Using a covid thermometer to implement a door locking mechanism.

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Using a covid thermometer to implement a door locking mechanism.

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# Abstract

Coronavirus has changed the way we connect with the world as a civilization. We have to follow the restrictions and protocols to reduce the chances of retrieving or spreading the virus. One of the most common symptoms of Covid-19 is high temperature. The problem is that most public buildings or business do not have the equipment to detect a person’s body temperature.

How can we make sure that someone’s temperature is suitable for the entry of a building? The primary goals of this dissertation will be to investigate and design a system for controlling an electrical locking mechanism based on body temperature monitoring.

The aim of the final system is to make sure that the person using the entrance of a building will have the suitable body temperature and the use of hand sanitiser. If the person does not to either of these demands, they will not be granted entry into the building. The system will be created with the use of a miniature computer and will consist of additional equipment such as a temperature sensor, an electrical lock, and an ultrasonic sensor. The combination of the equipment that have been mentioned will ensure that the user will have to use hand sanitiser and have a suitable temperature to be granted entry.

# Acronyms

|  |  |  |
| --- | --- | --- |
| Acronym | Definition | Page |
| NHPET | National Public Health Emergency Team | 1 |
| ASD | Autism Spectrum Disorder | 6 |
| RTD | Resistance Temperature Detectors | 8 |
| ITO | Indium-Tin-Oxide | 8 |
| TCO | Transparent Conducting Oxide | 9 |
| RTC | Resistance Temperature Coefficient | 9 |
| IOT | Internet of Things | 10 |
| PIR | Passive Infrared Sensor | 10 |
|  |  |  |
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|  |  |  |
|  |  |  |

# Table of Contents

[Declaration](#_Toc429471704)

[Acknowledgements](#_Toc429471705)

[Abstract](#_Toc429471706)

[Acronyms](#_Toc429471707)

[Table of Contents](#_Toc429471708)

[Table of Figures](#_Toc429471709)

[Table of Tables](#_Toc429471710)

[Table of Code Listings](#_Toc429471711)

[1. Introduction 1](#_Toc429471712)

[1.1. Purpose 2](#_Toc429471713)

[1.2. Background 2](#_Toc429471714)

[1.2.1. Raspberry Pi 2](#_Toc429471715)

[1.2.2. Firebase 3](#_Toc429471716)

[1.2.2. Hand Sanitiser 3](#_Toc429471716)

[1.3. Research Question 4](#_Toc429471717)

[1.3.1. Aims 4](#_Toc429471715)

[1.3.2. Objectives 4](#_Toc429471716)

[1.4. Report Outline 4](#_Toc429471718)

[2. Literature Review 5](#_Toc429471719)

[2.1. Covid Context 6](#_Toc429471720)

[2.1.1. The virus and how it spreads 6](#_Toc429471715)

[2.1.2. Restrictions 6](#_Toc429471715)

[2.1.3. Return of the workplace 7](#_Toc429471716)

[2.1.4. Hygiene and Prevention of viruses from hand sanitation 7](#_Toc429471715)

[2.1.5. Side effects and reactions from hand sanitation 8](#_Toc429471716)

[2.2. Temperature Sensors 8](#_Toc429471721)

[2.2.1. Thermocouples 8](#_Toc429471715)

[2.2.2. RTDs (Resistance Temperature detectors) 9](#_Toc429471716)

[2.2.3. Thermistors 9](#_Toc429471715)

[2.2.4. DS18B20 Temperature Sensor 10](#_Toc429471716)

[2.2.5. Comparison of temperature sensors 1](#_Toc429471716)0

[2.3. Access Control 11](#_Toc429471722)

[2.3.1. Face Detection 11](#_Toc429471715)

[2.3.2. Pin codes 1](#_Toc429471716)2

[2.3.3. Fingerprints 1](#_Toc429471715)2

[2.3.4. Temperature Monitor 1](#_Toc429471716)2

[2.3.5. Comparison of the access control methods 1](#_Toc429471715)2

[2.4. Presence Sensors 13](#_Toc429471723)

[2.4.1. Light Sensors 1](#_Toc429471715)3

[2.4.2. Ultrasonic Sensors 1](#_Toc429471716)4

[2.4.3. Passive Intrared Sensors 1](#_Toc429471715)5

[2.4.4. Comparison of Presence Sensors 1](#_Toc429471716)5

[3. Design Chapter 16](#_Toc429471719)

