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**DEPARTMENT OF INFORMATION COMMUNICATION TECHNOLOGY
PROJECT**

**DESIGN AND IMPLEMENTATION OF A SMART
SECURITY SYSTEM FOR LABS**

(Case study IPRC-HUYE)

**Submitted in Partial Fulfillment of the Requirements for the grade of
Advanced Diploma in Information Communication Technology.**

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DEPARTMENT OF INFORMATION COMMUNICATION AND TECHNOLOGY

DECLARATION AND AUTHORITY TO SUBMIT THE PROJECT

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Title of the Project: **“DESIGN AND IMPLEMENTATION OF A SMART SECURITY SYSTEM FOR LABS”**

a. Declaration by the Students

“We **NIYONZIMA Jean Leandre** and **HARERIMANA Jotham** do hereby declare that this Project submitted in partial fulfillment of the requirements for the Advanced Diploma in **Information Communication and Technology** at RP- IPRC HUYE, is our original work and has not previously been submitted elsewhere. Also, we do declare that a complete list of references is provided indicating all the sources of information quoted or cited.

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b. Authority to Submit the Project

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In Our capacity as Supervisors, we hereby authorize the students to submit their Project to the department ready for presentation.

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Date:/...../2022

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Signature:

DEDICATION

We are happy to dedicate this project to:

- ✓ Almighty GOD
- ✓ Lovely parents
- ✓ My brothers and sisters
- ✓ Lecturers
- ✓ Siblings, friends and colleagues
- ✓ Our supervisors;
- ✓ We appreciate determination and every support you gave us

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We would like to express our sincere gratitude to Our Almighty God, Lovely Parents for supporting us in our final year research project.

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ABSTRACT

This project on ‘‘ SMART SECURITY SYSTEM FOR LABS was done taking a case study at RP-IPRC HUYE, it has been presented and analyzed through the different specific objectives such as to detect an intruder in order to maintain the principles of security system, to illustrate database perceptions system for sending message to the system users and to demonstrate tools, and languages used in developing the system to protect the organization property. Theft tricks are increasing nowadays depending on the location institutions’ properties. Modern devices entered in all areas, became easy to narrow the opportunities for robber in several different ways without high cost of considerable material. Microcontroller has been used for design a security and reliability system for the lab.

The findings demonstrated that smart security system is used to specify unauthorized people entering into the lab where the database stores information of an intruder by using ESP8266 which is used as tool for application that require it to connect devices to local network and with the help of Wi-Fi module the message can be sent to the system users when an unusual movement is detected without wastage of time and at low cost of installation. This system is used mostly focusing on how to control the door using GSM technology with android application in order to reduce thefts. The main function of android mobile phone is to control the door either open or close via Bluetooth technology using Bluetooth module Hc-05. When there is an intruder presence the PIR sensor uses to sense the movement and body temperature of an intruder and responds to microcontroller then it gives commands to close the door to lock an intruder inside the place, then buzzer or alarm makes sound and GSM module direct sends SMS to a predefined mobile number of the system user to inform that there is an intrusion into the place. The project ended by saying that this system is useful to catch intruders and by this we can save much money spent on security guards and avoid violence of security guards caused by robbers(intruders).

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LIST OF SYMBOLS, AND ABBREVIATIONS/ACRONYMS

CSS: Cascading Style Sheet

DC: Direct Current

DBMS: Database Management System

ERD: Entity Relationship Diagram

GPIO: General Purpose input/output

GPS: Global Positioning System

GSM: Global System for Mobile communications

HTML: Hypertext Markup language

IDE: integrated development environment

ICT: Information Communication and Technology

IoT: Internet of Things

IP: Internet Protocol

MCU: Micro Control Unit

MIT: Massachusetts Institute of Technology

OS: Operating Systems

PII: Personally Identifiable Information

PHP: Hypertext Preprocessor

RP-IPRC: Rwanda Polytechnic Integrated Polytechnic Regional Collage

UART: Universal Asynchronous Receiver/Transmitter

SOC: system on a chip

SDK: Software development kit

SIM: Subscriber identity Module

SMS: Short Message Service

SQL: Structure Query Language

TCP/IP: Transmission Control Protocol/Internet Protocol

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CHAPTER 1. GENERAL INTRODUCTION

1.1. BACKGROUND

Over recent years, security systems have changed from simple control panels and locks into high-tech gadgets. But today's security systems aren't just the result of the technological developments that have rocketed over the past few years. The foundations for effective security systems were actually created generations ago. Many decades ago, security have been a big issue in the world society because since many centuries ago people used to secure what they have achieved. That value continued many generations to generations around the world till the come of the end of First World War increase in crimes followed in many areas after the First World War for those countries who fought especially in united states, they started to provide a service to those who subscribed called" door shakers" then came into place, which consisted of a group of evening watchmen who would shake people's doors every night to make sure they were locked (Venturous group ,2022).

In Rwanda, security issue of properties has been lied on many years ago until present even in future. In nowadays security maintained in various ways at homes, museums, banks and hotels where different sensors, alarms and buzzers used to inform security problem by generating sounds and then people nearby help. This research project will be implemented to ensure security in different places stated above by providing sounds around the house, communicating information of the situation from the field to the owner of place everywhere inside the country when an intruder reaches in restricted area without permission and then after communicating, system will hold that intruder until police or other security support alive. Some security services available in Rwanda are: Bad locks used on exterior doors, Inadequate reinforcement of door frames, Poor or no locking hardware on windows and sliding doors, Alarm system installed but not working or not system at all, Bad telephone lines for Intrusion Alarm System, Bad garage door vulnerability, Fire alarms not working or non-existent, Installation of new security and alarm systems, Security gates and outdoor lightning(homerwanda,2022).

1.2 STATEMENT OF THE PROBLEM

Maintaining security of people themselves and their properties is very huge problem in many areas. we have seen that the existing security systems for example here in Rwanda are not trustful and strong, where existing security system use sensor detectors to detect any motion of intruders or forced entry and then buzzer sounds to inform professional guards who are hired for guarding compound place. We still have different problems in

existing security system such as: guards should be located far from intrusion field to catch intruder on time, sometimes robbers should come with guns to fight guards and escape, it is hard to trust human being because they can disappoint you and become the source of being stolen, low accuracy and precision of human being compared to the system where many institutions spend much money paid to the security companies to protect their properties but finally, those properties are stolen with out to catch the robbers this leads big loses to the institutions.

1.3 PROJECT OBJECTIVES

1.3.1. General Objective

The main objective of this research project is to design and implement smart security system for labs.

1.3.2 Specific Objectives

The specific objectives of this research project are the following:

- ✓ To detect an intruder in order to maintain the principles of security system
- ✓ To illustrate database perceptions system for sending message to the system users
- ✓ To demonstrate tools and languages used in developing the system to protect the organization property.

1.4. HYPOTHESIS OF PROJECT

Will an intruder be detected in order to maintain the principles of security system? Will database perceptions system be illustrated for sending message to the system users? Will tools and languages used in developing the system be demonstrated to protect the organization property?

1.5. SCOPE OF THE PROJECT

This project will be applied for labs and is completely used to detect an intruder and close the door automatically, an operator could be notified by receiving a message sent by the system with the help of GSM module and open the door either using Bluetooth or web application with the internet connection in order to catch an intruder.

