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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
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OPTION: ELECTRICAL TECHNOLOGY

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FINAL YEAR PROJECT

**DESIGN AND IMPLEMENTATION OF SMART HOME FIRE FIGHTING
SYSTEM**

Final Year project submitted in partial fulfillment of the requirement for the award of an
Advanced Diploma (A1) in Electrical Technology.

Submitted By:

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Kigali, October 2024

DECLARATION- A

This research study is my original work and has not been presented for a degree or any other academic award in any University or Institution of Learning". No part of this research should be reproduced without the authors' consent or that of ULK Polytechnic Institute

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Date:

DECLARATION B

I confirm that the work reported in this research project was carried out by the candidate under my supervision and it has been submitted under my approval as the UPI supervisor.

Supervisor Name: Eng. Augustin KARANGWA

Signature:

Date:

DEDICATION

I dedicate this project to everyone who has participated with any help to assist me and to

make this task realized as well as:

To Almighty God, for His protection

To my parents, for my love, sacrifices

To my brothers and sisters, my inspiration

To My beloved classmates

To all my lecturers for giving me the knowledge

ACKNOWLEDGEMENTS

First of all, let's thank my Almighty God for his protection during all the time that I have spent for achievement of this this project.

Afterward, we would like to acknowledge the contributions of the following group and individuals to the development of this project:

The class peers for the cooperation and fellowship, UPI community, family members, relatives but especially Government of Rwanda for their financial contribution for carrying out the studies.

I am also thankful to the supervisor of this project, **Eng. Augustin KARANGWA** whose encouragement, guidance, and support from the initial to the final level enabled us to develop an understanding of the subject and for providing the necessary facilities to carry out this project work

DUSHIMIMANA EMMANUEL

ABSTRACT

*My project is designed to ensure security based on a **Smart home firefighting system**. This idea comes after observing some problems and risks caused by fire. Therefore, a smart home firefighting system was designed as one of the solutions needed for building protection because it uses some components to do its tasks based on its design and implementation composed of a smoke sensor used to sense the smoke in the serve room*

The project is used to notify user about the fire accident at home and correct those fire by using water pump in avoiding the absence of people and people's goods. Otherwise, user can receive the short message about their house wherever they are using mobile phone. It is designed to reduce the risk of more severe fire damage when the fire broke and make it minimum. With this system, it can help users in many aspects, especially to notify the user to make a call and send a message to user, so you can take early steps that can overcome the blaze spread rapidly

The hardware implementation in this project is a smoke sensor, GSM, buzzer, microcontroller and water pump. The result from this project is useful to be implemented in home and industrial to help in the risk of death and injuries furthermore to avoid the losses that need to be borne by the victims.

TABLE OF CONTENTS

DECLARATION- A	i
DECLARATION B	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	v
TABLE OF CONTENTS	vi
LIST OF FIGURES	ix
LIST OF TABLES	x
LIST OF ABBREVIATION	xi
CHAPTER 1: GENERAL INTRODUCTION	1
1.0 Introduction.....	1
1.2. Statement of the problem	1
1.3 Purpose of the study	2
1.4. Objectives of the project	2
1.4.1. General Objectives.....	2
1.4.2. Specific objectives	2
1.5. Research Questions	2
1.6. Scope of project	3
1. 7 Significance of the study.....	3
1. 7.1 Personal Significance.....	3
1.7.2 To the community	3
1.5 Organization of the study	3
CHAPTER 2. LITERATURE REVIEW	4
2.1 Concepts, Opinions, and Ideas from Authors/Experts	4
2.2.1 Hardware components	4
2.2.1.2 Transistor	4

2.2.1.3 Resistor	5
2.2.1.4 Electromagnetic Relay	5
2.2.2 Active components.....	7
2.2.2.1 Smoke sensor	7
2.2.2. GSM: (global system for mobile communication)	9
2.3 Related Study	10
2.3.1 Arduino microcontroller	11
2.3.2 Arduino Uno	11
2.3.3 A printed circuit Board	13
2.3.4 Jumper wires	13
CHAPTER 3: RESEARCH METHODOLOGY	14
3.0. Introduction.....	14
3.1 Research Design.....	14
3.2 Research Population.....	14
3.3.1 Sample Size.....	14
3.4 Research Instrument.....	14
3.4.1 Choice of the Research Instrument	15
3.4.2 Validity and Reliability of the Instrument	15
3.5 Data gathering Procedures	15
3.6 Data analysis and Interpretation.....	16
3.7 Ethical Consideration.....	16
3.8 Limitation of the study.....	16
CHAPTER 4: SYSTEM DESIGN ANALYSIS AND IMPLEMENTATION.....	17
4.0 Introduction.....	17
4.1 Calculations.....	17
4.2 Drawings	17
4.2.1 System block Diagram.....	17

4.2.2 FLOW CHART.....	18
4.3 Working Principle.....	19
4.4 Specification	19
4.4.1 General Specifications of single channel Relay module:	21
4.5 Implementation	22
4.5.1 Hard ware Implementation	22
4.6. The cost of the project.....	23
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS	24
5.0 Introduction.....	24
5.1 Conclusions.....	24
5.2 Recommendations.....	24
REFERENCES.....	26
APPENDIX.....	28

LIST OF FIGURES

Figure 1: Buzzer.....	4
Figure 2: Transistor symbol.....	5
Figure 3: Resistor.....	5
Figure 4: Electromagnetic relay.....	6
Figure 5: Basic operation of a relay.....	6
Figure 6: Water pump.....	7
Figure 7: Smoke sensor.....	8
Figure 8: GSM SIM900.....	9
Figure 9: Arduino Microcontroller.....	11
Figure 10:A printed circuit Board.....	13
Figure 11: Jumper wires.....	13
Figure 12: Hard ware Implementation.....	22