[3.1. Introduction 16](#_Toc429471720)

[3.2. System Requirements 16](#_Toc429471721)

[3.2.1. Software Requirements 1](#_Toc429471715)7

[3.2.2. Hardware Requirements 1](#_Toc429471716)7

[2.2.3. Functional Requirements 1](#_Toc429471715)7

[3.2.4. Non-Functional Requirements 1](#_Toc429471716)7

[3.3. Use Cases 18](#_Toc429471721)

[3.3.1. Diagram 1 1](#_Toc429471715)8

[3.3.2. Description 1 1](#_Toc429471716)8

[3.3.3. Diagram 2 1](#_Toc429471715)9

[3.3.4. Description 2 1](#_Toc429471716)9

[3.4. Flow Chart Diagram 20](#_Toc429471721)

[3.4.1. Diagram 1 : Body Temperature 20](#_Toc429471715)

[3.5. Conclusion 20](#_Toc429471721)

[4. Testing Strategy 21](#_Toc429471719)

[Appendices](#_Toc429471724)

[Appendix A: References](#_Toc429471725)

[Appendix B: Code Listing](#_Toc429471726)

# Table of Figures

[Figure 1 : A linear graph of the total cases of coronavirus in ireland 1](#_Toc429427538)

[Figure 2 : A Raspberry Pi 4 model B 3](#_Toc429427539)

[Figure 3 : Use case diagram 1 15](#_Toc429427538)

[Figure 4 :Use case diagram 2 16](#_Toc429427539)

[Figure 5 : Flow chart diagram 18](#_Toc429427538)

# Table of Tables

[Table 1. Comparison of temperature sensors 11](#_Toc429429027)

[Table 2. Comparison of access control methods 13](#_Toc429429028)

[Table 3. Use case description 1 16](#_Toc429429027)

[Table 4. Use Case description 2 17](#_Toc429429028)

[Table 5. Results for testing strategy 19](#_Toc429429027)

# Table of Code Listings

# Introduction

Since the beginning of March 2020, we have been in a pandemic which had multiple lockdowns. Ireland’s coronavirus cases have affected more than 400,000 people, 5,000 deaths, and 262,000 recoveries (‘Worldometer’ 2021). In Ireland, 7,264,000 doses of Covid-19 vaccination had been delivered as of Sunday, October 2021 (Gov.ie 2021a). Figure 1 below displays the graph of covid cases from March 2020 – October 2021.

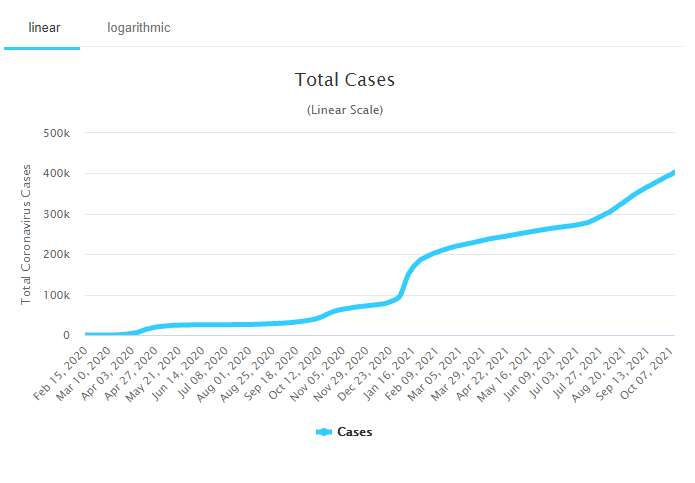


Figure 1 : A linear graph of the total cases of coronavirus in Ireland (‘Worldometer’ 2021)

The numbers on the graph above are showing us how easily that the virus can be caught and spread. We will have look at the symptoms for covid and methods that are used to prevent the spreading of the virus. One of the most common methods for the prevention of spreading covid is the use of hand sanitiser. Throughout the time of the pandemic in Ireland, the National Public Health Emergency Team (NPHET) has been monitoring the restrictions and the containment of Covid-19 in the country. NPHET was formed on 27th January 2020. They would host meetings to discuss their agendas to contain the level of covid cases. NPHET’s suggestions are sent to the Minister of Health for a review immediately after each meeting, and these suggestions are implemented to help the government make their choices about how to address the pandemic. (Gov.ie 2021b) The most common symptom for covid is a fever (high temperature – 38 degrees Celsius or above) accompanied with chills. (HSE.ie 2021).

