SIMS: SMART IOT-BASED MONITORING SYSTEM WITH SECURITY SURVEILLANCE USING MOBILE APPLICATION

Edmon O. Fernandez
Electonics Engineering Department
edmon_fernandez@tup.edu.ph

Angela Denise P. Alcantara
Electronics Engineering Department
angeladenise.alcantara@tup.edu.ph

Alvin Kenneth A. Cabanlit
Electronics Engineering Department
alvinkenneth.cabanlit@tup.edu.ph

Ma. Celine V. Grecia
Electronics engineering Department
maceline.grecia@tup.edu.ph

Reynald B. Minguez
Electronics Engineering Department
reynald.mingues@tup.edu.ph

Vincent Paulo D. Soriano
Electronics Engineering Department
vincentpaulo.soriano@tup.edu.ph

***Abstract*- The Internet of Things (IoT) is characterized by the networking of commonplace items that have sensors and communication capabilities that gather and share data online. This connectivity opens up a wide range of opportunities, from enhancing a smart security, and constructing a monitoring network. Using IoT systems and smart devices like Android, Raspberry Pi, and Motion sensors, we can simply reduce the cost and labor needed by society by using sensors and other technologies. In this thesis, we give a thorough explanation of the smart security system's assets, architecture, functionality, and capabilities.**

Keywords: Internet of things, Raspberry Pi, Sensors, Smart Security

I. INTRODUCTION

With the emerging development of the technologies in our society, new innovations have occurred that could help us in our daily life, to provide an efficient service, and innovative process. The IoT benefits include better asset management and tracking. Increasing the volume of data and products, it enables the equipment and resource use that can result in cost savings are optimized. Additionally, it provides the chance to develop brand-new intelligent, networked products and investigate brand-new business strategies. Similarly, educational institutions like Technological University of the Philippines- Manila face the challenge of ensuring the safety of their facilities and valuable possessions. For the past years, the establishment has encountered damage and loss of properties, particularly in its laboratory facilities. Today, TUP College of Engineering Room 5 has several newly-acquired and expensive engineering apparatuses that demand improved supervision and safekeeping. Thus, the incitement of the plan to develop an Internet of Things-based security and control system, which can provide authorized users with real-time updates about the room, send electronic warning in case of emergencies, and allow remote access to the network of devices within.

II RELATED STUDIES

Human and Object Monitoring

Systems that are capable of monitoring human activities and tracking object movements are widely used in various industries. Their meaningful contribution to ensuring the safety and security of a specific place is unquestionable. Monitoring systems are normally deployed with the use of AutoID technologies such as barcodes, RFID, magnetic stripes, etc. in areas where various items are accessed by several users thus elevating the tendency of loss or theft due to weakness in terms of surveillance (Wahab et al., 2011).[1] In this study, the researchers plan to use RFID cards and stickers to precisely monitor the activities inside the room.

Security Systems

Security systems serve as a safety scheme against intrusion, theft, or any form of unauthorized access. According to statistical data examined by Nios II Development Kit Cyclone II Edition, a particular area with a state-of-the-art security system is three times less likely to be broken into compared to a locale without one. Further, several pieces of research suggest the improvement of security system using smart monitoring devices such as motion detectors and automated door locks to curb burglary and gather evidence against trespassing (Assaf et al., 2012; Tseloni et al., 2016). [2] If this IoT-based network of systems will be implemented efficaciously, the level of competency of the room in terms of safety and security will be heightened. [3]

Inventory Management

Keeping a precise and organized inventory has become a taxing job for most people, especially for large-scale inventory stock supervisors. Thus, some establishments decide on shifting to automated inventory systems. On the word of Wolcott (2000),[4] inventory management systems provide information to efficiently administer the flow of materials, effectively employ people and equipment, and harmonize internal activities. Although most inventory systems are created for business corporations, the study is specific to the adoption of automated tracking devices only like RFID technology, with the intent of refining the security system.

About the implementation of the automated monitoring system in this study, the most comparable project is of Savakar and Hosur in 2016.[5] Their journal discusses the design and development of an automated library system, wherein issuing of books, return of them, and other relative transactions are recorded periodically with the help of an electronic system. The Library Management System is a program that assists the admin in storing results in a database, generating reports, adding new books and categories, updating the old books, and collecting results. Concerning the storage, the team used cloud computing technology to digitally secure all activities and systematize the old-fashioned library management practices.

Likewise, as stated in an article on Fedena, inventory management in school is simply the management of their assets – facility objects (e.g., chairs and tables), room equipment such as projectors and video

players, and library assets like books. Inventory management is essential to ensure that they are properly taken care of and utilized in an ideal fashion, to ascertain that there is a good return of investment, and to guarantee that all the stakeholders will benefit from the school necessities.