LIST OF TABLES

Table 2.1: Smoke sensor pins description.....	8
Table 2.2: Smoke sensor summary	8
Table 2.3: GSM SIM 900.....	10
Table 3.4: Microcontroller Arduino Uno	12

LIST OF ABBREVIATION

A	: Ampere
AC	: Alternating Current
ADC	: Analogue to Digital Converter
A0	: Analogue input
DC	: Direct Current
D0	: Digital output
EEPROM	: Electrically Erasable Programmable Read-Only Memory
EPROM	: Erasable Programmable Read Only Memory
GND	: Ground
GSM	: Global System for Mobile
ICSP	: In-circuit serial programming
IDE	: Integrated Development Environment
KB	: Kilobyte
LCD	: Liquid crystal display
LED	: Light Emitting Diode
mA	: mill ampere
MHZ	: Mega hertz
Mr.	: Mister
NPN	: Negative Positive Negative
PC	: Personal computer
P_H	: Heating consumption
PPM	: Parts Per Million
PWM	: Pulse Width Modulation

R_H	: Heater resistance
R_L	: Load resistance
R_X	: Receiver
SMS	: Short Message Service
TX	: Transmitter
UART	: Universal Asynchronous Receiver/Transmitter
USB	: universal serial base
V	: Voltage
VC	: Circuit Voltage
V_H	: Heating voltage

CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

This project refers to the house protection against the fire accidents happen in the houses. The Smoke sensor detects the smoke in the house, this project will be capable to solve those fire accidents happen in the building through turn on the water pump order to switch off that smoke which was detected and turn on alarm signaling and sending the message to the owner of the building, there is the smoke detected in the house.

Actually, this projection concern with fire, so the project will sense the smoke instead of temperature because smoke due to same thing burned in the building and smoke is earlier fire's information, detection and solve those fire will be done by using water pump quickly and working automatically by using microcontroller.

Now today there are many companies, offices, hospital and school laboratory which can be damaged by fire's accidents without any switch off the fire and that can cause same deaths and loose of people's goods. After examinee those problems we decided to design and implement a Smart home firefighting system by using microcontroller and water pump and GSM which will send the message in order to solve those fire's accident and alarm as warning to react to potential danger in providing earlier building's information.

In commercial industrial that device issues a signal to a fire alarms generally issues a local audible or visual alarm from detector itself.

Especially for my country this project is going to be implemented to prevent fire spread to damage building environments and to ensure companies, hospital, school labs and toilets also residential buildings security.

1.2. Statement of the problem

Many building were burned involuntary due to the loose of conscience of the presence of that taken fire in the specific room or region, there was no way to detect and solve that fire , excepted the presence of human seeing it presence. The same case in my country today, where there are many accident of fire burning due to the same problem explained before. This smart home fire fighting system is going to resolve those fire accident risks.

My project will provide the solution to the fire accidents sometimes happen in the house and solve those fire accidents automatically by using smart home fire fighting system which will stop fire's accidents such as death of people, loose of different things that were in the house.

This old method of stopping the incoming flame is not enough and intelligent because it stops something which is already happen, so this smart home firefighting system is going to be implemented in the way of avoid all risks caused by the fire.

Actually here, a smoke sensor is connected to a circuit, which produces a digital output when the smoke is detected. This digital output is connected to the microcontroller pin as interrupt signal. A water pump driven program or a part of it is written in the interrupt service routine, which is executed when the sensor digital output is high. A water sprinkler mechanism is connected to the shaft of the dc motor, which will sprinkle the water and sending the message to the fire fighter with alarm signaling when the smoke is detected by the sensor.

1.3 Purpose of the study

The purpose of this study is to come up with Smart home fire fighting system which will overcome the problems of fire's accidents happen in the different buildings due to a certain point in the combustion reaction.

1.4. Objectives of the project

1.4.1. General Objectives

My project used to detect and solve fire's accidents by using Smart home firefighting system basing on the smoke from the fire in the building.

1.4.2. Specific objectives

- i. To design a circuit which detect incoming smoke from the fire.
- ii. To install the alarm and water pump.
- iii. To send SMS to the user by using GSM.

1.5. Research Questions

1. Which challenges may face the project in detecting the smoke?
2. What are the contributions help us to implement my project?
3. How can I solve those problems of fire's accidents in the building?

1.6. Scope of project

Scope of this project is to design a smart home firefighting system, which will be used in different locations such as hospital, offices, school laboratories, industries and commercial building.

I will take into consideration ULK Polytechnic Institute is too large I could not cover whole ULK Polytechnic Institute, I will do my practice in Electrical lab and expand the result to the whole ULK Polytechnic Institute Lab.

1. 7 Significance of the study

1. 7.1 Personal Significance

The project will conduct us into different technologies and good understand their working principles and hence a competitive edge on the my career job on market, it will allow us to put in practice different skills got from college and the theoretical knowledge acquired during my studies and will give us experience with a hand on skills experience in electrical and electronics engineering.

1.7.2 To the community

Especially for my country this project is going to be implemented to prevent fire spread to damage building environments and to ensure companies, hospital, school labs residential buildings security.

1.5 Organization of the study

This project is subdivided into five chapters:

Chapter 1 is introduction

Chapter 2 is literature review

Chapter 3 is research methodology

Chapter 4 is System design, analysis and Implementation.

Chapter 5 is conclusion and recommendation:

CHAPTER 2. LITERATURE REVIEW

2.0 Introduction

In this chapter, I am going to discuss some projects, that are related to the Smart home firefighting system, and some components, which will be used to detect smoke and solve fire accidents so we will get from them the importance and the working principle of using Smart home firefighting system.

2.1 Concepts, Opinions, and Ideas from Authors/Experts

By improving home technology, I had been through research related to my projects to seek ideas from authors, opinions, and other expectations. Through this research, I found many related works and was able to come up with many ideas.