This dissertation will aim to create a product that will benefit future pandemics by applied more preventative measures against covid or other viruses.

## Purpose

The purpose of this dissertation is to create a product that will detect someone’s body temperature and their temperature will define their entry or not into a public place. The reason for a project like this is going to be created is reduce the rates of covid. To have the ability to detect if a person has a fever due to the level of body temperature will make the world a safer place. The use of this work has the aims to be implemented in medium to large sized premises.

## Background

This document is provided to demonstrate the layout for headings, image captions, etc. Where third level headings are required a further numbered list may be used providing that the items constitute more than one line per section.

### Raspberry Pi

The Raspberry Pi is a low-cost computer which is around the size of a credit card that can connect to a computer or TV and it utilizes a regular keyboard and mouse (Raspberry Pi n.d.).

Raspberry Pi has risen in popularity over time due to its low prices and accessibility. It has caught the attention of quite the range of users, from people who do programming as their profession to kids who are trying to learn computing in a school. (Lifewire 2021).

This miniature computer can have its pros and cons. To start off with the pros, Raspberry Pi has a vast amount of peripheral support. It comes with 26 GPIO Pins, which is extremely helpful for hardware interfaces and embedded applications. The vast range of languages that Raspberry Pi supports is a lot as a comparison to other open-source electronics like Arduino. Raspberry Pi can almost support the code of any language, for instance, Java, Python, C, C++, and many others.

For the cons of Raspberry Pi, a problem that comes up from time to time is the board overheating. It doesn’t come with any cooling fans for the board. This would only happen if the raspberry Pi were being used approximately 7 hours straight, without no form of air-conditioning. It can also be impractical as a Desktop Computer. The raspberry Pi would lack performance in speed, as a comparison to a standard computer.(MACFOS 2020).

A picture containing electronics, circuit

Description automatically generated

Figure 2. A Raspberry Pi 4 Model B (‘Raspberry Pi’ 2021)

### Firebase

The archiving of the sensor data that will be utilized in the project’s main artefact’s testing will be Firebase. Firebase is a “Google-backed application development software” that has the ability to create a web app. It can offer capabilities for analysing data, reporting, and resolving errors in applications. (SearchMobileComputing 2021)

Firebase is a well-known backend development platform and cloud-service that is well-known for its capabilities. Around 19,217 developers have said that they use Firebase on StackShare. Firebase gives the opportunity to a number of services such as Analytics, Realtime database, Performance, cloud messaging and many other services. Due with the involvement of Google, it can be a reliable and extensive database. Firebase Realtime database provides apps that may access cross-platform data in realtime, due to connecting to NoSQL cloud-storage (Back4App Blog 2021).

### Hand Sanitisers

Hand sanitiser is mainly used after going into a public premises or transport. It is the best option when soap and water is not available for use. Hand sanitiser products that contain alcohol content with a number greater than 60 percent has the most impact for protection from covid. (Cruse 2020)

## Research Question

The dissertation will attempt to answer the following question below:

“How effective is a raspberry pi with a door locking mechanism in preventing unauthorised access for people with high temperatures”

**1.3.1 Aims**

The aim of this project is to design and build a locking system that will be used to define a person's body temperature and either give or deny them access (depending on their body temperature). If a person is granted entry, they will have to use hand sanitiser to further the prevention of spreading covid-19. To detect the movement of someone’s hand, the use of a presence sensor will be implemented. If a person is denied entry, their body temperature will be too high.

**1.3.Objectives**

* Develop an application that uses a Raspberry Pi and thermometer to monitor body temperature
* To use firebase as an area to store the sensor data
* To utilize a locking mechanism that sends out error messages when something goes wrong.

## Report Outline

The second chapter will be a literature review, including an assessment of current literature, critique and justification of decisions, technical advancement, and a state of the art of comparable artefacts in that field of study. The project's non-functional and functional criteria, as well as the design structure, will then be explained in Chapter 3. The product development and testing will be discussed further in chapter 4.

2. Literature Review

Introduction

In the literature review, the correct material for this project is going to be gathered, reviewed, and evaluated. Work from articles, books, and research papers will all be included in this chapter. This is going to provide us a firm foundation that will be employed in the Design chapter and the Testing chapter later on in the thesis.