1.6. METHODOLOGY AND TECHNICS

1.6.1. Research methodology

Observation and interview were the main methodologies used in the development of this project. The library is the main source of books that helped our research to understand basic concepts and terminologies, which has been used during the whole process, Consultation

of our courses syllabus. The internet helped us as a wide resource to gather and gain knowledge related to this work.

1.6.2. Software development

The scientific methodology used in this research is prototyping model which is a sequential software development process, in which progress is seen as flowing increasingly downwards (like prototyping) through phases.

1.7. SIGNIFICANCE OF THE PROJECT

This project has a purpose of designing and develop a smart security system in labs as a part of smart security and to address unauthorized entry in the labs. Its significance focuses on three concentrations such as personal, social and academic.

1.7 .1 Personal Interest

To get some incomes by publishing and selling this project to the market.

To fulfil our curiosity about technology.

To increase our knowledge and skills in ICT and electronics devices.

1.7.2 Social interest

This research project will reduce the amount of money paid for security guards.

This research project will help people to ensure the security of their properties.

This research project will help people to catch the intruders or thieves who can still and damage their properties.

1.7.3 Academic Interest

The main academic interest of this research project is to encourage other researchers to make research and provide where to start up their research project.

This research project will emphasize other researchers from academic to get new ideas to their projects according to the previous ideas.

This project will help people from academic to become innovators based on electronic devices and ICT.

1.8. ORGANIZATION OF PROJECT

This project is subdivided into 5 chapters.

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Methodology

Chapter 4: Presentation and Analysis of Results

Chapter 5: Summary, Conclusion and Recommendations

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

All over the world, security has been a major concern in every home. Automated security systems are a useful addition to days home where safety is an important issue. Vision-based security systems have the advantage of being easy to set up, inexpensive and non-obtrusive. Here, a security system has been developed that uses sensors to detect any security violation and sends out the alert signal by high intensity Buzzer. This chapter briefly focuses on authors works that present some similarities with one, which said in this Final year project. It explains basic concept and information that have been used during development of this project and contains basic components used and their functions. Also deals with the analysis of the related subject of the study and to have general idea.

2.2. DEFINITIONS

2.2.1. Design

Security system design is the process that allows clients to control the access that people (insiders and outsiders) have to their organizations assets with a coordinated and prioritized approach to asset protection by design.

Security by design is an approach to software and hardware development that seeks to make systems as free of vulnerabilities and impervious to attack as possible through such measures as continuous testing, authentication safeguards and adherence to best programming practices(protus3,2022).

2.2.2. Smart security

Smart Security refers to the advanced security systems, including IP (internet protocol) surveillance cameras, smart intruder alarms, access control systems, and others that support the monitoring and surveillance of, as well as protection against, illegal activities.

Smart Security refers to the advanced security systems, including IP (internet protocol) surveillance cameras, smart intruder alarms, access control systems, and others that support the monitoring and surveillance of, as well as protection against, illegal activities (Venturous group ,2022)

2.2.3. Security System

Security system is designed to detect an unauthorized entry into a building, shops or a protected area and deny such unauthorized access to protect personnel and property from damage or harm. Security systems are mainly used in inhabited, commercial,

manufacturing, and army properties for protection against burglary or property damage, as well as private safety against intruders (ijert ,2021).

2.3. INFORMATION SYSTEM AND FUNDAMENTALS

2.3.1. Information system

information systems encompass a variety of topics including systems analysis and design, computer networking, information security, database management, and decision support systems (Wikipedia , 2012).

2.3.2 The fundamentals

The three principles of information security in mind as you put together an information security program and evaluate platforms to store your company's data. Any platform you use should deliver on each of the three principles in some way (boxblogs,2022).

2.3.2.1. Confidentiality

The principle of confidentiality ensures that only the people who have permission or authority to view content can do so.

This means establishing some sort of controls to ensure confidentiality. Those controls can include:

- ✓ Identification
- ✓ Authentication
- ✓ Authorization
- ✓ Encryption

Some forms of content need more protection than others. For example, a company might want to make a marketing video available to the public, but will likely want to restrict access to budget spreadsheets or personal information about your employees.

For this reason, content classification is a key part of ensuring the confidentiality of the content because when there aren't measures or controls in place to protect your content, someone can easily access it without permissions and a hacker could break into your system, download personally identifiable information (PII), and share that information with others.

2.3.2.2. Integrity

Integrity is the second principle in the triad. Content needs to be consistent, accurate, and complete at all stages, whether it is at rest or in transit. Authorized or unauthorized users shouldn't be able to alter the data in a way that affects its integrity and the incident led to the development of protocols that protect the integrity of medications.

Unauthorized users can't alter content if they can't get access to it where additional measures beyond confidentiality controls can help protect the integrity of content or data and audit logs let you see who has done what to a piece of content, while backup controls allow you to regain access to deleted content.

2.3.2.3. Availability

The third principle in the triad, availability, reflects the ease with which authorized users can access information or content. If want to ensure company's data confidentiality, and also want to ensure the people who need to use the content can do so because working in the Content Cloud is one way to ensure your data availability. Authorized employees can access the content from any device that connects to the internet, provided they also have the relevant access level and authentication tools.

Some factors that affect availability include:

Where content can be accessed as availability of content can vary based on a user's geographic location, how content can be accessed because the way someone accesses content can be determined by their user credentials or information they provide and when content can be accessed because it might be necessary to set time limits for content where maintaining a company's software and hardware is a crucial part of ensuring availability (boxblogs,2022).

2.4. THE CONCEPTS OF DATABASE

Database system is an excellent computer-based record-keeping system. A collection of data, commonly called a database, contains information about a particular enterprise. It maintains any information that may necessary to the decision-making process involved in the management of that organization. It can also be defined as a collection of interrelated data stored together to serve multiple applications; the data is stored so that it is independent of programs that use the data (geeksforgeeks,2013).

To store and manage data efficiently in the database let us understand some key concepts:

Database Schema: It is a design of the database. Or we can say that it is a skeleton of the database that is used to represent the structure, types of data will be stored in the rows and columns, constraints, relationships between the tables.

Data Constraints: In a database, sometimes we put some restrictions on the table that what type of data can be stored in one or more columns of the table, it can be done by using constraints. Constraints are defined while we are creating a table.

Data dictionary or Metadata: Metadata is known as the data about the data. we can say that the database schema along with different types of constraints on the data is stored by DBMS in the dictionary is known as metadata.

Database instance: In a database, a database instance is used to define the complete database environment and its components. Or we can say that it is a set of memory structures and background processes that are used to access the database files.

Query: In a database, a query is used to access data from the database. So, users have to write queries to retrieve or manipulate data from the database.

Data manipulation: In a database, we can easily manipulate data using the three main operations that is Insertion, Deletion, and Updating.

Normalization: is the process of organizing data in a database. This includes creating tables and establishing relationships between those tables according to rules designed both to protect the data and to make the database more flexible by eliminating redundancy and inconsistent dependency.

DBMS is an attribute or set of attributes which helps you to identify a row(tuple) in a relation(table). They allow you to find the relation between two tables. Keys help you uniquely identify a row in a table by a combination of one or more columns in that table.

Super Key: A super key is a group of single or multiple keys which identifies rows in a table.

Primary Key: is a column or group of columns in a table that uniquely identify every row in that table.

Candidate Key: is a set of attributes that uniquely identify tuples in a table. Candidate Key is a super key with no repeated attributes.

Foreign Key: is a column that creates a relationship between two tables. The purpose of foreign keys is to maintain data integrity and allow navigation between two different instances of an entity.

