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Development of POLIMAS Smart Digital Campus with Internet of Things (IoT)

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ABSTRACT*: The Internet of Things (IoT) is expanding at a rapid rate and becoming increasingly important in public necessities. The IoT will change the real world, activities and objects from simple to most complexes including living in campus life. In general, campus spread over a fairly large area, hundreds of students, staffs and visitors are present in the campus. Consequently, this scenario brings a difficulty to put the manpower for monitoring their details or reporting all irregularities observed. This paper describes the development of smart campus using Internet of Things (IoT) technology in Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS) known as POLIMAS Smart Digital Campus. The rationale and significance of the development is to reduce the power consumption in POLIMAS campus and monitoring the parking space availability as well as the environmental protection in POLIMAS campus. Therefore, development of smart campus covered the development of attendance monitoring system, room automation system, smart parking system and smart environmental system. The methodology of IoT is which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. All the output data and activities from these devices are captured and managed properly through available cloud storage. By implementing smart digital campus with IoT technology in Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS), a variety of digital solutions in campus environments can be enhanced such as the quality of life as well as management, safety, & environmental protection aspects. As a result, POLIMAS Smart Digital Campus will make the campus more attractive to prospective students, staff and top management.*

KEYWORDS - *Attendance Monitoring System, Internet of Thing (IoT), Room Automation System, Smart Environmental System, Smart Parking System*

1. Introduction

Recently, the booming growth of the Internet of Things (IoT) technology specifically in Malaysia is in sight. The IoT is a technology that integrated many objects of everyday life which equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks to interconnect with each other and the users [1]. Many applications have been introduced and implemented in many different domains such as healthcare monitoring [2], smart vehicles [3], smart warehousing [4], smart cities [5] and smart campuses [6],[7]. In fact, the smart campus originated from the concept of smart cities which applying the principles of smart cities to the operation of the campus. Initially the idea of smart digital campus is to digitalize the learning and administrative process in the digital environment [7]. In contrast with the traditional digital campus, smart campus provides services in a timely manner, reduces effort and cut operational costs. Several researches have been done and determine that implementation of IoT in Malaysia will gives loads of advantages to the consumer, industry and public sector [8]. One of the potential sectors that can beneficial from this technology is education industry where the learning and administrative process can be enhanced. Consequently, the smart digital campus with IoT based is very much needed to utilize the secured and modern technology for classy environment as well as management, safety and environmental protection [6].

In Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS), especially during the working day, many students and staff members spend a frustrating amount of time to find an available car parking lot. This is not only a time consuming and expensive, but it may also cause car traffic jams and increase pollution levels. Utilizing sensing technologies in parking lot and driveways would assist students and staff to find the nearest available car parking lot. Furthermore, it can be some human mistakes where the students or staffs forget to switch off the appliances in classroom, staff offices or laboratories when is not in used. As a result, it has a direct impact on the cost of operation and power consumption of the buildings. Similarly, the existing staff attendance system has drawback and process of tracing staff attendance is harder. Hence, by implementing smart campus with IoT technology in POLIMAS, a variety of digital solutions in campus environments can be enhanced such as the quality of life as well as management, safety and environmental protection aspects. Furthermore, by implementing smart digital campus in POLIMAS, not only operational costs can be reduced but able offers a technology tools for the students and staffs.

The main objective is to design and implement an IoT based system to enhance the quality of life as well as management and environmental protection aspects for POLIMAS campus. To achieve the main objective, there are some specific objectives need to be done which include:

1) To develop the prototype of POLIMAS Smart Digital Campus with internet of things implementation
2) To simulate the functionality of the POLIMAS Smart Digital campus system.
3) To innovate the system with better improvement such as in power consumption by controlling the appliances, protection of air quality and waste monitoring.