IoT-based Smart Home Security System with Alert and Door Access Control using Smart Phone

In 2016, S. Anwar et al., developed a low-cost system to monitor the home remotely using a smartphone. The system could detect an intruder and capture his image using a PIR motion sensor and PiCamera, respectively.[6] Also, the system comprises a relay driver to control the electromagnetic door lock, and a loudspeaker system to enable voice alert. All these devices are interconnected to a Raspberry Pi set up for storage of the captured image in an SD card. For the sending of email notification to the user, SMTP software was used. The python script is the command language adopted for SMTP software and other devices like the door lock. For the voice alert, the user sends a Linux command through the Internet, which stimulates the voice alert. SSH Client is used to transmit the instruction, which is implemented on the android platform using JavaScript.

IoT-based Integrated Home Security and Monitoring System

Novosel et al. (2017) develop a system for automatic recognition using facial images to identify a user and grant him/her entrance to the premises. The system consists of two main parts: the front-end, where the Raspberry Pi and USB web camera run with OpenCV. And the backend, which possesses a server running the Django web framework using OpenCV library. For the recognition process, the front-end is responsible for motion detection, it is used to detect if the user is ready for image processing. When the user starts the system, OpenCV will process him/her image using the Viola-Jones algorithm and sends the enhanced image to the backend for classification, using pertained SVM model to get the user ID. To enhance the image, the team used Gaussian blurring to reduce noise and histogram equalization to mitigate the external lighting. Lastly, in the evaluation process, 95% recognition accuracy is achieved on the ORL dataset [7]

III. METHODOLOGY

A. *Software Design*

Object Detection

In object detection, an image or frame of an object can be determined. It is computationally expensive and therefore slower than object tracking. Object detection is commonly used in deep learning-based object detectors.

Object Tracking

Object tracking focuses on the x and y input coordinates of an object in an image and assigns a unique ID per object. Also, object tracking provides real-time tracking of a video stream based on frame attributes.

Centroid Tracking Algorithm

Centroid tracking combines object tracking and detection algorithms, creating unique ID for each object identified on the system. The given attributes can be utilized to compute the Euclidean distances of the centroids and identify their distances from each other.

Inventory Mapping

The mobile application will feature a simple yet dependable inventory map of the equipment inside the room. This will allow the faculty members to locate apparatuses.

Sensors, Surveillance, and Smart Switches

These devices will remain active 24/7 to prevent any form of accident or criminal case from happening around the area. They will alert the system to any unusual activities happening in the area. The data gathered by these devices will be stored in a database, set up for any instructions for information lookups.

Mobile Application

This project aims to create a mobile application that will provide access to the features of the network. It includes controls, visual reports like room availability and a list of instruments, as well as security and alarm notifications.

Data Access

The mobile application features a log-in interface to identify if the person is a limited or administrative user.

Application Interface

The graphical user interface will have a simple and user-friendly design. The interface will allow the user to access certain features of the system, depending on his identity. As mentioned earlier, the mobile application will provide access to CCTV real-time footage, visual reports such as inventory maps and temperature, and control appliance power switches.

B. *Hardware Design*

The representation below denotes the physical characteristics of the system proposed in the study. It comprises the proposed security and control systems. Because this project is a system of systems, the following illustrations show the individual systems as well.