Compound Key: has two or more attributes that allow you to uniquely recognize a specific record. It is possible that each column may not be unique by itself within the database.

Composite Key: is a combination of two or more columns that uniquely identify rows in a table. The combination of columns guarantees uniqueness, though individual uniqueness is not guaranteed.

Entity Relationship Diagram (ERD) is a graphical representation that depicts relationships among people, objects, places, concepts or events within an information technology (IT) system. An ERD uses data modeling techniques that can help define

business processes and serve as the foundation for a relational database(Talheim, Bernhard , 2000).

Entity: is an existing, object, concept or real thing that is uniquely identifiable where is used for storing the organizational data.

Attribute: is a part of the description of the entity. The entity itself is described by one or more attributes together; they describe all things of importance about the entity.

Relation: is an association between several entities; it is on ordered pair consisting of particular related entities.

Line: is used to join entities to their attributes, and joining entities with their relations (Geeksforgeeks, Wikipedia ,2013, 2022)

2.5. TOOLS AND LANGUAGES USED IN DEVELOPING THE SYSTEM.

2.5.1. Tools used to develop the system

Android mobile phone

Here, the user transmits instructions to the system to control the appliances in the form of SMS through an android application



Figure 1: Android mobile phone

Receiver GSM Handset

The receiver GSM handset is used to receive the SMS sent by the user and then to transmit an acknowledgement or status to the user's mobile. The receiver handset has to be equipped with an AT Modem and a valid SIM card. The handset has a built in AT modem with UART interface and supports most of the AT command instructions. This handset is attached with the microcontroller used to control the appliance through UART. AT Modem is a Modem, which supports AT commands. The command set consists of a series of short text strings which combine together to produce complete commands for operations such as dialing, hanging up, and changing the parameters of the connection. Most modems follow the specifications

of the Hayes command set. AT commands are instructions used to control a modem. AT is the abbreviation of Attention. Every command line starts with "AT".



Figure 2: Receiver GSM Handset

ESP8266(node MCU)

The ESP8266 is a system on a chip (SOC) Wi-Fi microchip for Internet of Things (IoT) applications produced by Espressif Systems. ESP8266 module enables microcontrollers to connect to 2.4 GHz Wi-Fi, using IEEE 802.11 bgn. It can be used with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or it can be used as a self-sufficient MCU by running an RTOS-based SDK. The module has a full TCP/IP stack and provides the ability for data processing, reads and controls of GPIOs.



Figure 3: ESP8266(node MCU)

PIR Sensor

A Passive infrared sensor (PIR sensor) is an electronic sensor that actions infrared (IR) light transmitting from objects in its field of view. They are regularly utilized in PIR-based movement identifiers. PIR sensors are normally utilized in security alerts and programmed lighting applications (ijert ,2021).



Figure 4: PIR sensor

DC Battery

DC batteries use direct current, which flows in a single direction and is generally used to power small appliances, radios, laptops, mobile phones and other electronic gadgets. And also, the battery is the primary source of electrical energy. It stores chemical not electricity, two different types of leads in acid mixture react to produce an electrical pressure. This electro chemical reaction changes chemical energy to



Figure 5: DC Battery

Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Also buzzer is a sounding device that can convert audio signals into sound signals. It is widely used in alarms, computers, printers and other electronic products as sound devices. It is mainly divided into piezoelectric buzzer and electromagnetic buzzer.



Figure 6: Buzzer

Bluetooth Module Hc-05

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. By default, the factory setting is slave. The role of module (master or slave) can be configured only by AT commands the slave modules can not initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate connection to other devices. The user can use it simply for a serial port replacement to establish connection between MCU and GPS and PC to your embedded project, etc.

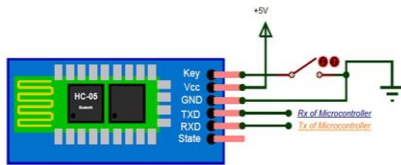


Figure 7: Bluetooth Module Hc-05

L293D (Motor driver)

The L293D is a popular 16-Pin Motor Driver IC. As the name suggests it is mainly used to drive motors. A single L293D IC is capable of running two DC motors at the same time; also, the direction of these two motors can be controlled independently.



Figure 8: L293D (Motor driver)

Arduino Software (IDE)

The open-source Arduino environment allows user to write code and upload it to the I/O board. The environment is written in Java. The Arduino development environment contains a text editor for writing code, message area, text console, and toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Arduino programs are written in C or C++. Arduino features, capable of compiling and uploading programs to the Board with a single click. Software written using Arduino is called sketches.

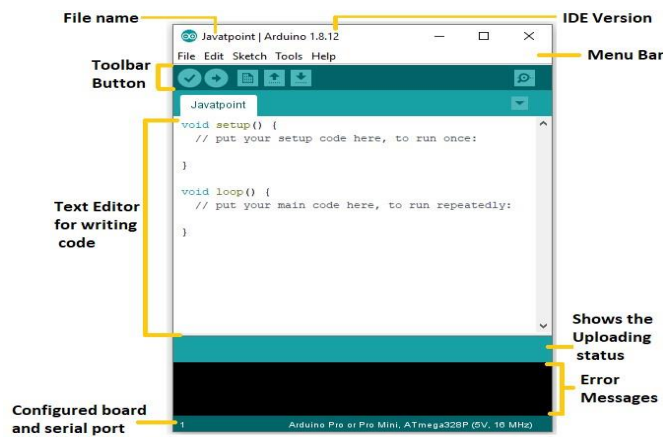


Figure 9: Arduino IDE

APP Inventor

App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It allows newcomers to computer programming to create application software (apps) for two operating systems (OS): Android, and iOS. It uses a graphical interface, which allows users to drag-and drop visual objects to create an application that can run on Android devices. Here we are making an android application for home automation, which will control the home appliances just by one click. The application consists of password protected security feature. (App Inventor for Android, 2019)



Figure 10: MIT App inventor

DC motor

A direct current or DC motor convert's electrical energy into mechanical energy. It is one of two basic types of motors: the other type is the alternating current or AC motor. Among DC motors, there are shunt-wound, series-wound, compound-wound and permanent magnet motors(faranux,2022).



Figure 11: DC motor

2.5.2. Programming Languages

Programming languages tell computers what actions to perform and programming language so important in software security because it gives assurances (to the programmer, team, and organization) that some vulnerabilities will not exist, and it does this automatically by default

The top programming languages include HTML, CSS Java, JavaScript, Python, SQL, PHP, C and C++. Depending on your career path, you may find other languages useful as well.

These languages are widely used in systems programming and mobile app development, so it's popular with hackers who want to access operating systems or exploit mobile vulnerabilities.

Java is often used to create botnets and perform identity theft, but is also used in ethical hacking programs and Hackers can use Java to send messages from their victims' phones(kinsta,2022).

HTML and CSS

HTML and CSS are technically not programming languages, but they are two of the most basic and essential building blocks of any web page. HTML is a markup language that builds the structure of a page's content, while CSS is a language used to style those HTML elements with coloring, sizing, and positioning. Beginning programmers can get a handle on the basics of HTML and CSS very quickly, making them great stepping stones into the field of front-end web development.