2.2 Theoretical Perspectives

2.2.1 Hardware components

2.2.1.1 Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sound commonly used to indicate that a button has been pressed are a click, a ring or a beep.



Figure 1: Buzzer

2.2.1.2 Transistor

A **transistor** is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals (base, collector, and emitter) for connection to an external circuit.

A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the output power can be much larger than the input power, the transistor provides amplification of signal. The type of Transistor used is **2N2222A/8FA**.

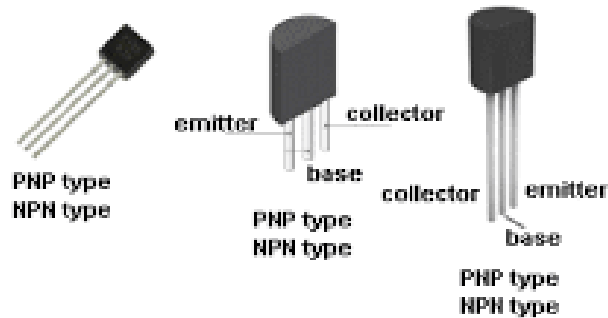


Figure 2: Transistor symbol

2.2.1.3 Resistor

A **resistor** is a two terminals passive electronic component which implements the electrical resistance as property that all bodies have to oppose the passage of current at a time. The value of a resistor can be measured with an ohmmeter, which may be one function of millimeter. Usually, probe on the ends of test leads connect to the resistor. Note that the resistor has no polarity.[3]

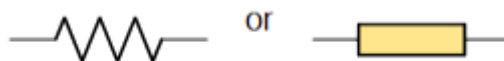


Figure 3: Resistor

2.2.1.4 Electromagnetic Relay

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically.

They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage.

For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, say, a fan or an electric bulb.

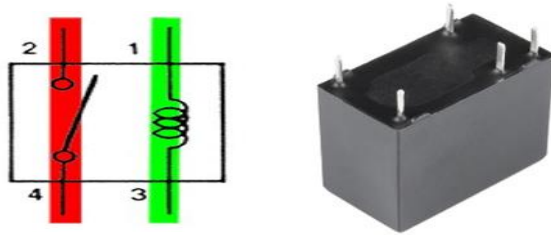


Figure 4: Electromagnetic relay

An electromagnetic relay is a type of electrical switch controlled by an electromagnet. The electromagnetic relay is used in a variety of applications, including water pump and sensors, signal switching, and the detection and control of faults on electrical distribution lines. The core of the electromagnetic relay, naturally, is an electromagnet, formed by winding a coil around an iron core. When the coil is energized by passing current through it, the core in turn becomes magnetized, attracting a pivoting iron armature. As the armature pivots, it operates one or more sets of contacts, thus affecting the circuit. When the magnetic charge is lost, the armature and contacts are released. Demagnetization can cause a leap of voltage across the coil, damaging other components of the device when turned off. Therefore, the electromagnetic relay usually makes use of a diode to restrict the flow of the charge, with the cathode connected at the most positive end of the coil.

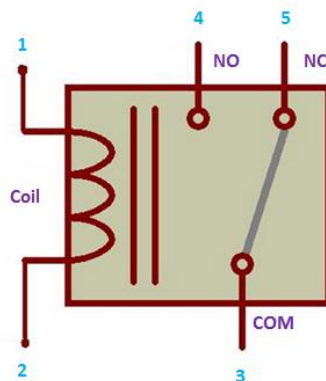


Figure 5: Basic operation of a relay

2.2.1.4 Water pump

A pump used for raising or circulating water, the pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or lifting it in a hand held bucket.

This is true whether the water is drawn from fresh smyce, moved to a needed location, purified, or used for irrigation, washing, and sewage treatment or for evacuating

water from an undesirable location. Regardless of the outcome, the energy required to pump water is an extremely demanding component of water consumption.

All other processes depend or benefit either from water descending from a higher elevation or some pressurized plumbing system.



Figure 6: Water pump

A water pump composed by two main parts build in it such as dc motor and pump. Those part help a water pump in it function of pumping water (circulating or raising water). It has two terminals such as vcc as voltage supply of 5V and ground of 0V

Dc Motor: is an electrical device that convert electrical energy into mechanical energy. Those mechanical energy pull a water from one contain to another one. As working principle of water pump.

Pump: it a plastic material that draw a way of water from contain.

The operator has to supply the two terminals on it. As supplying a dc motor that produce a mechanical energy that pull a water from contain through a pump.

2.2.2 Active components

2.2.2.1 Smoke sensor

Smoke sensor is an advice that senses smoke, typically as an indicator of fire used in smoking zone. It detects the concentrations of combustible gas in the air and outputs reading as an Analogue voltage.

The smoke sensor has a built-in potentiometer that allows you to adjust the sensor sensitivity according to how accurate you want to detect gas.

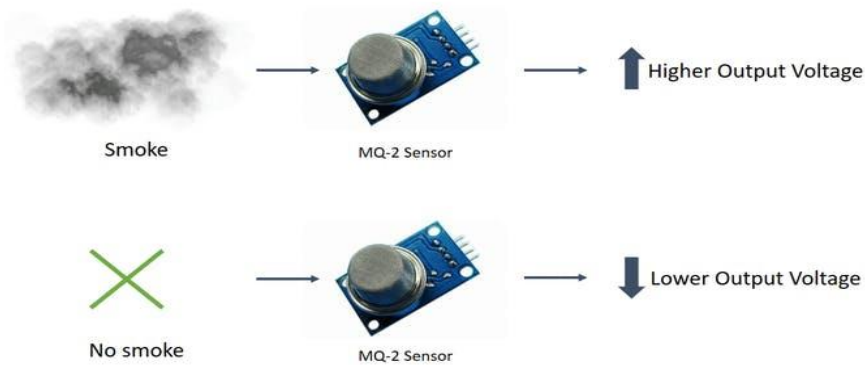


Figure 7: Smoke sensor

The output can be an Analogue signal (A0) that can be read with an Analogue input of the Arduino or a digital output (DO) that can be read with a digital input of the Arduino.