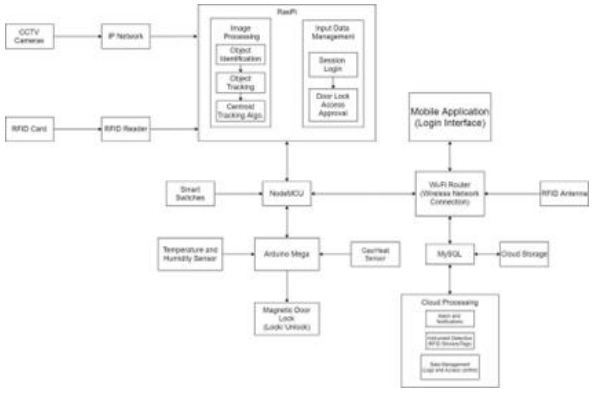


Figure 1Project Flow Chart

C. *Block Diagram*

Door Control and Intruder Detection

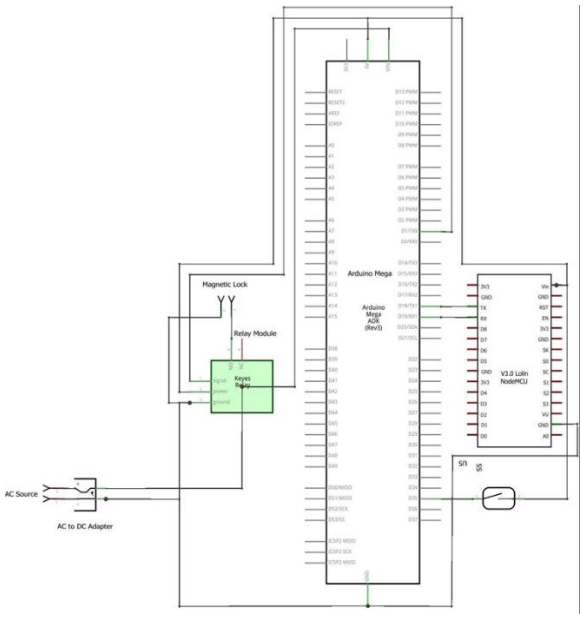


Figure 2 Door Lock System Schematic Diagram

The setup will be installed at the doors of COE 52; connected to the D1 of Arduino Mega is a relay module, which powers the magnetic lock. The magnetic lock is connected to an AC to DC 12V adapter. This system also features a reed switch that will allow it to detect force break-in or intrusion. Moreover, the NodeMCU is connected to Tx and Rx of the Arduino to work as the transceiver, connected to the wireless router.

Smoke Sensor and Temperature Monitoring

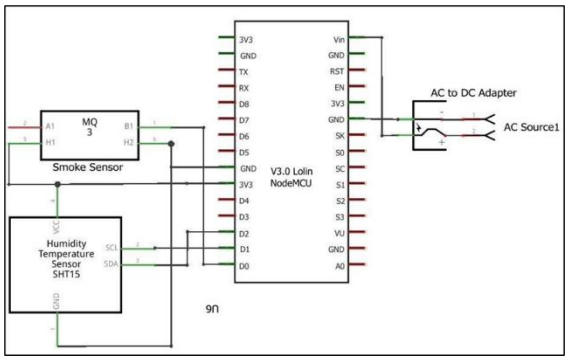


Figure 3 Temperature/Humidity/Smoke Detection System Schematic Diagram

In this circuit, the NodeMCU is powered by an AC to DC adapter. The temperature and humidity sensor is connected to the NodeMCU via line D1 and D2, which are powered by the limited power output 3V provided by the NodeMCU module. Moreover, with the same DC power source of the temperature humidity sensor, the smoke sensor with a 3V DC supply is connected via the D0 line of the NodeMCU.

Appliance Control

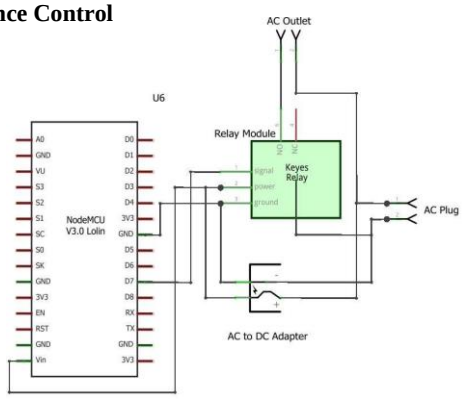


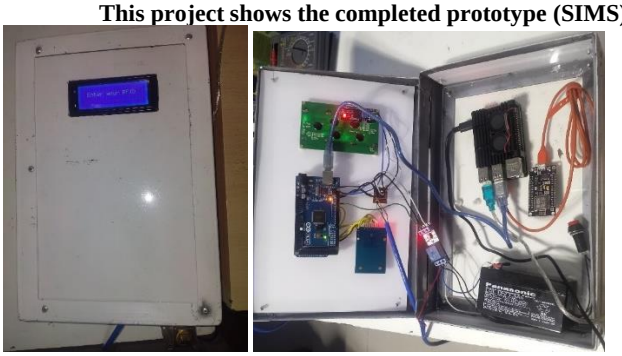
Figure 4 Appliance Control System Schematic Diagram

In this part, an AC plug will be used to serve as a power source for the AC to DC adapter. Also, a DC supply will be utilized to power the NodeMCU and the relay module. The common line of the relay is connected to one line of the AC source (to power Normally Open (NO) and Normally Closed (NC) lines of the relay module. Then, the NO line is connected to an AC outlet plug. Lastly, the other AC line is linked directly to the AC outlet plug. The trigger line of the Relay module is connected to D7 of the NodeMCU.

IV. TESTING AND ANALYSIS

Project structural design

This project shows the completed prototype (SIMS).

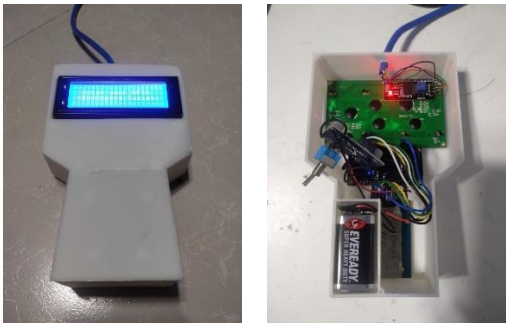


Figures 5 and 6 Front and inside view of the front panel of SIMS.