The primary research topics of interest that are going to be implemented are:

1. **Covid Context**

In this chapter, the main topic of discussion will involve the restrictions that was implemented during the global pandemic and how it affects each individual physically and mentally, the opening of the workplace and an explanation how workplace operated before and after the opening of the workplace, and finally an elaboration of the use of hand sanitiser and it can prevent viruses and some of the side effects that some individuals may experience.

1. **Temperature sensors**

In this chapter, the primary area of discussion is about the different types of temperature sensors, ranging from thermocouples, thermistors, RTDs (Resistance Temperature detectors), and the DS18B20 Temperature sensor. Each example of the temperature sensor is going to have a introduction, specifications, and some temperature sensors will have their pros and cons. There will also be a comparison area in the research topic.

1. **Access Control**

In this chapter, different areas that can be utilised for access control is going be discussed such face detection, pincodes, fingerprints, and temperature monitors. Each topic will consist of general information, the reason for its use, what tools are going to be used and other areas of discussions. In the access control chapter, there is also a comparative section.

1. **Presence Sensors**

In this chapter, the topics of discussion will consist of ultrasonic sensors, passive intrared sensors, and light sensors. In each research topic, it will have general information about the sensor, the possibilities that the sensors can do and other areas that the sensors may have in mind. There will also be a topic of comparison for each sensor that is mentioned in this chapter.

2.1 Covid Context

2.1.1 The virus and how it spreads

In December 2019, Wuhan, Hubei Province, China, saw an epidemic of an unknown illness identified as pneumonia of unclear origin. Several independent laboratories identified the primary cause of this strange pneumonia as a new coronavirus a few days later. The World Health Organization (WHO) has provisionally designated the causal virus as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as well as the corresponding infected illness as coronavirus disease 2019 (COVID-19) (He *et al.* 2020). SARS-CoV-2 is easily transferred between people by coughing or sneezing and direct and indirect interaction. It's unclear how important airborne droplet nuclei are in SARS-CoV-2 transmission in the population. Other physiological fluids may potentially include SARS-CoV-2 RNA and live virus particles (Li *et al.* 2020).

2.1.2 Restrictions

Since the beginning of March 2020, Ireland has been through multiple restrictions and lockdowns to prevent the chance of getting the Covid-19 virus. The main goal that was trying to be achieved by the public health board was to increase the physical health of each person in Ireland, but there was less focus aimed towards the psychological effects of the global epidemic, particularly to many of the most vulnerable groups of individuals in the population. The harmful impact of the limits on the well-being of the younger generations was addressed by parents, and even children. Negative mental health impacts were seen in children and adolescents, particularly the feelings of social withdrawal, sadness, anxiety, and an increase in antisocial behaviour. There were also reports that families that had a child or multiple children who has ASD (autism spectrum disorders) had experiences of higher mental health problems due to the vast amount of changes in their daily routine throughout the pandemic *(O’Sullivan et al. 2021)*.

2.1.3 Return of the workplace

As each day goes by, one of the main aims is to implement the return of the workplace and adapt it in a way where it is physically and psychologically safe for each individual. There has been a lot of changes in the practices of work, it is encouraged that most employees in a company (mainly specified towards office jobs) would work from their own home. Some employees, and even employers of companies were unfortunately to be able to open up their work due to the unavailability of using remote work. Due to the availability of an effective vaccine, it has improved the chance of people returning back to being able to return to their workplace. With the opening of the workplace now, it is improving the mental health of an individual due to the increase of social interactions (Kniffin et al. 2021) (Callery and Meehan 2021).

# 2.1.4 Hygiene and Prevention of viruses from hand sanitation

The main purpose for the use of hand sanitation is hygiene. The World Health Organisation (WHO) recommends that we should use alcoholic hand sanitiser which has a percentage over sixty percent. Hand sanitiser with a percentage as high as that have a better chance to reduce the spread and the rates of infections of coronavirus. These hand sanitisers are encouraged to be used quite frequently. The majority of hand sanitisers are made of alcohols such as ethanol, isopropyl, and hydrogen peroxides (WHO,2020). The range of either ethanol or isopropyl alcoholic based hand sanitisers are between sixty percent and ninety five percent of concentration (Barrett and Babl 2015)(Mahmood *et al.* 2020) .