Pin Wiring

The MQ-2 sensor has 4 pins.

Table 2.1: Smoke sensor pins description

Pin	Wiring to Arduino Uno
A0	Analogue pins
DO	Digital pins
GND	GND
VCC	5V

Standard work condition

Table 2.2: Smoke sensor summary

Symbol	Parameter name	Technical condition	Remarks
VC	Circuit voltage	$5V \pm 0.1$	AC OR DC
V _H	Heating voltage	$5V \pm 0.1$	AC OR DC
R _L	Load resistance	Can adjust	
R _H	Heater resistance	$33\Omega \pm 5\%$	ROOM TEMP
P _H	Heating consumption	Less than 800mw	

2.2.2. GSM: (global system for mobile communication)

It is a digital mobile telephony system that uses a variation of time division multiple access (TDMA) and is the most widely used of three digital wireless telephony technology (TDMA, CDMA).

It digitalizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slots. It operate at either the 900MHz or 1800 MHz frequency band. It used to send message and making the call to the user.



Figure 8: GSM SIM900

Specification of GSM

PCB size	71.4mm X 66.0mm X 1.6mm
Indicators	PWN, status LED, net LED
Power supply	5V
Communication protocol	UART
RoHS	Yes

2.3 Related Study

ELECTRICAL CHARACTERISTICS				
Parameter	Min.	Typical	Max	unit
Power voltage (V Supply)	4.5		5.5	VDC
Input voltage VH	0.7VCC		5.5	V
Input voltage VL	-0.3	0	0.3VCC	V
Current Consumption (pulse)	-		2000	mA
Current Consumption (continuous)			500	mA
Baud rate		115200		bps
Pins description				
Rst	1	Reset the sim900 module		
P	2	Power switch pin of SIM900 module		
TX	3	UART data output		
RX	4	UART data in		
-	5	GND		
+	6	VCC		

Table 2.3: GSM SIM 900

2.3.1 Arduino microcontroller

Arduino is an open-slyke electronics prototyping platform based on flexible, easy-to-use hardware and software. It can sense the environment by receiving input from a variety of sensors and can affect its surrounding by controlling lights, water pump, buzzer and other actuator. The microcontroller on the board is programmed using the Arduino programming language (based on wiring) and Arduino development environment (based on processing).

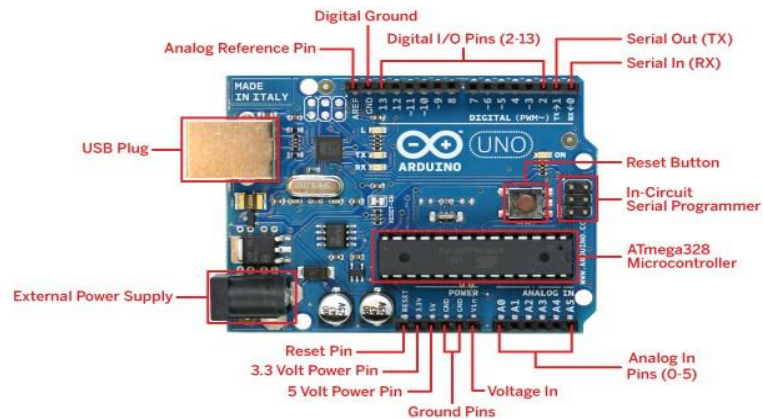


Figure 9: Arduino Microcontroller

2.3.2 Arduino Uno

Overview

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs). 6 Analogue inputs, a 16MHz crystal oscillator, a USB connection, power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with AC to DC adapter or battery to get started.

Summary

Microcontroller	AT mega 328
Operating voltage	5V
Input voltage(recommended)	7-12V
Input voltage (limits)	6-20V
Digital I/O pins	14(of which 6 provide PWN output)
Analogue input pins	6
DC current per I/O pin	40Ma
Dc current for 3.3V pin	50MA
Flash memory	32KB of which 0.5 KB used by boot loader
SRAM	2 KB
EEPROM	1 KB
Clock speed	16 MHz

Table 3.4: Microcontroller Arduino Uno

Memory

The AT mega328 has 32 KB of flash memory for storing code (of which 0.5 KB used for the boot loader), 2 KB of SRAM, and 1KB of EEPROM (which can be read and written with the EEPROM library).

Programming

The Arduino mega can be programmed with the Arduino software. The ATmega328 on the Arduino mega comes pre-burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer.

It communicates using the original STK500 protocol. You can also bypass the boot loader and program

2.3.3 A printed circuit Board

Printed circuit board (PCB) is an electronic circuit used in devices to provide mechanical support and a pathway to its electronic components. It is made by combining different sheets of non-conductive material, such as fiberglass or plastic that easily holds copper circuitry. PCB is also known as printed wiring board (PWB) or etched wiring board (EWB). A printed circuit board(PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto an on-conductive substrate. Components (e.g. capacitors, resistors or active devices) are generally soldered on the PCB (Peter, 2012).

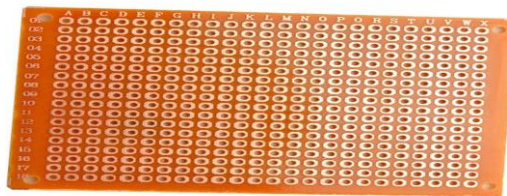


Figure 10:A printed circuit Board

2.3.4 Jumper wires

A jumper wire is an electrical wire that has connector pins at each end, allowing it to be used to connect two points without soldering. Jumper wires are typical with breadboards and other prototyping tools to make it easy to change a circuit as needed. Individual jumper wires are fitted by inserting their end connectors into the slots provided in a breadboard the header connected to a circuit board or piece of test equipment. Jumper wires are in three versions: - male-to-male, male to female and female-to-male (Puckett, 2015).