The scope of this research is to integrate all the objects such as room automation system, to reduce the power consumption in POLIMAS campus. Furthermore, to monitoring the staff attendance and parking space availability as well as the environmental protection in POLIMAS campus. All the output data and activities from these devices will be captured and managed properly through available server and cloud. The smart digital campus is a smarter object connected daily in the IoT. The integration of the object will perform by using sensors, building system and other devices (over the same common infrastructure that enables digital technology), then the data can be collected from a variety of sources across the campus. As a result, all of the data can be used by campus operations teams to pursue the common goals of IoT implementations.

2. Methodology

The work undertaken in this research is divided into two stages; designing the smart campus system platform and experimental work. In this research, the focus is to implement smart campus with IoT technology in POLIMAS with the aspects to enhance the quality of life as well as management and environmental protection such as the quality of attendance monitoring, room automation, smart parking and environmental system. As mentioned before, the IoT is a technology that integrated many objects of everyday life which equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks to interconnect with each other and the users. In first stage, Smart Digital Campus system is design of the smart campus system by integrates all devices involved by using controlling and monitoring platform as shown in Fig. 1. Each controlling and monitoring platform will be used according to the purpose.

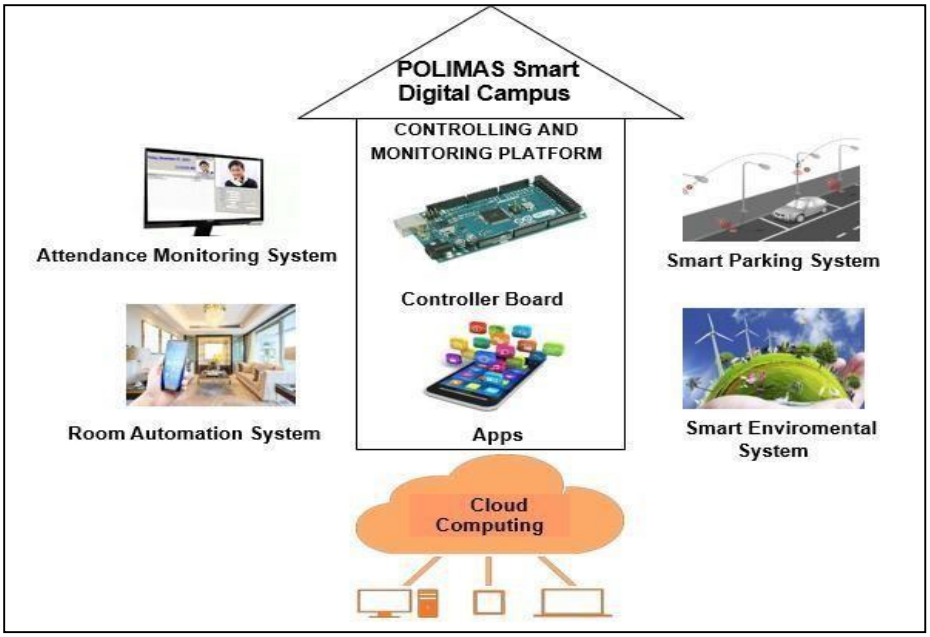

Figure 1: Integration of Smart Digital Campus devices

Next, in stage two or experimental work, the details discussion on the proposed platform for POLIMAS Smart Digital Campus can be seen in Fig. 2. As shown in Fig. 2, the proposed architectures for POLIMAS Smart Digital Campus have three main layers includes perception layer, network layer, and application layer. The bottom layer provides all the sensors to collect sensory data about the monitored phenomena such as the smart parking consists of RFID tag and RFID reader to recognize and updating the availability of parking lot. A parking system will provide information related to the available parking lot. RFID reader is put in the parking entrance to senses the vehicle that enters the parking lot. The information will be processed by the system that provides information to the users about the available parking lot. In the middle layer i.e., network layer which responsible for reliable transmission of information from perceptual layer such as data aggregation, filtering, fusion, and information extraction will be occurred. In the top layer, servers or a cloud are used to store and retrieve data.

To reduce the power consumption in POLIMAS's Smart Digital Campus, motion sensors are used to control lights, turn them off periodically when there is no movement in the classroom. This motion sensor shuts off power if it does not detect any motion within some duration. In other words, the sensors automatically cut off power when the room is empty. Attendance monitoring system was proposed by using face detection in order to track attendance automatically and adequately. Similarly, the campus environmental can be monitored by using humidity sensors and gas detectors to monitor temperature, humidity and gas contamination.