CSS stands for Cascading Style Sheets; Styles define how to display HTML elements such as to increase their appearance. Styles can be stored in External Style Sheets in order to save you lot of work where multiple style definitions will cascade into one. Style sheets allow style information to be specified in many ways. Styles can be specified inside a single HTML element, inside the <head> element of an HTML page, or in an external CSS file. Even multiple external style sheets can be referenced inside a single HTML document.

Python

Currently only second to JavaScript in popularity, Python is an extremely useful and versatile general-purpose programming language. It can be used for a diverse range of projects and applications, from standard back-end web development to more advanced technologies such as machine learning, artificial intelligence, and the internet of things. Python is relatively easy to learn, comes with an extensive library that supports common commands and tasks, and is used in a wide variety of industries and professional roles, making it an excellent first language for new programmers to start with.

SQL

SQL organizes relational databases, allowing users to query the database and find records that match their search and Hackers can run an SQL injection on an SQL database, allowing them access to confidential information. Because SQL is used in most enterprise environments, learning SQL is the best programming language for hackers to use to attack large databases.

SQL is among the top cybersecurity database languages to know because stopping an attack on a database is nearly impossible without it. Cybersecurity professionals need a solid understanding of how databases work alongside SQL. You can learn SQL at many data science bootcamps, along with general cybersecurity, web development, and software engineering bootcamps.

C and C++

C++, an expansion of the original C programming language, is a popular general-purpose language known for its versatility in building all kinds of applications. Programmers can use C++ to create mobile apps, computer programs, operating systems, video games, web browsers, and more. While it is highly useful and its skills transfer very well to other languages, C++ is not necessarily the best programming language for complete beginners, as it is very complex and can be tricky to learn.

JavaScript

JavaScript is one of the most popular programming languages in the world. Used to power most websites today, including internet giants such as Facebook and Google, JavaScript is unlikely to become obsolete in the foreseeable future. Compared to other languages, it is relatively easy to learn, and it can be used to build dynamic front-end elements such as animated graphics, clickable buttons, and interactive maps, as well as back-end support using a variety of frameworks, including Node.

PHP

PHP is a well-established server-side scripting language that is capable of handling enormous projects, including entire content management systems like WordPress, which alone powers millions of websites around the world. It is one of the easiest scripting languages to learn and is supported on virtually every operating system, including Windows, macOS, and Linux. It is an older system, so PHP's popularity may be on the decline as newer, faster languages take its place, but its ubiquity on the internet, abundance of resources, ease of use, and promising job prospects make it a valuable language to learn nevertheless (hosting,2022).

2.6. RELATED STUDIES AND GAPS OF SYSTEM

Basing on different researches done by the different authors, their results showed that there is a link between SMART SECURITY SYSTEM FOR LABS. Previously, there were some of research have been done about home security system.

The first research has been done by S. Tanwar, P. Patel, K. Patel, S. Tyagi, N. Kumar and MS Obaidat entitled "An Advanced Internet of Thing based Security Alert System for Smart Home. It describes inexpensive home security systems using Infrared (PIR) and Raspberry Pi modules to minimize delays during e-mail alerts. Therefore, there are PIR sensors as motion detection and Raspberry Pi as its processing module. But this system was implemented without controlling the door to catch an intruder.

The second study was conducted by Singh, Yadav et al. proposed a security system using the sensor, ATmega Microcontroller, buzzer and relay to control the system. PIR sensor detects an intruder at home and the sensors data is sent to the microcontroller. Then the Micontroller commands the GSM module to send the message to user's mobile phone. This system was not able to catch an intruder.

Third study was intruder detection systems for surveillance and security systems. They either need human intervention to detect intruder or need a long work for the installation and there is also a possibility of false alarms. In Surveillance system, the intruder is detected using the video recordable cameras which are already installed and stored in an external storage disk. But in this system needs a huge investment for installing, storing and monitoring the activities. Though the occurrence of activity is less, the footage is to be deleted, after examining by the owner. This leads to waste of many hours as he/she should watch the complete video and this may lead to missing small details during analysis. We couldn't monitor the streaming video directly. The Automatic robbery/theft detection using smart surveillance in banks by V. K. Bhanse (ijert ,2021)

Therefore, in our research we propose our design to maximize the existing system and provide better feedback to the system users in order to catch an intruder on time and to control a door by using Bluetooth with the help of mobile device and web application by using internet at very low cost and saving time.

CHAPTER 3. METHODOLOGY

3.0. INTRODUCTION

Methodology refers to a set of methods and principles that are used when projecting a particular kind of work. Research methods refer to a number of ways of arriving at the knowledge regarding that research. This research is carrying out to Design and implement smart security system for labs. This chapter deals with study area, study design, study population, study sample, sampling strategy, data collection methods and procedures to be used, data analysis, problems and limitations of the project and ethical considerations (Kothari, C. 2014).

3. 1. STUDY AREA

Our project will be implemented at IPRC HUYE in different Labs such as ICT, Mechanical Engineering, Electrical and Electronics Engineering and Civil Engineering.

3.2. STUDY DESIGN

Based on the problems faced, we propose an IoT system with additional capability to detect and recognize intruder by using ESP8266, PIR Sensor, Buzzer and DC motor to push the Door for catching the intruders. ESP8266 is used to integrate all the electronic devices in one environment. To detect the motion, the PIR sensor is utilized. Firstly, we need to consider the scenario of possible intruder entry and scenario how the warning is informed. From a possible intruder scenario, it can be seen in the “Arrival of Intruder”. In this research, we assume the intruder to enter the labs from the front door. From the arrival of intruders, the PIR Sensor that is located near the front door is the first component to be activated when detect the motion of intruder. The PIR sensor read every movement that passes through the detection range of the PIR sensor. In the process of motion detection, the system will read continuously until a movement is found.



Figure 12: study design

3.3. STUDY POPULATION

For this study, population was comprised of staff of IPRC Huye, the students and other people who are interested for the working of the system.

3.4. STUDY SAMPLE

The simple random was used in sampling technique. It is one in which each element of the population has an equal and independent chance of being included in the sample, a sample selected by randomization method is known as simple random sample and this technique is simple randomizing.

The researcher used this technique to have a representative in 4 departments (ICT, Mechanical Engineering, Electrical and Electronics Engineering, Civil Engineering) And two staff were interviewed in each department basing on lab technicians because smart security system for labs is valuable by IPRC HUYE staff. We have used interview and observation as we need reliable information and every respondent has been given equal chance of being selected as others.

3.5. SAMPLING STRATEGY

The study used stratified sampling technique by selecting employees working in IPRC Huye Labs. The researcher selected 2 employees from each department to be the representative of the entire population.

Stratified department sampling technique was chosen because it shows the advantages of focusing on important subpopulations and ignores irrelevant ones; it allows the use of different sampling techniques for different subpopulations and improves the accuracy of estimation.

3.6. DATA COLLECTION METHODS AND PROCEDURES TO BE USED

3.6.1. Documentation

Documentation is one of the method of data collection from written sources internet library, journals and different kind of publications among these sources, we used IPRC Huye Library, internet to find out the information in our research and to have necessary understanding about the project. Also, in this section, different people have been consulted for their ideas and we tried to have a discussion looking for how the research for our project could be done successfully.

3.6.2. Observation

This is the act of watching something attentively and taking measurements with our sense of eyes in order to get some information. We observed how the old system have been functioning in order to note new features to come with in new developed system.