A brilliant method for hand sanitation during the pandemic is the automatic hand sanitiser dispensing machine. It's a non-contact hand sanitizer with alcohol as the primary solvent. This device is utilized in a variety of settings, including hospitals, businesses, workplaces, intuitions, and so on. Alcohol disinfects better than soap or any other solid soap, but it does not need water to clean since it is a volatile substance that evaporates quickly once applied to your hands (Lakkarsu 2021).

# 2.1.5 Side effects and reactions from hand sanitation

When it comes to the side effects and the reaction from the use of hand sanitiser, the popular issues that appear is the irritation and itching of the skin, the dryness of the skin, and even in some cases, cracking and bleeding of the skin. It is highly recommended to use a hand sanitiser product that is less irritating on the skin (Information *et al.* 2009).

* 2.2 Temperature Sensors

# 2.2.1 Thermocouples

The first type of a temperature sensor that is going to be look at in this research topic is thermocouples. The thermocouple is a low-priced thermometer sensor that is a frequently used device for temperature measurement. Boilers, heating systems, cookers, and jet aircrafts, to highlight a few areas and then employ them in a range of applications up to roughly 2500°C. The type K thermocouple has a range of approximately of –200°C to 1250°C and is made up of Chromel and Alumel (branded nickel alloys comprising chromium and aluminium, manganese, and silicon, correspondingly) (Duff and Towey 2010).

A few advantages of using a thermocouple temperature sensor is that it has a vast range of temperature that can be measured, it is a solid device that can survive in a dangerous environment, it is very fast at responding, and it does not consist of self-contained heating. A list of disadvantages that should be listed about thermocouples is they are not as accurate as other temperature sensors, and it needs protection to prevent corrosion*(Duff and Towey 2010)* .

2.2.2 RTDs (Resistance Temperature detectors)

The second research topic for a temperature sensor is a Resistance Temperature Detector (also known as RTDs). A thermal resistor whose resistance value fluctuates linearly with temperature is referred to as a resistance temperature detector. Previously, most RTDs were wire and foil kinds, but thin film RTDs are beginning to replace them in industrial applications for temperature readings of work components. The foil and wire forms of RTDs have a small standard of temperature of operation. The temperature of operation range begins at -190 degrees Celsius, and it would go up to 600 degrees Celsius. An example of an RTD would be an Indium-tin-oxide (ITO). An ITO is a degenerated material that contains a large band gap and strong level of conductance. In photonic applications such as solar cells, ITO would be most commonly utilized as a transparent conducting oxide (TCO) (Wang *et al.* 2017).

2.2.3 Thermistors

The third type of temperature that is going to be discussed in this research topic is thermistors. An example of a thermistor is a Wien-Bridge (WB)-Based Temperature Sensor. The thermistors will be inserted in a resonance circuit through with the Wien-bridge RC filter. Thermistor-based temperature sensors can reach greater accuracy over standard BJT-based temperature sensors, according to recent studies. A further essential characteristic of a thermistor-based temperature sensors is the remarkable efficiency in terms of energy, therefore it makes low-power RTCs possible (Park *et al.* 2015).

## 2.2.4 DS18B20 Temperature Sensor

The DS18B20 is a temperature sensor for a raspberry Pi, and it will play a vital part in the project. This sensor will detect the body temperature of a person. The DS18B20 is an electronic temperature sensor with only one wire. It can detect temperatures from 9 to 12 bits in Celsius. Since each of these sensors does have its own 64-bit serial code, numerous DS18B20s can be used on the same wire bus.(Bhalla *et al.* 2018) The DB18B20 has a temperature range from -55 degrees Celsius to 125 degrees Celsius. (Vlad and Roman 2017).

## 2.2.5 Comparison of temperature sensors

From looking the temperature sensors that are mentioned above this paragraph, there is a quite a selection to choose. Thermocouples is a thermometer sensor that is reasonably priced that is used in areas such as boilers, heating systems, and aviation. RTD’s have a good range of temperature which is ranging from -190 degrees Celsius to 600 degrees Celsius. A thermistor, in this example in the research topic is the Wien-Bridge temperature sensor. It has a high standard of accuracy over some thermometer sensors. The final example of a thermometer sensor that was being used was the DS18B20 temperature sensor. I believe this thermometer sensor has the most potential because of its temperature range as it is more realistic when it comes to body temperature, it is easily edited due to raspberry pi and for the connection it only has one wire. The table below shows a comparison of each temperature sensor that is mentioned above.