Figure 11: Jumper wires

CHAPTER 3: RESEARCH METHODOLOGY

This chapter explains how the data shall be presented, analyzed, and interpretation of results. The presentation format of data is designed based on the data collection instruments

3.0. Introduction

This chapter outlines the research methodology used to develop and evaluate the Smart home firefighting system. It includes the research design, population, sampling methods, research instruments, data gathering procedures, data analysis methods, ethical considerations, and limitations of the study

3.1 Research Design

According to the statements in my abstract and background of the project, research design was based on the population we have considered. System design (SD) is the process of designing internal structure of the target system that satisfies the requirements define in requirement analysis and definition (RA&D) process.

3.2 Research Population

According to my statement in my project abstract and background of the project, am targeting to protect houses away from fire

3.3.1 Sample Size

The description of the sample size I used in my project was also based on the population or consumers am targeting

3.4 Research Instrument

In my project research “ **SMART HOME FIRE FIGHTING SYSTEM,**” I used techniques like surveys, interviews, observations, and focus groups. They fit to my project because it is where I found problems in the society and discuss what the solutions is and how I can implement them and that’s where the idea came from.

I also used existing smyces like published materials, online database, and past research studies. As am not the ones to solve problems, I needed some related works so that I can make an innovation by referencing to others

3.4.1 Choice of the Research Instrument

For a **Smart Home firefighter System project**, selecting the appropriate research instrument involves choosing the sensor, components, and Arduino modules that will send code that codes it to control the GSM and smoke sensor to work (devices).

Here's a guide to help you choose the research instruments for my project:

Relay module: single channel this will help to switch the water pump(devices)

GSM: it will send a message to notify that there is a fire

Sensor: smoke sensor to sensor if there is fire

Buzzer: to create noise where fire is about to happen

Water pump: to pure water to the fire in order to stop it

Arduino: is like the head of the project because it will command all project according to the working principle

Wires & connectors: Use appropriate wiring and connectors to connect the nodemcu, to the relay and other components. Ensure proper insulation and strain relief to prevent electrical hazards and maintain reliability

3.4.2 Validity and Reliability of the Instrument

Ensuring the validity and reliability of selecting Arduino which much with project goals, validating by connecting with sensor and Gsm & water pump consistency through calibration and field tests. Internal consistency and test-retest reliability are essential for accurate data collection, while inter-rater reliability minimizes discrepancies in interpretation.

3.5 Data gathering Procedures

Date gathering procedures I used are follows:

Primary data: are data which are collected from the smyces, such as surveys, interviews, observations, experiment, etc.

Secondary data: are data which are collected from existing smyces, such as published materials, online database, and past research studies.

Based on the above description, in my project I used both primary and secondary data because they were all needed so as to make it fulfilled.

3.6 Data analysis and Interpretation

Systems analysis (SA) is the process of collecting and interpreting facts, identifying the problems, and decomposing a system into its components. System analysis conducted for studying a system or its parts in order to identify its objectives.

3.7 Ethical Consideration

My research project smart home appliances control system used by physical disabled people (leg disabled cases) will be submitted in partial fulfillment of the requirements for the grade of advanced diploma in electrical and electronics engineering department.

3.8 Limitation of the study

- i.** same time GSM fail to send message due to the bad network
- ii.** Cost of sms is very expensive

CHAPTER 4: SYSTEM DESIGN ANALYSIS AND IMPLEMENTATION

4.0 Introduction

This part describes the project design for the connections and arrangement of the devices within the circuit and how they have to be followed part to part in a result of the implementation, these are shown below by using a system flow chart diagram, block diagram, circuit diagram and it describes the system project by working principle, all these are shown below:

4.1 Calculations

We calculated the level of smoke in part per million by using test of combustible gases.

Smoke sensor: $PPM = 3.027 * e^{(1.0698 * VRL)}$

• FOR smoke=50PPM,

$$50 = 3.027 e^{1.0698V}$$

$$50/3.027 = e^{1.0698V}$$

$$16.51 = e^{1.0698V}$$

Apply ln for both sides

$$\ln(16.51) = \ln e^{1.0698V}$$

$$\ln(16.51) = 1.0698V \ln e$$

$$\ln(16.51) = 1.0698V$$

$$V = \ln(16.51)/1.0698$$

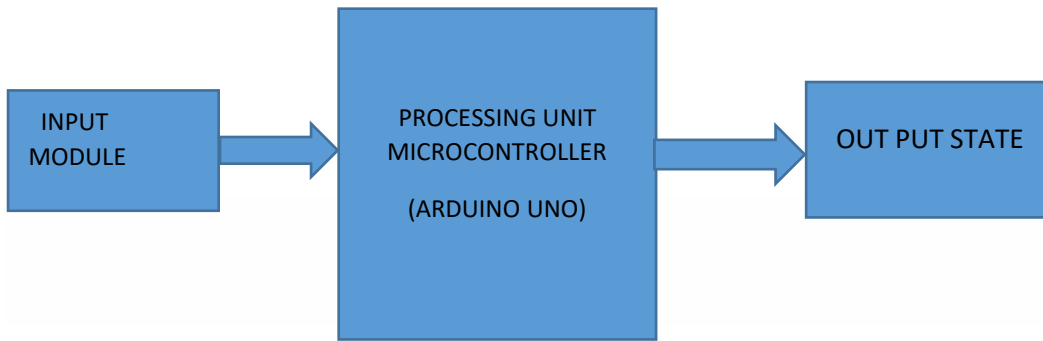
$$V = 2.62V$$

4.2 Drawings

In my research project the used diagrams are as follows:

4.2.1 System block Diagram

This part is where the system project is constructed in the way of blocks and it describes how the process has to follow one another.