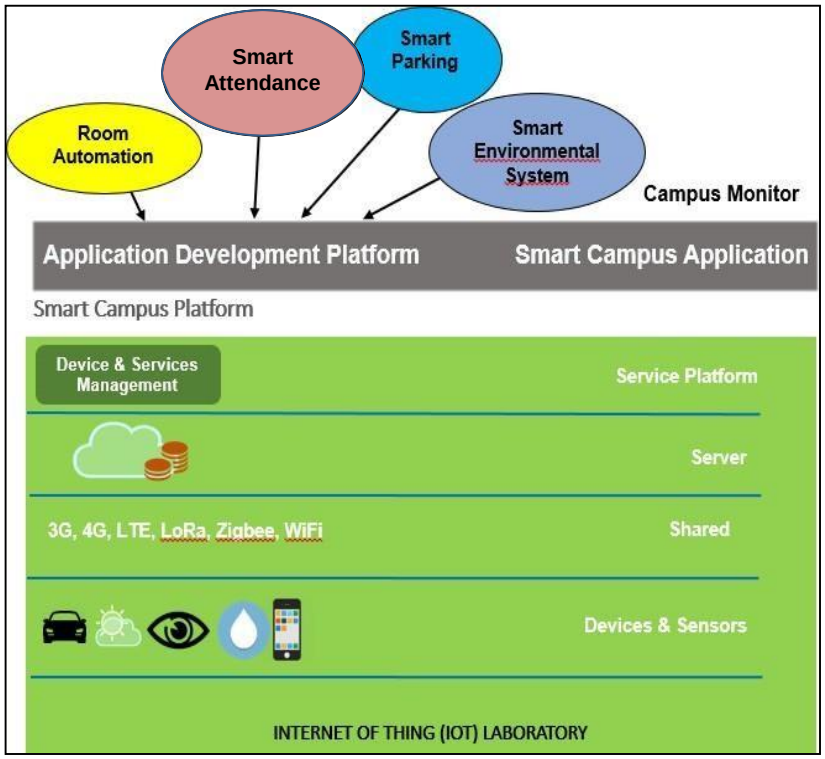

Figure 2: Proposed platform for POLIMAS Smart Digital Campus

3. Result and Discussion

The prototype of the attendance monitoring system, room automation system, smart parking system and smart environmental system had been successfully set up. Fig.3 shows how the face recognition is captured with percentage of accuracy. The method used for face detection is Haar cascade classifier while face recognition is Local Binary Pattern Histogram (LBPH). The distance between camera and face also play important role in determining recognition rate of human face.