|  |  |  |
| --- | --- | --- |
| **Name** | **Approximate Cost** | **Accuracy** |
| Thermocouples | *£30* | *accuracy of 0.1°C* |
| RTDs (Resistance Temperature Detectors) | *£65* | *accuracy of 0.1°C* |
| *Thermistors* | *£15* | *±0.2, ±0.1, and ±0.05˚C from 0 to 70˚C.* |
| *DS18B20 Temperature Sensor* | *£17* | *±0.5°C Accuracy from -10°C to +85°C* |

* 2.3 Access Control

# 2.3.1 Face detection

The first area of research that is going to be discussed for access control is face detection supported by OpenCV. The study for face detection is an IOT Door Access Control using facial recognition. For their project, they used face detection with the use of a raspberry Pi camera, which has the specifications of a 8MP Camera, a servo motor, a PIR sensor, and finally a Raspberry Pi 3 Model B. The aim of their project was to have their work in use at places such as using an ATM, security, and home security (Nag *et al.* 2018).

# 2.3.2 Pin codes

The second area of the research topic that is going to be discussed is pin codes. In this current time, security is vital for smartphones and other devices that may need a pin code or a password. Pin codes are used to protect personal data or information that a user may want to keep safe. With the widespread usage of mobile devices in a multitude of regular everyday tasks, the demand for safe access control is emerging as consumers increasingly keep personal and sensitive data on their handheld devices (Chakraborty 2018).

# 2.3.3 Fingerprints

The third area of the research topic that is going to be discussed the use of fingerprints. Biometrics has indeed been examined as well as utilized for generations as a way of guaranteeing confidentiality and the protection of confidential material. One of its most extensively utilized biometrics is the fingerprint. The fingerprint would be well-known for being specific and age-insensitive, implying that individual identification may be based on comparing different fingerprints(Gil *et al.* 2003).

# 2.3.4 Temperature Monitor

The fourth area of the research area that is going to be discussed is the temperature monitor. The study contains information about a measuring system that detects the body temperature of a person to implement access control for Covid-19. The use of thermal cameras has been implemented to detect a person’s temperature and fever. The plan of the use for this study would be used in public places such as offices, hospitals, airports, and shops. The product of the study is using a reasonably priced IoT platform which will give a thermographic identification that is both quick and precise, reducing the danger of spread (Rocha *et al.* 2021).

# 2.3.5 Comparison of the access control methods

From looking at the research topics that were used for the improving of access control, there is various of methods to implement these changes. Face detection was the first research topic and what made this topic interesting was how easily accessible it is to use a face detection system and where it can be placed. Pin codes was another interesting topic due to impact of how it can keep confidential information safe. Fingerprints is probably the most specific and unique method for access control due to no person having an identical fingerprint. Finally, the temperature monitor for access control was an intriguing topic due to the use of thermal cameras, which can detect someone’s body temperature. The table below shows a comparison of access control methods.

|  |  |  |
| --- | --- | --- |
| Name | Cost | Accuracy |
| Face Detection | Free and payable options | 97% accuracy |
| Pin codes | Approx £40-130 |  |
| Fingerprints | $100-300 | 98.6% single-finger tests |
| Temperature monitor | Approx. 200 | Accuracy + - 0.5º |

* 2.4 Presence Sensors

# 2.4.1 Light Sensors

Photoresistor is the first area of light sensors that is going to be looked at. The photoresistor sensor has a quick reaction speed, a straight input–output relationship, and great reproducibility and durability. This same sensor also has the benefits of being reasonably priced, low energy consumption, as well as the ease of manufacture (Cao *et al.* 2014).

Photodiodes is another type of light sensor that is going to be in this research topic. A photodiode is an optical sensor that may convert light into the current depending on how it is used. Photodiodes is identical to normal semiconductor diodes unless they are exposed to either UV or X-ray radiation or is packed with a glass or waveguide linkages to enable light to penetrate the photodiode's vulnerable part (Jabbar *et al.* 2021).

Finally, Phototransistors is the final aspect of light sensors that is going to discussed in this topic. A phototransistor belongs to the photoconductive electrical components category. The phototransistor is an electrical switching and amplifying device that functions as a result of light exposure (Bansal and Maiya 2020).