3.6.3. Interviews

After having a trust of making something from carrying out our previous researches if we've been looking for how we can start prototyping some trials, we needed to have the full information of what the examination allowance checking requires, we asked some of the IPRC Huye lab technicians who have that affair in their responsibilities and we obtained the required information about it. After these collections of information, we started with making the way it can be made easy to finish all of the described tasks correctly and accurately and as fast as possible and we came up with our project:” Smart Security System for Labs” and we hope it will help many people as well as our institution.

3.7. DATA ANALYSIS

3.7.1. Prototyping_model

Prototyping is developed based on the currently known requirements and is designed for online systems which are OOA (Object Oriented Approach). By using this prototype, the client can get an “actual feel” of the system, since the interactions with prototype can enable the client to better understand the requirements of the desired system. Prototyping is an attractive idea for complicated and large systems for which there is no manual process or existing system to help determining the requirements. Prototyping process is said to be an iterative process as it helps to fulfill the needs of the users and customers depend on the moment.

Prototyping model

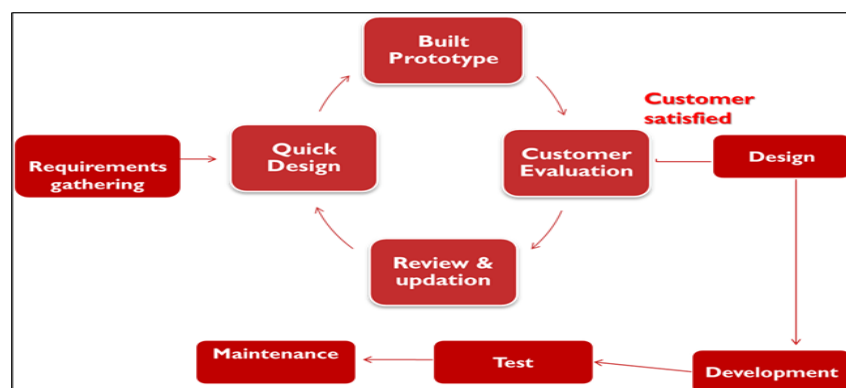


Figure 13: Prototyping model

Requirements Gathering

In the first phase of the prototype model, information about all the essential needs is taken. The beginning of making any prototype model starts with the analysis of requirements and the requirement of the system. Full details are taken from the user to know all the features of system.

Quick Design

A preliminary design is created for the system when the requirement is known. It is a quick design and include the elements required for the system, the quick design helps to develop the prototype for the system.

Built Prototype

In this phase, initial prototype is developed based on all the information received from quick design. It gives working model and user interface for the system requirement.

Customer Evaluation

When the prototype is created, it is presented to the user and provides feedback to the user about what is to be added or removed by developing this prototype and using the evaluation made by the user, makes the system even better. Work is done in making all possible changes and decorations.

Review and Updating

Once the client evaluates the system to see if it is according to its need and changes to the based on its suggestions, If the user is not satisfied with the prototype, then a new prototype is created and the process will continue until the client is satisfied.

Development

Actual software developed based on the final prototype when all the needs are fulfilling and the client is satisfied. In this face coding is done and the software is divided into small modules

Testing

In the stage, the entire process is tested to see if there is any fault in the system and it is according to the client's requirements.

Maintenance

This is the last phase of the model in which the complete system is develop and delivered to the client after the all the testing is done. Regular maintenance is continued to prevent error and failures and reduce downtime(examrace,2022).

3.8. PROBLEMS AND LIMITATIONS OF THE PROJECT

Limitations are those characteristics of design or methodology that impacted or influenced the interpretation from the research. As far as geographical scope is concerned, this study has major constraint based on methodological limitation. Given that the study was based on a case study approach, it follows that it inevitably exhibits the limitations of the method. Critics of the case study believe that the study of a small number of cases can offer no grounds for establishing reliability or generalizability of findings. This point was valid when one considered that given the sensitive nature of the research some key informants within RP-IPRC Huye would deny the researcher access to important documents or information and this would lead to information irregularity. In light of this, others would decline to be interviewed.

However, to overcome the above limitations there was careful planning ahead of time. The planning took into account use of different data collection techniques such as in-depth interviews and observations in order to improve the validity of data. Communication with interviewees respondents was done on time in order to facilitate meetings. Besides, prior awareness of these limitations invoked constant sensitivity to their possibility so that due care was constantly enforced.

Concerning proper information, the researcher opted to ask questions that are easy for respondents to remember. And finally, concerning the lack of confidence in respondent, the researcher will expose to the respondents the importance their responses will have to the research and will ensure them that the study will have a positive impact.

3.9. ETHICAL CONSIDERATIONS

In order to protect human subjects in the conduct of this legion study, ethical considerations were upheld as follows: Authorization to conduct the research: authority to conduct the research was obtained from the ethical review committee of the IPRC Huye and subsequently the respective authorities at Direction boarder. The research participants were informed of the purpose of the research and what the data was used for. It was ensured that the ethical dilemma 'was balanced to gather the data with the interests of the participants and that of the researcher considered, Openness and truthfulness were the key words to the participants about the research.

The researcher did not force the respondents to take part in the study but rather their participation was voluntary. Sufficient information was given to the respondents about the research which enabled them to make up their minds as to whether to participate or opt out,

verbal consent was sought from participants. Confidentiality and anonymity were ensured by avoiding writing names on the research tools, instead they were coded, interview and observation were used to collect reliable information. All data gathered was collected and processed in a fair and lawful manner; the data collected will only be used for the study; the data are accurate, kept secure and not distributed to third parties; and finally, the data was kept anonymous and destroyed after the report has been handed out. Respondents were assured that participation in this study was totally voluntary, and that no incentives was to be given to them as a reward for participation. Participants were also told that they were free to withdraw from the interview at any time without the need to justify their decisions.

CHAPTER 4: PRESENTATION AND ANALYSIS OF RESULTS

4.1. INTRODUCTION

This chapter is demonstrating system design and modeling, system actors and user characteristics, interface design and verification of hypothesis.

4.2. SYSTEM DESIGN AND MODELING

4.2.1. System design

Below diagram explains how the system is designed.

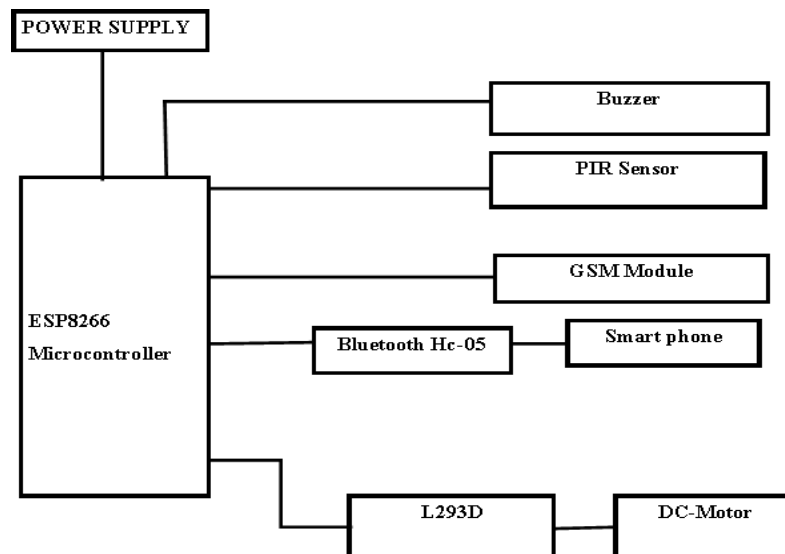


Figure 14: Block diagram of the system

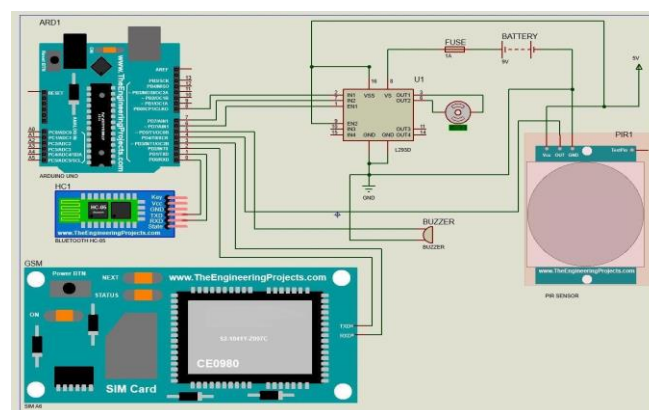


Figure 15: Circuit Diagram of the system

The function of each system block

No	System block	Function
1	Android smart phone	As data input
2	Bluetooth module HC-05	As data receiver

