 6. The Display of view database (a) Database Menu (b) Database User (c) List of student (d) List of lecturer

Furthermore, in the view menu, the function is to view attendance data found in each subject. In this menu you can find out the presence of students at each lecture meeting. The class used by the presence view menu is AdminPresensiActivity.java. When the admin chooses this option, there will be a display to choose the course the president wants to see. After choosing a course, then the display will go to the AdminPresensiMatkulActivity.java class. with all_activity_presensi_masuk.xml as a display. On the display, you will be asked to choose one of the meetings. When a meeting is selected, the student list will appear along with the information of attendance or not. The attendance page of the course is also equipped with features inputting the presence to the Result Results database which can then be converted into table form.

The next menu is to see a schedule that serves to see all the schedules available in the database, along with the names of the supervisors, the space, and the code of each subject. In addition, the admin has access rights to delete courses through this menu so that the courses contained in the database will be deleted. Menu view space will display all the space in the database. The variable that will appear on the space list is the name of the room, location, faculty, and major identity of the beacon. This menu can monitor the identity of beacons in each corridor.

c. Input Schedule

Input schedule is a menu that functions to input complete course data along with the time and space available at the base of the data. The data will then be inputted into the MataKuliah database. The base of the data is a data in the form of JSON. The input method is the same as inputting many users, that is by parsing JSON, then inputting it with the looping for command. The data base is in the DataMatkul (course) database.

d. Reset menu

The reset menu is a function where the user can delete all data in the database. When a user selects the reset menu option, the display will go to the reset option found in the OptionsResetActivity.java class. This class displays three options, as follows. Option to reset course, reset presence, reset all databases. Reset this course will delete all the list of courses in the course database. The preset reset option will delete all presence data in the database. All reset options function to

delete all data in the database as a whole. All attendance data and courses will be deleted by selecting this option. The programming code is a combination of the preset reset option code and the course reset option. All commands on the menu have a confirmation dialog like Figure 7 (d). The confirmation dialog serves to ensure the user is suitable in selecting options.

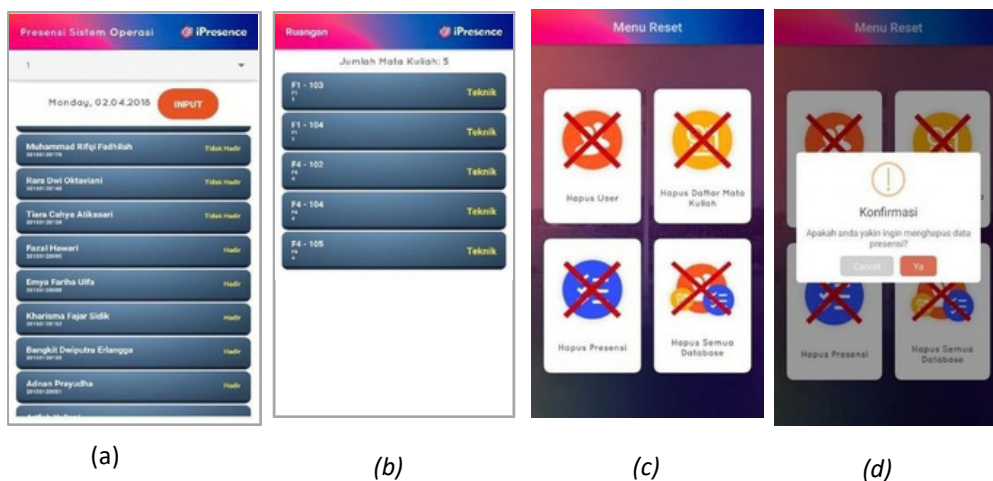


Figure 7. The Display of view database (a) Database Menu (b) Database User
(c) List of student (d) List of lecturer

2) Lecturer Role

The next user is a lecturer. In this lecturer mode, it has a value status of 1. The class that runs on the main page of the lecturer mode is `MainDosenActivity.java` with `dosen_activity_main.xml` as its appearance. The lecturer mode's display ss shown in Figure 8. The main lecturer page contains the identity of the lecturer, namely the full name, staffing number, department, and the status of the teacher. It also contains list of courses taken along with the space and time of the lecture.

In addition to the lecturer identity and course schedule, there are 2 main buttons, namely the presence button and the send notification button. The following is the explanation of the two buttons.

a. Presence/Attendance

Presence on lecturers serves to activate courses at a course meeting. The presence of student courses depends on the lecturer. If the lecturer does not activate the course, there will be no courses at the meeting, or in other words students will

not be able to attend the meeting. When selecting the presence button, the display will move to the view to select space. The class that works in this process is RuangKuliahActivity.java with all_activity_room. xml as the interface. This class requires Bluetooth connectivity because the device will search for signals emitted by beacons. If the Android device has not turned on Bluetooth, then a dialog box will appear in the form of a request to activate Bluetooth. If bluetooth is already on, the device will receive a signal from a beacon that has an identity that represents the identity of each room in one corridor. When the room name has been detected, the next thing is to choose the course to be activated. Then there will be a confirmation dialog whether the lecturer will activate the course at the meeting. If the lecturer chooses yes, then the course at the meeting is successfully activated. The box success dialog will appear. In addition to successful notifications, there is also a random code entered by the system. The entry code functions as a password for students who will attend. This aims to reduce student cheating during attendance. The following is a simulation activating courses by lecturers.



Figure 8. The Display of application to (a) choose the room (b) choose the course (c) confirmation (d) inform the presence status

b. Send Notification

The Button of send notification functions is used to inform students through the iPresence application. When the lecturer chooses the send notification button, the Notification Activity class will work and the display will move to dosen_activity_notifikasi.xml. The send notification button is shown in Figure 9. This display has 2 forms, namely the form for the notification title and content form.