# 2.4.2 Ultrasonic Sensors

An example of an ultrasonic sensor is one that can connect to a Raspberry Pi device which can detect an moving object. Ultrasonic sensors are reasonably priced and don’t process a lot of power when in use. The sensor has a high standard of accuracy when it comes to the distance of an object (Bi *et al.* 2019). Ultrasonic sensors have been employed widely in engineering, physics, as well as scientific diagnostics for a variety of sensor applications. There are two primary types of ultrasonic sensors. Temperature, pressure fluctuations, and gas concentration may be measured quickly using propagation-path sensors, which decode changes in propagation. Ultrasonic flow sensors, for example, for engine intake air or air/gas measurement, are the most critical. Distance sensors collect echoes from objects and analyse the timing and amplitude of their propagation. Distance meters and presence detectors are two examples (Magori 1994). The type of output that is used for an ultrasonic sensor is an digital output (Latha *et al.* 2016).

# 2.4.3 Passive Intrared Sensors

The type of a passive intrared sensor is a PIR-based motion detector. The study of this motion detector that is going to be looked at is about the evaluation of area control of an workplace. The aim of the PIR-based motion detector is to detect motion. Security alarms and automated lighting systems frequently employ PIR-based motion detectors (Longobardi 2019). When an incursion occurs, it is unable to distinguish between an animal and a human. To verify the infiltration, an IP camera is employed. It is favoured above other motion detectors since it is passive in nature, meaning it's doesn't release any radiation. This is in contrast to IR sensors, ultrasonic sensors, and other sensors that emit radiation. The type of output that is used for a Passive Intrared sensor is a digital output (Sahoo and Pati 2017)

# 2.4.4 Comparison of Presence Sensors

There are three different types of light sensors that was mentioned in this chapter, photoresistors, photodiodes, and phototransistors. Photoresistors are a cheap type of light sensor, it can be easily manufactured and has great durability. Photodiodes have their similarities to a photodiode, but it has the exposure to X-ray radiation. Phototransistors has the functionality to expose itself to light. The ultrasonic sensor seems to be the most appealing sensor due to how accurate it is when it comes to distance. The PIR-based motion detector is also interesting due its ability to detect motion in an enclosed area.

Conclusion

From the discussion of each of the research topics that are evaluated above, there has not any project or research that includes each of these values. There have been some areas where face detection was used for access control and research on a temperature monitor that detects the body temperature of a human for a fever. This project is going to consist on a security method for someone who may have a fever (more specifically, symptoms of covid-19) and their temperature will either allow them entry into a building or not. This project is also going to consist of the correct measures of hygiene before going into a building with the usage of hand sanitiser.

**3.Design Chapter**

## **3.1 Introduction**

The design chapter will focus on the proposed system's design as well as the software and hardware elements which will be used to construct the artefact. This chapter will also look into the system's functional and non-functional needs.

The chapter's major purpose is to provide an insight of the system's final artefact's architecture and functionalities. The final artefact will attempt to answer the following research question:

“How effective is a raspberry pi with a door locking mechanism in preventing unauthorised access for people with high temperatures”

## **3.2 System requirements**

**3.2.1 Software Requirements**

* **Firebase**

Google's platform, Firebase offers a wealth of functionality for creating applications. A realtime database, authentication mechanism, and hosting are the three key functions. Firebase will be used as a platform to send data of each temperature from raspberry Pi.

* **Python**

Python is considered as the primary language by the Raspberry Pi Foundation because of its strength, adaptability, and simplicity of its use. It is one of the most popular programming languages in the world of computing. It's a high-level programming language with a simple layout. It is well-known for having less amount of code, but in a straightforward and easy-to-understand format. Many major enterprises utilize Python significantly.

The main purpose of its use for this project is that Python is the primary language in Raspberry Pi, it’s simplicity of code, and its popularity. There will also be a various amount of material for Python online due to its popularity and role in Raspberry Pi.

* **Raspbian**

Raspbian is a free operating system that is based on Debian and designed specifically for the Raspberry Pi.