3	PIR sensor	As data input
4	Battery	As a power supply
5	ESP8266	As data processing center
6	L293D	As direction controller
7	DC motor	As output driver
8	GSM Module	As communication receiver

Table 1: The function of each system block

4.3. Physical Database System Design

4.3.1. Entity Relationship Diagram

An Entity–relationship model (ER model) describes the structure of a database with the help of a diagram, which is known as Entity Relationship Diagram (ER Diagram). An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

Diagrammatically, An ER diagram has three main components: Entity, Attribute, Relationship

Entity: An entity is an object or component of data such as table name.

Attribute: An attribute describes the property of an entity.

Relationship: A relationship is showing the relationship among entities.

This diagram shows the real structure of the database which the system depends on by showing used entities which are weak entities, strong entities, cardinalities, attributes and their relationships linking those entities.

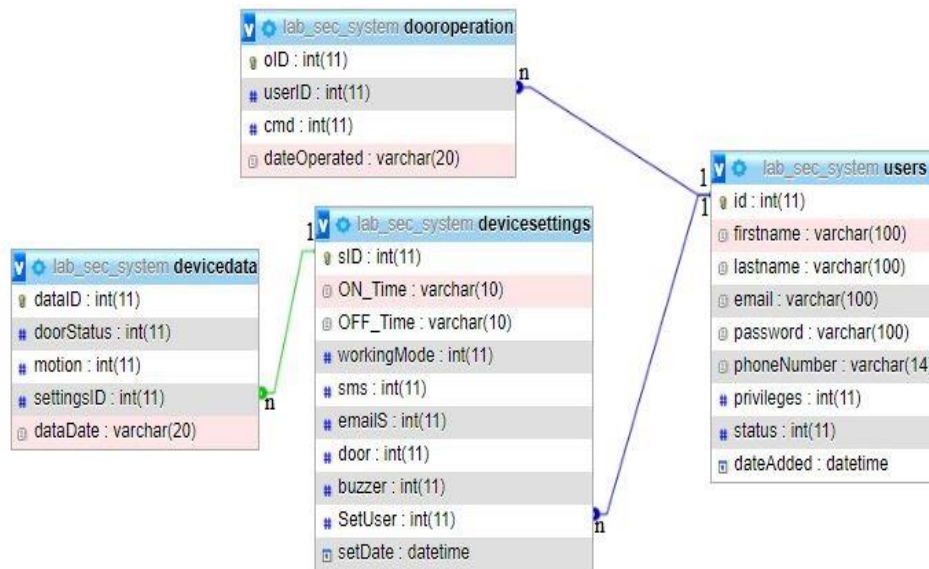


Figure 21: Entity Relationship Diagram

4.4. DATA DICTIONARY

Here is a list of tables that have been used in the database

Table	Action	Rows	Type	Collation
devicedata	Browse Structure Search Insert Empty Drop	3	InnoDB	utf8mb4_general_ci
devicesettings	Browse Structure Search Insert Empty Drop	38	InnoDB	utf8mb4_general_ci
dooroperation	Browse Structure Search Insert Empty Drop	134	InnoDB	utf8mb4_general_ci
users	Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci
4 tables	Sum	177	InnoDB	utf8mb4_general_ci

Figure 20: database tables

✓ System Users table

Field	Type	Null	Key	Default	Extra
-------	------	------	-----	---------	-------

Id	Int (11)	No	PRI	Null	Auto_increment
First name	Varchar (100)	No		Null	
Last name	Varchar (100)	No		Null	
Email	Varchar (100)	No		Null	
Password	Varchar (100)	No		Null	
phoneNumber	Varchar (14)	No		Null	
privileges	Int (11)	No		Null	
status	Int (11)	No		Null	
dataAdded	Datetime	No		Current_timestamp ()	

Table 2: System Users table

✓ **Door Operation table**

Field	Type	Null	Key	Default	Extra
oID	Int (11)	No	PRI	Null	Auto_increment
userID	Int (11)	No		Null	
cmd	Int (11)	No		Null	
dateOperated	Varchar (20)	No		Null	

Table 3: Door Operation table

✓ **Devices Settings table**

Field	Type	Null	Key	Default	Extra
sID	Int (11)	No	PRI	Null	Auto_increment
ON_Time	Varchar (10)	No		Null	
OFF_Time	Varchar (10)	No		Null	
Working Mod	Int (11)	No		Null	
Sms	Int (11)	No		Null	
EmailS	Int (11)	No		Null	
Door	Int (11)	No		Null	
Buzzer	Int (11)	No		Null	
SetUser	Int (11)	No		Null	
SetDate	datetime	No		Current_timestamp ()	

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Table 4: Devices Settings table

✓ **Device data table**

Field	Type	Null	Key	Default	Extra
dataID	Int (11)	No	PRI	Null	Auto_increment
doorStatus	Int (11)	No		Null	
motion	Int (11)	No		Null	
settingsID	Int (11)	No	MUL	Null	
dataDate	Varchar (20)	No		Null	

Table 5: Device data table

4.5. INTERFACE DESIGN OF THE SYSTEM

The system has been designed with user friendly interfaces. User interface design is the overall process of designing the interaction between a human (user) and machine (computer). It includes graphic design, information design and a wide variety of usability methods.