4.2.2 FLOW CHART

A flow chart is a type of diagram that represents a workflow or process. A flow chart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solve a task

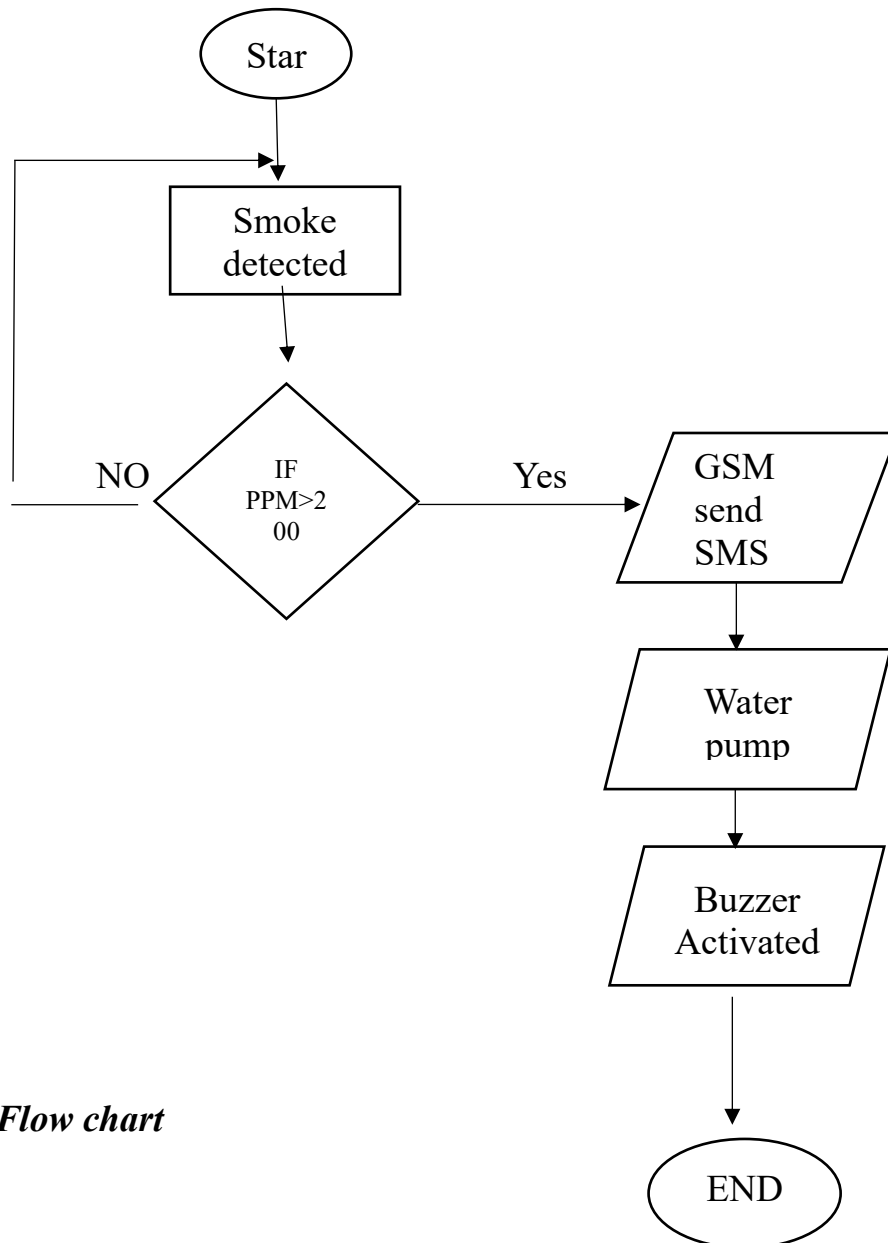


Figure 3.12: Flow chart

4.2.3 Circuit Diagram

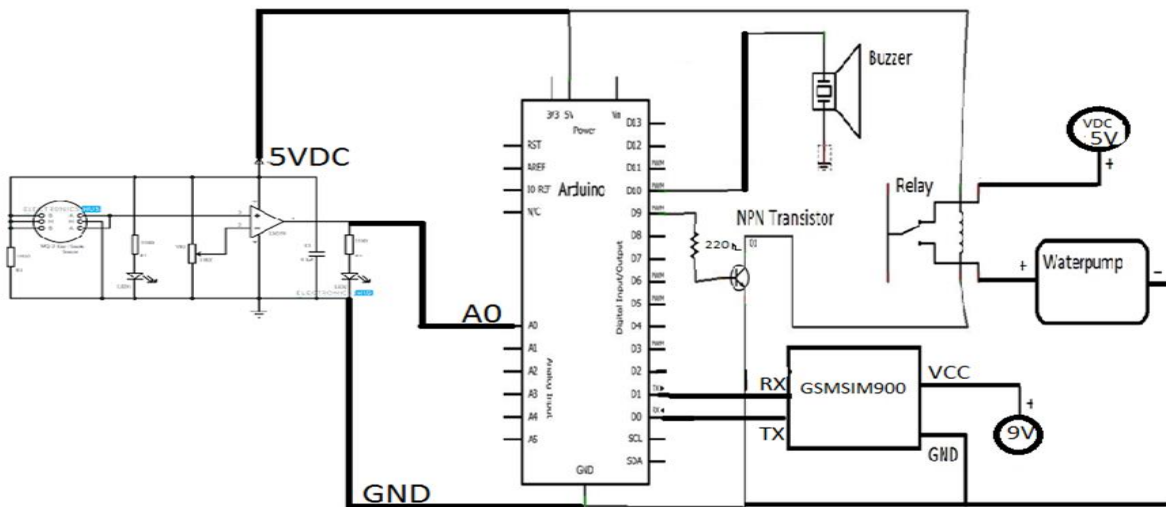


Figure 12: Smoke Detector Alarm Circuit

4.3 Working Principle

Microcontroller arduino is an open source electronics platform based on easy to use hardware and software. The processor unit or controller is the main part of my system, to make it functional we need to make program codes according to what we need for working of my system. The code program will be written in the Arduino IDE, this code will depend on the interface connected to the controller.