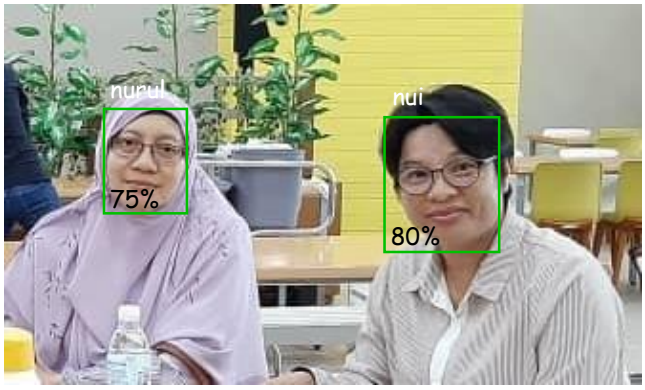

Figure 3: Face Recognition with Percentage Accuracy

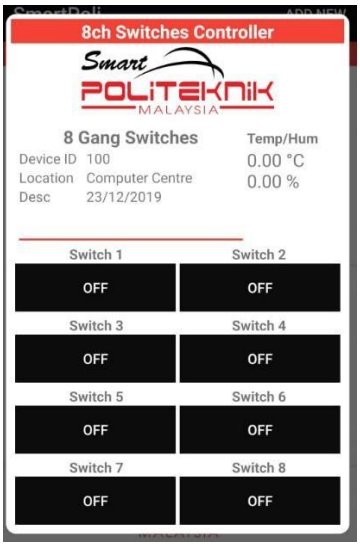

Figure 4: Room Automation 8 Gang Switches

Vehicle		
Position	Front and Skewed	Rear and Skewed
Accuracy	70%	66%

(a) Detection from different position

Vehicle		
Day/Night	Day	Night
Accuracy	80%	80%

(b) Detection from different Situation

Figure 5: Car Plate Number Detection with Percentage Accuracy

Fig. 4 displays the 8 gang switches apps used to connect the appliances for the room controller automation system. Each of appliance is able to be turn off and on from the smart device regardless of where is the user. Furthermore, a switch will be turned off itself when no movement detection. Fig. 5 shows the result of car plate number detection taken from difference angle and situation. It displays the percentage of accuracy for each position. This will be used for car parking system. Fig. 6 displays sample readings of temperature and atmosphere pressure. This will be integrated with smart environment system to alert surrounding people.

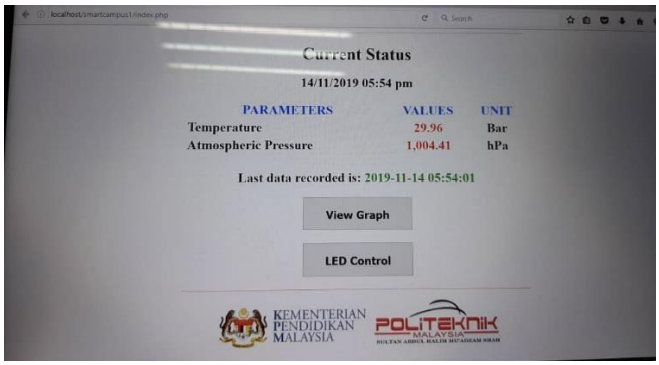

Figure 6: Sample Readings of Temperature and Atmospheric Pressure

Smart Digital Campus technologies based on Internet of Things (IoT) transforms the campus life in powerful new ways as the IoT connecting sensors, devices and collaboration tools over a common network infrastructure. POLIMAS Smart Digital Campus not only empowers the staff but also the students to become more engaged and successful in their Technical and Vocational Education and Training (TVET) programs. As a result, POLIMAS Smart Digital Campus will make the campus more attractive to prospective students, staff and top management. Besides that, the expected impact of POLIMAS Smart Digital Campus is one of the initiatives for brings the better social wellbeing to the campus by lowering the power consumption, costs and environmental protection.

4. Conclusion

The idea of Smart Digital Campus came out of the recent attention given to Smart Cities and also with IoT implementations. Essentially it is aimed at deployment of internet-based applications, content management platforms and broadband infrastructures in every sphere of public systems (such as healthcare, media, energy and the environment, safety, and public services) [9]. Through the study, since there is no smart digital campus has been implemented in any Malaysia's Polytechnic. Thus, POLIMAS should also embody principles of a smart campus in view of the fact that an academic campus essentially for people who are expected to be engaged in intellectual progress, knowledge creation and guiding societies for better living. According to [9], a typical smart campus would have three pillars: infrastructure, operations and people. The most important is each pillar would work in an interconnected and integrated fashion to utilize resources efficiently which involving IoT and sensor technologies as the main facilitators of smart infrastructure. For ensuring sustainability, sensor based environmental monitoring of the campus has planned. To enhance sustainability, smart classroom will be introduced to reduce the electricity consumption. For a simple way and fastest way of taking staff attendance by using face detection was proposed. Further, the car parking availability has planned to enhance the usage of car parking space in the campus. As an expectation result, all of the data collected can be used by campus operations teams to pursue the common goals of IoT implementations to reducing energy consumption and power costs, the car parking availability, refining the environment quality as well as safety and environmental protection aspect.

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