Figure 22: users login form

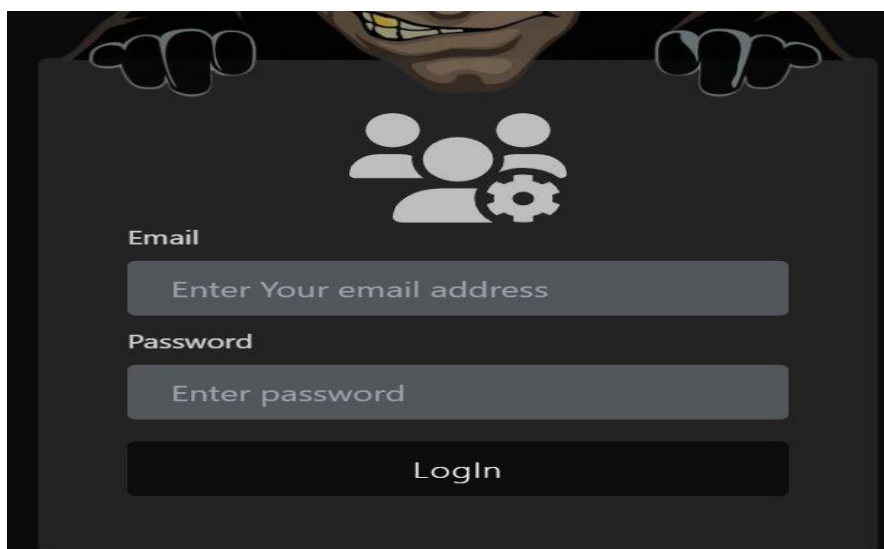


Figure 23: admin dashboard



Figure 24: system users report

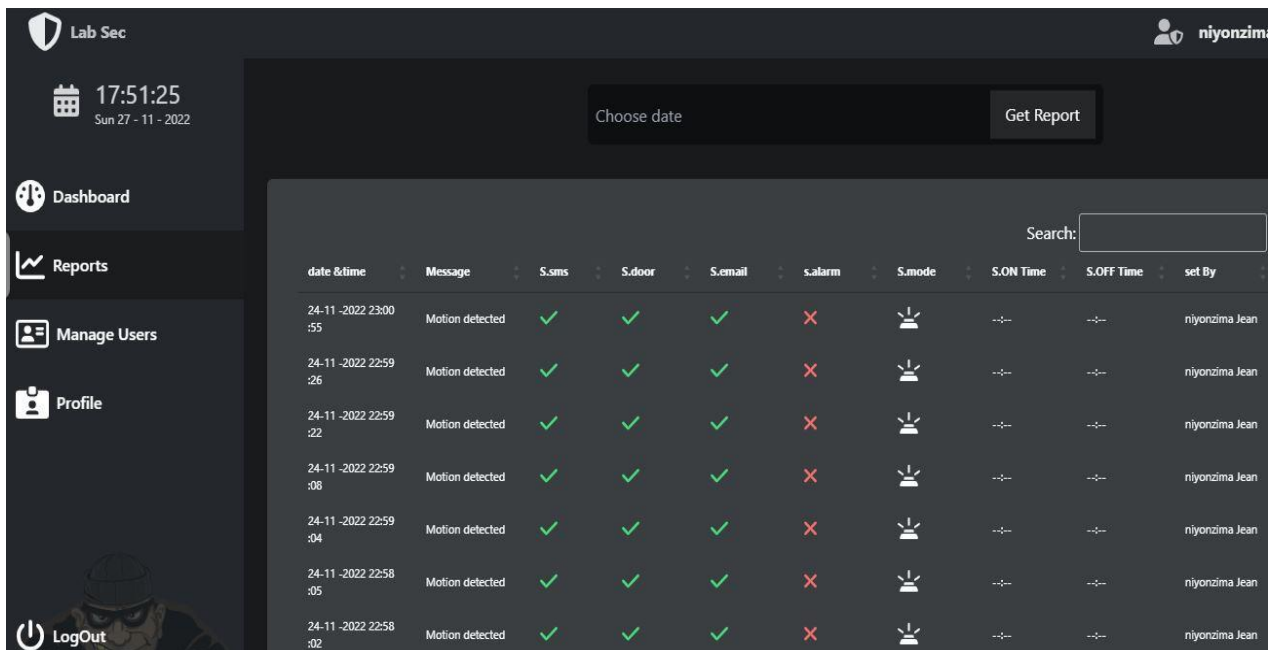


Figure 25: Admin profile

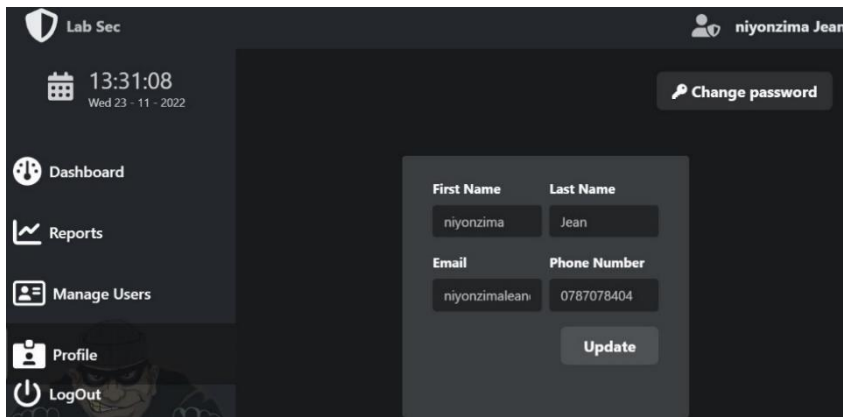


Figure 26: Lab Technicians profile

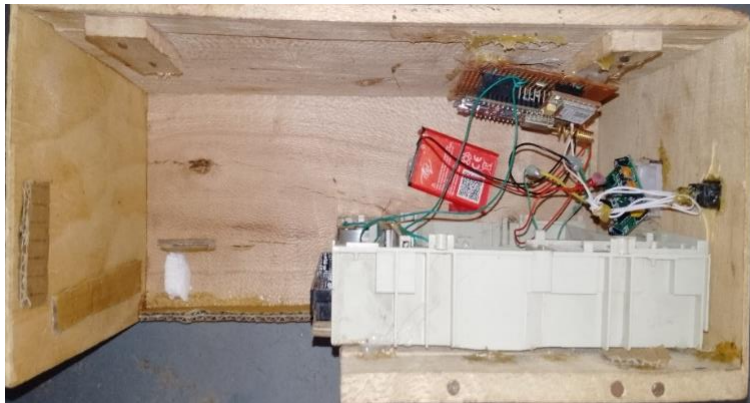
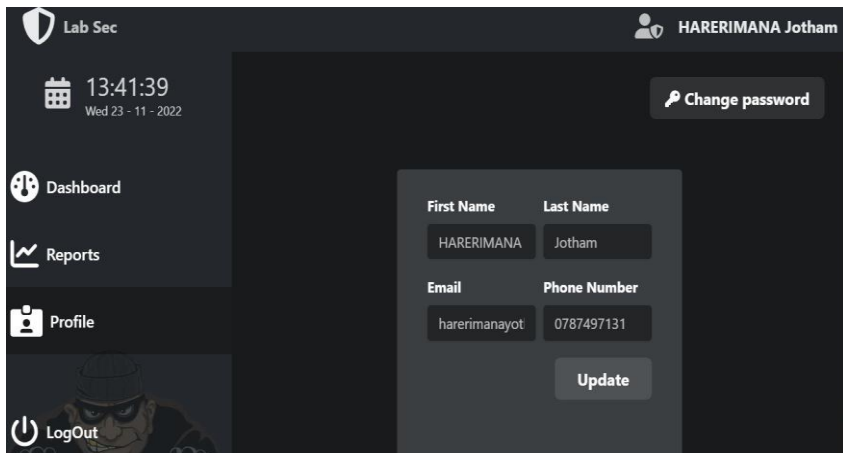


Figure 27: Project structure

Project before running mode while the door is open



Figure 28: project before running mode while the door is open

Project in running mode while the door is closed after motion detected



Figure 29: project in running mode while the door is closed after motion detected

4.6. VERIFICATION OF HYPOTHESIS

Designing and implementing of smart security system for labs with different parts which are the input part acting as supply to boost the system by applying an electrical signal into the system, second part is PIR sensor for detecting any motion, the third is GSM module for communicating the system and the user via SMS, the Fourth part is mobile phone for controlling door via Bluetooth module ,the fifth part is Buzzer acting as an alarm, and sixth part is DC motor acting as an output for pushing the door, all of these parts are connected on ESP8266 which acts as microcontroller. As the result an intruder was detected and blocked immediately in lab, message and email was sent to the system users for being notified. therefore, our project is emphasizing that the system users can control the door remotely for helping the guards to catch an intruder.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. SUMMARY

Our project is implemented as a prototype and it can be used in various places such as universities, hotels, banks, industrial areas and other places need to be more secured. As the Automated door lock system can provide additional security to our institution which is suitable to implement in RP- IPRC HUYE. Actually, as the system locked the door with the help of PIR sensor by detecting an intruder and buzzer for ringing and GSM module give notification to the system user's mobile phone by sending SMS showing that there is an intrusion into the place, the users have to come with the security guards to catch an intruder, then will need to get near the door having our system and take the smart phone then open the android app that has been installed and link it with the system to open the door through Bluetooth module and web application after tap on open button and automatically the door will be opened and then catch an intruder .