Figures 6 and 6 show the actual front panel's front and inside view. The prototypes' dimensions are measured at 8.3 inches x 2 inches x 12 inches. The frame is made with steel and chassis are made from acrylic. The front panel is installed with a 12V battery that serves as backup power for any power outage.

Figures 7 and 8 Smoke detectors and Temperature/humidity sensors of SIMS.

Figures 7 and 8 show the actual smoke detectors and temperature or humidity sensors. The prototype's dimensions are measured at 4 inch in diameter and 2.1 inch in height. It is 3D printed PLA+ plastic for the chassis.



Figures 9 and 10 Actual front and inside view of the borrower's device of SIMS.

Figures 4.5 and 4.6 show the actual borrower's device RFID. It is 3D printed PLA+ plastic for the chassis.

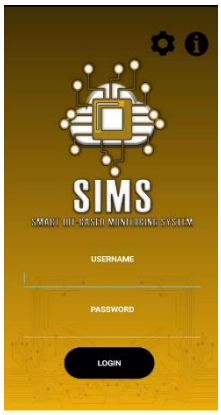
Figure 11 Actual 3d view of enrollment device of SIMS.

Figure 11 shows the actual enrollment device. It is 3D printed PLA+ plastic for the chassis.

Figure 12 and 13 RFID Antenna and CCTV network.

Figure 12 shows the actual position of the RFID antenna located outside the secured area. The antenna detects any attempt of stealing or registered equipment within the secured area.

Figure 13 shows the CCTV cameras installed at a wide viewing angle to monitor and detect the number of people within **the** secured area. This serves as log for the number of people who are using the area



Figures 14 and 15 SIMS mobile application login and dashboard UI.

Figure 14 shows the actual mobile application login UI. It is coded using visual basic. The user is required to enter their credentials granted with access rights specified to their position within the faculty, as students or professors.

Figure 15 shows the actual mobile application dashboard for professors. For professors using the application within the dashboard, they can access the CCTV monitor, room entry logs, temperature, humidity, borrowers' log, people counter, door lock status, and fire alarm status.

V. CONCLUSION

Based on the gathered data, outcomes of the tests conducted, and the analysis of findings, the following statements were inferred:

1. The system utilized only 4 GB of RAM and a 1.5 GHz Quad-Core Raspberry Pi, which proved to be insufficient when all subsystems were activated simultaneously. It can still operate but with an apparent compromise in processing speed, resulting in a decrease in accuracy rating.
2. The prototype was deployed at an alternative location, which became a limiting factor in terms of internet speed. Given that the project is an IoT-enabled system of systems, its functionality is highly dependent on a reliable internet connection. Consequently, this led to a decline in its precision rating.
3. Wireless devices requires wireless power supply. The alarm modules in this project operated using only 9V batteries, which deplete quickly over time, necessitating periodic battery changes.
4. The entire system is designed to be implemented at TUP-COE Room 52, including the backup power supply. However, due to unforeseen events, the researchers had to use an alternative location, resulting in compromises to several features of the study.

REFERENCES

[1] Wahab, M. H., Abdul, H., Tukiran, Z., Sudin, N., Ab. Jalil, M. H., & Johari, A. (2011). "RFID-Based Equipment Monitoring System." InTech. https://doi.org/10.5772/18776.

[2] Assaf, M. H., Mootoo, R., Das, S. R., Petriu, E. M., Groza, V., & Biswas, S. (2012). "Sensor-based home automation and security system." In IEEE International Instrumentation and Measurement Technology Conference (I2MTC), 2012 (pp. 722-727). https://doi.org/10.1109/i2mtc.2012.6229153.

[3] Tseloni, A., Thompson, R., Grove, L., Tilley, N., & Farrell, G. (2017). "The effectiveness of burglary security devices." Security Journal, 30(2), 646–664. https://doi.org/10.1057/sj.2014.30
[4] Wolcott, H. (2000). "Logistics and Supplies Management." Pearson Education Ltd.
[5] Savakar, D. G., & Hosur, R. (2016). "Automation of Department Library System." International Journal of Science and Research (IJSR), 5(6), 635-637. Retrieved from https://www.ijsr.net/getabstract.php?paperid=NOV164176
[6] Anwar, S., & Kishore, D. (2016). "IOT based Smart Home Security System with Alert and Door Access Control using Smart Phone." Volume 5(12), 504–509.
[7] Novosel, R., Blaz, Z., Vitomir, & Peter. (2017, September). "Face recognition with Raspberry Pi for IoT environments." ResearchGate, 477-480.