Then underneath of the application display there is an option for which corridor the notification will be sent. The corridor itself represents the identity of the beacon. In other words, the notification range can be selected according to the corridor. After the corridor option, there is a send button at the bottom. When the lecturer presses the send button, the current class will make a command to make a notification and be stored in the Storyline database in the mesosphere.

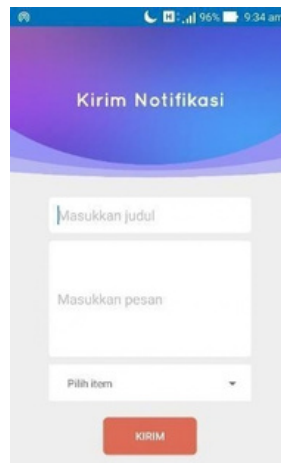


Figure 9. The Display of Application to Send Notification

3) Student Role

The last role is a student which has student mode application. Ipresence student mode has an identity status number 2. The class that runs on the main page of the student mode is the Activity.java Main Student with mhs_activity_main.xml as the display. Display the student's main page exactly with the lecturer mode display, but there is no send notification button. The student role application display is shown in Figure 10.

Student mode has a feature to receive notifications from lecturers. The way to display it is to open the navigation drawer, then select View Notifications. When a user selects the presence button on the main page, the next display is the same as in lecturer mode, namely the choice of lecture room and course. The difference is after the student user chooses the course. Users will be asked to enter the entry code according to the code found on the lecturer user when activating attendance. After that a confirmation appears to enter the presence to the database. When the user selects the option Yes, the class will run the input function according to the user. This feature is shown in Figure 11.

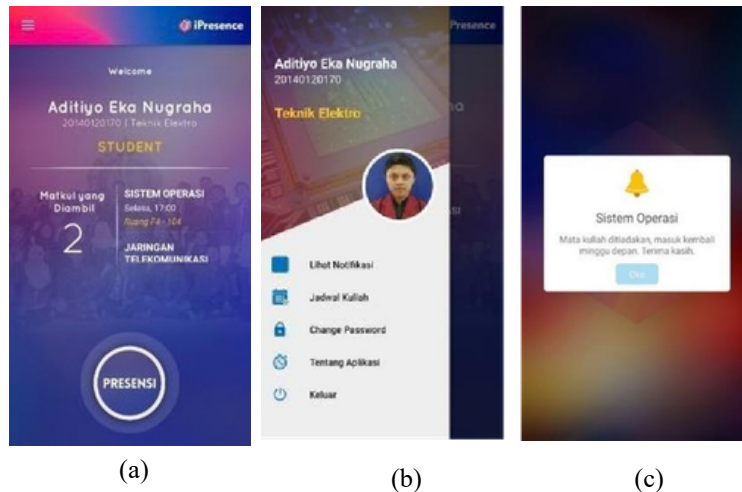


Figure 10. The display at Student mode: (a) Main page for student mode (b) Navigation drawer at student (c) Notification display.

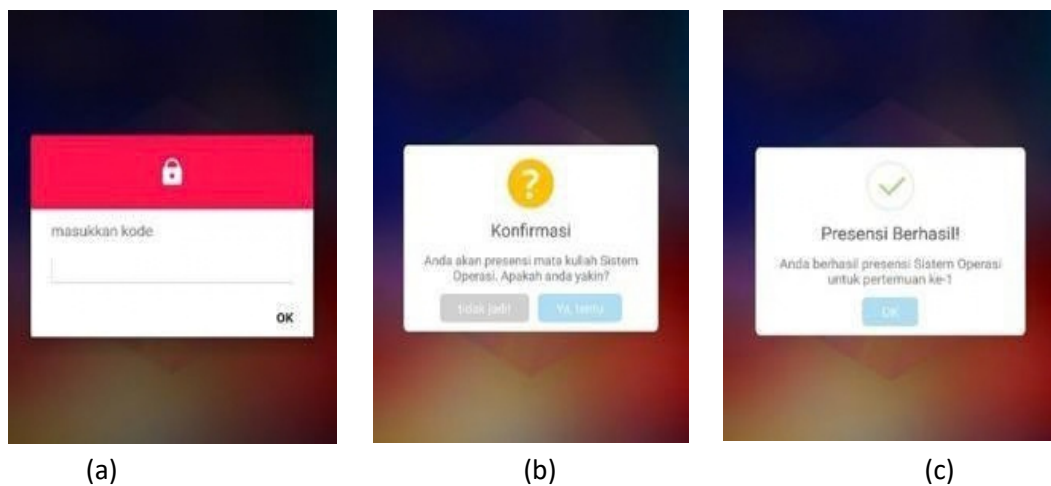


Figure 11. The display at Student mode: (a) Code Input to enter the course (b) Attendance Confirmation (c) Attendance success

4) Additional Features

In addition to presence and notifications, the iPresence application is equipped with a feature showing a schedule list. These features are found on the main page of lecturer and student modes. Schedule list displays the name of the course, day, time of entry, to the course lecture room. Another additional feature is that all iPresence user modes can change passwords according to the user's wishes.

CONCLUSIONS

Based on the results of testing the iPresence application conducted on 17 respondents with various types of end devices, it can be concluded as follows.

- This research has succeeded in designing, creating, and implementing the Ipresence application.
- All end devices successfully install and run the application, with details of 16 end devices successfully presenting and succeeding in providing input to the database, while 1 device fails to attend because it failed to detect the beacon, so the list of lecture rooms doesn't appear.
- The greater the transmission power, the maximum distance that can be reached by the beacon farther away.
- The farther the distance between the device and the beacon, the lower the RSSI value received by the android devices.

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