4.4 Specification

In my project smart home appliances control system specification is as follows:

1. Microcontroller:

- **Arduino Uno:** ATmega328P
- Other boards use different microcontrollers, such as ARM Cortex on the Arduino Due or ATmega32U4 on the Arduino Leonardo.

2. Operating Voltage:

- Typically **5V** (some boards like Arduino Due operate at 3.3V)

3. Input Voltage (recommended):

- **7-12V** via external power supply

4. Digital I/O Pins:

- **14 pins** (on Uno), where 6 can provide **PWM output**

5. Analog Input Pins:

- **6 pins** (on Uno) for reading analog signals

6. DC Current per I/O Pin:

- Maximum **40 mA**

7. Flash Memory:

- **32 KB** on the ATmega328P (with 0.5 KB used by the bootloader)

8. SRAM:

- **2 KB** on the ATmega328P

9. EEPROM:

- **1 KB** (on Uno, for non-volatile storage)

10. Clock Speed:

- **16 MHz** (on Uno)

11. USB Connectivity:

- Arduino boards like the Uno come with a **USB Type B** port for programming and serial communication.

Current specifications on the PINs of the microcontroller:

Absolute Maximum ratings:	Practical measurements:
DC Current per I/O Pin: 40.0 mA DC Current	DC Current output Pin for transistor : 21.9 mA
VCC and GND Pins: 5V	VCC and GND Pins: 4.81V

DC Current per I/O Pin: 40.0 mA DC Current	DC Current output Pin for transistor : 21.9 mA
VCC and GND Pins: 5V	VCC and GND Pins: 4.81V

4.4.1 General Specifications of single channel Relay module:

- **Number of Channels:** single(1)
- **Control Signal Voltage:** 5V DC
- **Trigger Voltage:** 0-5V DC (High-level trigger or Low-level trigger, depending on the module)
- **Operating Voltage:** 5V DC
- **Current Consumption:** ~70-100mA per relay (when activated)
- **Relay Type:** Electromagnetic relay
- **Control Method:** TTL logic (typically GPIO pins from microcontrollers like Arduino, Raspberry Pi, etc.)

4.5 Implementation

4.5.1 Hard ware Implementation

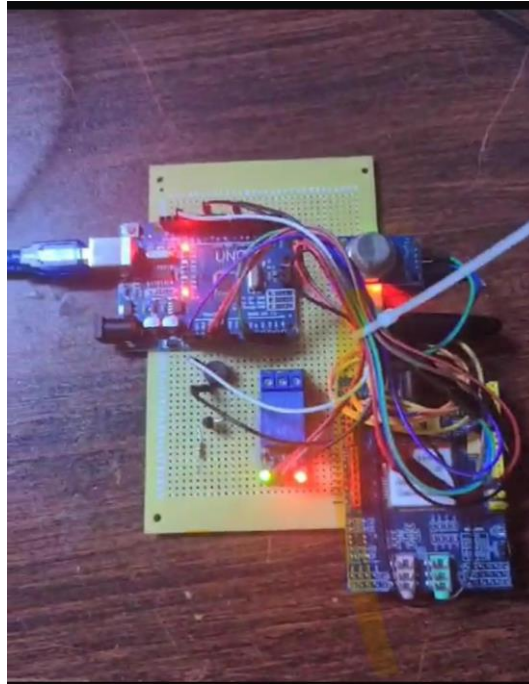


Figure 13: Hard ware Implementation

4.6. The cost of the project

The currency used is Rwandan Francs (Rwf).

Table 1: Cost Estimation

Passive components	Amount	Price/unit in Frw	Total Cost
Resistor	1	100	100
Dc water pump	1	9000	9000
Breadboard	1	1500	1500
Buzzer	1	1600	1600
Jump cables	20	50	1000
Relay	1	1500	1500
Active components			
Arduino Uno	1	15000	15000
Smoke sensor	1	6500	6500
GSM	1	16500	16500
Transistor	1	1200	1200
All total cost			

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

In this chapter we are going to discuss about conclusion and recommendation of this project smart home firefighting system which will reduce the number of fire accidents in different environment especially in gas stations across whole country and to recommend the next researchers to improve the project by adding hardware devices as GPS to increase security

5.1 Conclusions

After analyzing and working in this project we concluded that project is very useful in daily life of people. This project has based on designing and implementation of smart home firefighting system which will pose the number of fire accidents such as people's goods and lives. The choice of a particular type of equipment to be used in firefighting system depends on the nature of the occupancy, the size of the building, the number of occupants and the level of protection desired. The designer of the system must understand the function and limitations of the equipment chosen to obtain maximum efficiency and safety.

Hence after looking my project, we want to improve the security technology based on the microcontroller to protect against the fire accidents and correct those fire accidents in the building through water pump which will pump the water to the building after smoke sensor sense the smoke.

The cost of implementing this system is relatively low since the components used are relatively cheap and are easily available in the market. The single microcontroller can be used to interface several sensors with alarms located in different locations as long as more pins are freed for multiple inputs and multiple outputs.

5.2 Recommendations

I would like to recommend all organizations use this system so that they can reduce all daily challenges of fire accidents happening for different locations such as companies, hotels, offices, and hospital and school laboratories.