5.2. CONCLUSION

According to the purpose of our project of increasing security to the different labs, we conclude that this system is performing correctly and it will be useful for catching the intruders with notifying the system users what is going on with the system and open the door by using smart phone. And by this we can save much money spent on security guards and avoid violence of security guards caused by robbers or intruders.

The smart security system for labs feature become draws much attention in the future. Institutions are getting more concerned to protect their properties from unauthorized people. This system can monitor a lab by use of sensors that integrated with a microcontroller and a GSM unit. A notifying mechanism is used to alert users by sending message via mobile phone and emails when a possible intrusion occurs. Today almost every lab technician using mobile phone so by use this system user will not have to carry additional device to monitor their labs. This system is design using modularity to become a flexible system that can be add more sensors without change the whole system, only add some sensors to increase systems functionality. So, this system is a modular smart security system for labs by using notify function to communicate between system and user. The project model can be used in places such as banks, office, schools, and home.

Theft tricks have becoming now possible to control it, which different depending on the location and type of things. Modern devices entered in all areas, became easy to narrow the

opportunities for robber in several different ways without cost of considerable material. Microcontroller has been used for design a security and reliability system for the lab.

GSM has been used for notifying purpose to the owner (Under any circumstances and in any place) to inform him that his lab has been attached.

5.3. RECOMMENDATION

During the design and implementation of our project we have faced some difficulties. So, we would like to recommend the following:

During design and implementation of this project we have met many challenges like cost of materials. As the work has to be shown in reality without simulation, the availability of the components is not that easy and components are very expensive; that's why we recommend the academic to increase the number of group members so that the students can cooperate and make a powerful project.

- ✓ We recommend RP-IPRC HUYE and our government to provide all resources required to level up our project so that it will be on the standard of the country.
- ✓ We recommend other researchers that they can make the improvement to this project by adding other checking systems like surveillance system where they can add cameras.
- ✓ We recommended other researchers who will be interested by this work to focus on other parts of building like windows because our project is based on the main entrance.

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APPENDICES: WORKPLAN

Appendix 1 : Work plan

N°	TASK to be Performed	Date to be completed	People in charge of tasks	N° of people
1	Choosing Project proposal	On 05 th May 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
2	Project proposal submission and presentation	On 20 th May 2022 On 27 th June 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
3	Data collection	On 2 th July 2022 On 29 th Julyt 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
4	Data analysis	On 30 th July 2022 On 17 th Aug 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
5	Project design	On 18 th Aug 2022 On 18 th Nov 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
6	Project testing	On 19 th Nov 2022 On 25 th Nov 2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2
7	Project submission	On 30 th Nov2022	NIYONZIMA Jean Leandre HARERIMANA Jotham	2

Table 6: Work Plan

Appendix 2: Gantt chart

ACTIVITIES	2022							
	May	June	July	August	September	October	November	December
Choosing the topic	5/5/2022							
Documentation in library	11/5/2022	12/5/2022						
Presentation of project Proposal		27/6/2022						
Construction of data			5/7/2022	12/8/2022				
Presentation of chapter one and two					1/9/2022			
Collecting data from the field						5/10/2022		
Editing and coding the data						6/10/2022		
Analysis of the results						29/10/2022	4/11/2022	
Discussion of the results							15/11/2022	
Presentation of project								6/12/2022

Table 7: Gantt chart

Appendix 3: A BUDGET PLAN

3.1. Preparation of study

N°	Item	No. of Persons	No. of Days	No. Person days	Cost/Unit (RWF)	Total RWF
1	Mineral water	2	30	2	500	30000
2	Food	2	30	2	1000	60000
3	Communication (Airtime and internet)	2	30	2	300	18000
	Sub-total 1					108,000

Table 8: Preparation of Study

3.2. The Survey of study

N°	Item	Persons/ Materials	No. of days	Persons	Unit Cost (RWF)	Total (RWF)
1	Transport	car	5	2	5000	50,000
2	Communication	Airtime	5	2	250	2500
3	Food	-	5	2	1500	15000
	Sub-total 2					67,500

Table 9: Survey of Study

3.3. Project Supplies

N°	Item	Quantity	Unit Price RWF	Total RWF
1	Note Books A4	2	1200	2400
3	Restaurant	10	3000	30,000

4	Pencil	2	200	400
5	Pen	2	200	400
6	Rubber eraser	1	200	100
7	Printing	60	50	12,000
8	Airtime	3	5000	15,000
9	Transport	5	5000	25,000
10	Binding	4	500	2000
		Sub– total 3	5080	87,300

Table 10: Project Supply

3.4. Production of Report

N°	Item	Quantity	No. of days	Pers.days	Unit Price RWF	Total RWF
1	Internet	15 GB	90	2	6000(per month)	18,000
2	Food	-	90	2	4000	360,000
4	House	1	90	2	25,000(per month)	75,000
		Sub -total 4				453,000

Table 11: Production of Report

3.5. Workshop for report validation

N°	Item	Quantity	NO./Days	Pers-days	Unit Price RWF	Total RWF
1	ESP8266	1	90	2	10,000	10,000
2	Bluetooth Module	1	90	2	7000	7000
3	Buzzer	1	90	2	500	500
4	GSM	1	90	2	18,000	18,000

5	PCB	1	90	2	1000	1000
6	PIR sensor	1	90	2	5000	5000
7	Battery	1	90	2	5000	5000
8	DC motor	1	90	2	1500	1500
9	Wires	2m	90	2	1000	1000
10	L293D	1	90	2	2000	2000
11	Bread board	1	90	2	5000	5000
12	Soldering wire	50 cm	90	2	1000	1000
13	Soldering iron	1	90	2	2000	2000
14	electricity	1.5 watt	90	2	1000	1000
15	Timber	1	90	2	2500	2500
16	multimeter	1	90	2	8,000	8,000
17	nails	0.5 kg	90	2	1000	1000
18	SIM Card	1	90	2	500	500
19	Charger	1	90	2	3,000	3,000
20	Door	1	90	2	10,000	10,000
	Sub-total 5					85,000

Table 12: Workshop for report validation

3.6. Budget Summary

N°	DESCRIPTION	TOTAL/ RWF
1	Preparation for the Study	108,000
2.	The survey	67,500
3	Study supplies	87,300
4.	Production of the Report	453,000
5	Workshop for report validation	85,000
TOTAL BUDGET		800,800

Table 13: Budget Summary