This system should be placed in a cool and dry place to ensure a longer life span. It should also be placed in a high place in the room and in the direction of the window where there is most likely to be the direction of the wind to facilitate the contact of the sensor with the

smoke. The visual alarms should be positioned a few meters above the ground in an easily visible place. The audio alarm should be as well positioned in a place the its alarm can be easily heard.

I recommend improving the external hardware devices controlled by Arduino by adding GPS and Camera to take information where the location has fire accidents for the purpose of increasing more security.

REFERENCES

- [1] “<https://en.m.wikipedia.org/>” [Online]. Available: <https://en.m.wikipedia.org/wiki/buzzer>. [Accessed 10 06 2021].
- [2] “<https://e.m.wikipedia.org/>” [Online]. Available: <https://e.m.wikipedia.org/wiki/Transistor>. [Accessed 12 06 2021].
- [3] “<http://en.wikipedia.org/>” [Online]. Available: <http://en.wikipedia.org/wiki/Resistor>. [Accessed 02 07 2021].
- [4] “<https://en.m.wikipedia.org/>” [Online]. Available: <https://en.m.wikipedia.org/wiki/Relay>. [Accessed 06 07 2021].
- [5] “<http://www.pumpfundamentals.com/>” [Online]. Available: <http://www.pumpfundamentals.com/tutorial1.htm>. [Accessed 20 08 2021].
- [6] “www.hackster.io/” [Online]. Available: <https://www.hackster.io/Aritro/smoke-detection-using-mq-2-gas-sensor-79c54a>. [Accessed 15 08 2021].
- [7] “www.instructables.com/” [Online]. Available: www.instructables.com/id/How-to-use-MQ2-Gas-Sensor-Arduino-Tutorial. [Accessed 12 08 2021].
- [8] “https://www.iteaad.c/wiki>SlqqM900/SIM900A_GaaSM/GPRS_Minimum_system_Module” [Online]. Available: https://www.iteaad.c/wiki>SlqqM900/SIM900A_GaaSM/GPRS_Minimum_system_Module. [Accessed 13 07 2021].
- [9] “www.hobbytronics.co.uk/” [Online]. Available: www.hobbytronics.co.uk/arduino-summary. [Accessed 25 07 2021].
- [10] “<http://arduino.cc/>” [Online]. Available: <http://arduino.cc/en/Main/Hardware>. [Accessed 17 07 2021].
- [11] “<http://arduino.cc/>” [Online]. Available: <http://arduino.cc/it/Main/ArduinoBoardMega328>. [Accessed 2 10 2021].
- [12] “www.circuitstoday.com/” [Online]. Available: www.circuitstoday.com/gsm-based-fire-alarm-system-using-arduino. [Accessed 07 08 2021].
- [13] “www.projectsof8051.com/” [Online]. Available: www.projectsof8051.com/sms. [Accessed 08 09 2021].
- [14] “www.npeducations.com/” [Online]. Available: www.npeducations.com/2013/10/automatic-fire-detection-system-with.htm. [Accessed 10 09 2021].
- [15] “<https://learn.sparkfun.com/>” [Online]. Available: <https://learn.sparkfun.com/tutorials/hazardous-gas-monitor/calculate-gas-sensor-ppm..> [Accessed 14 09 2021].
- [16] “<http://arduino-info.wikispaces.com/>” [Online]. Available: <http://arduino->

] info.wikispaces.com/ArduinoPinCurrent. [Accessed 16 09 2021].

[17.s://en.wikipedia.org/wiki/System, Retrieved August 23, 2020, from

<https://en.wikipedia.org/wiki/System>:

<https://en.wikipedia.org/wiki/Microcontroller>, Retrieved August 23, 2020, from

<https://en.wikipedia.org/wiki/Microcontroller>:

<https://dictionary.cambridge.org/dictionary/english/automatic>, Retrieved February24, 2020,

from <https://en.oxforddictionaries.com/definition/Automatic>:

[http](http://)

APPENDIX

```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(7, 8);
int smoker_sensor=A0;
int waterpump=11;
int buzzer=6;
int value;
int limit;
void setup() {

    //Begin serial communication with Arduino and Arduino IDE (Serial
    Monitor)
    Serial.begin(9600);

    //Begin serial communication with Arduino and A6
    mySerial.begin(9600);

    pinMode(waterpump,OUTPUT);
    pinMode(buzzer,OUTPUT);
    pinMode(smoker_sensor,INPUT);

}
void loop() {
value=analogRead( smoker_sensor);
Serial.println(value);
delay(500);
if(value>=200)
{
Serial.println("Initializing...");
    delay(5000);
    //Begin serial communication with Arduino and Arduino IDE
    (Serial Monitor)
    Serial.begin(9600);

    //Begin serial communication with Arduino and A6
    mySerial.begin(9600);

    Serial.println("Initializing...");
    delay(5000);
```

```

    mySerial.println("AT"); //Once the handshake test is successful,
it will back to OK
    updateSerial();

    mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
    updateSerial();
    mySerial.println("AT+CMGS=\"+250788693816\""); //change ZZ with
country code and xxxxxxxxxxxx with phone number to sms
    updateSerial();
    mySerial.print("accident please home fire detected"); //text
content
    updateSerial();
    mySerial.write(26);

digitalWrite(buzzer,HIGH);
digitalWrite(waterpump,HIGH);

}
else
{
digitalWrite(buzzer,LOW);
digitalWrite(waterpump,LOW);
}
}
void updateSerial()
{
    delay(500);
    while (Serial.available())
    {
        mySerial.write(Serial.read()); //Forward what Serial received to
Software Serial Port
    }
    while(mySerial.available())
    {
        Serial.write(mySerial.read()); //Forward what Software Serial
received to Serial Port
    }
}
}

```