**3.2.2 Hardware Requirements**

* **Raspberry Pi 4 Model B** - The Raspberry Pi 4 Model B is going to be the centrefold of the final system which will have the DS18B20 Temperature Sensor, Solenoid Door Lock and an Ultrasonic Sensor working with it.
* **DS18B20 Temperature Sensor** – The DS18B20 Temperature Sensor is going to be utilised with the Raspberry Pi to detect body temperature. This is a vital area in the project as
* **Solenoid Door Lock** -The solenoid Door Lock will be used for the security of the project. It will be working with the temperature sensor to detect a person’s body temperature.
* **Ultrasonic Sensor** – The Ultrasonic sensor will be used to detect the motion of a person for either using hand sanitiser or not.

**3.2.3 Functional Requirements**

A system's functional requirements specify what the system should be able to achieve. For the system to function, several conditions must be met.

**R001** – The system must have the ability to detect someone’s body temperature.

**R002** – The system must allow entry if the person has the suitable temperature.

**R003** – The system shall not allow entry if the person’s body temperature is above 38 Degrees.

**R004**  – The system must be able to detect if someone has used hand sanitiser or not.

**3.2.4 Non-Functional Requirements**

A system's non-functional requirements explain how it functions. Metrics are sometimes used to assess these requirements, which helps to determine how effectively the system is working.

**NFR001** – The system should be correct 90% of the time when detecting someone’s body temperature.

**NFR002** – The system should be impenetrable to manual tampering and should be secure

**NFR003** – The system should have a response time within the first five seconds when unlocking the door.

## **3.3 Use Cases**

**3.3.1 Diagram 1**

Diagram

Description automatically generated

**3.3.2 Description 1**

|  |  |
| --- | --- |
| Use Case | Unlocking System |
| Objective | A user wants to get access to the system and pass through the door. |
| Main Flow (Story) | 1. User Approaches Temperature Sensor 2. Suitable temperature detected 3. System will be unlocked. |
| Alternative Flow (Test Cases) | Body temperature is too high for entry. The suitable body temperature has to be below 38 degrees and will be said on the temperature sensor. |
| Post Condition | User has been granted entry while having a high temperature |

**3.3.3 Diagram 2**

Diagram, text, letter

Description automatically generated

**3.3.1 Description 2**

|  |  |
| --- | --- |
| Use Case | Hygiene System |
| Objective | A user needs to use hand sanitiser before entry of a building |
| Main Flow (Story) | 1. User approaches hand sanitiser 2. Proof of use 3. User will be granted entry 4. Green light displayed |
| Alternative Flow (Test Cases) | Not using hand sanitiser. The ultrasonic sensor will detect if the user has applied hand sanitiser or not, and will display a red light |
| Pre-Condition | Body Temperature has to be acceptable |
| Post Condition | User has been granted entry while not using hand sanitiser. |

## **3.4 Flow Chart Diagram**

**3.4.1 Diagram 1 : Body Temperature**

Diagram

Description automatically generated

**3.5 Conclusion**

This chapter provided an overview of the design process. To build and describe the suggested system, high-level diagrams were given. The criteria were broken down into hardware, software, functional, and non-functional categories. The following are the major elements: Raspberry Pi 4 Model B, DS18B20 Temperature Sensor, Solenoid Door Lock, and Ultrasonic Sensor. The suggested system was created to answer the following research question, as stated in Chapter 1: “How effective is a raspberry pi with a door locking mechanism in preventing unauthorised access for people with high temperatures”. The following chapter explains how the artefact was made, as well as how the data was collected and analysed.

4.Testing Strategy

Introduction

The testing strategy which will be utilized to test the system which will be constructed will be discussed in this chapter. It provides test cases that will be used to evaluate the system's functional and non-functional needs. Testing is a vital step that ensures the user is completely satisfied with the program. If the tests aren't done, the software and system may not be reliable enough to be distributed to the public. The types of testing that is going to be implemented are the correct temperature of someone’s body temperature, the accuracy of the temperature, detection of usage of hand sanitiser and many other forms of testing.

Black Box Testing

Black Box Testing is a software testing approach that involves testing the functions of software applications without knowing the internal code structure, implementation details, or internal routes. Black Box Testing is a type of software testing that concentrates on the input and output of software applications and is totally driven by software requirements and specifications. Behavioural testing is another name for it (Hamilton 2020a). An example of black box testing would be a person may input a password in an invalid manner, and an invalid password may not result in an automated message showing the error.

White Box Testing

White Box Testing is a software examining approach that involves testing the product's underlying structure, architecture, and code in order to validate input-output flow and enhance design, usability, and security. White box testing is also known as Clear box testing, Open box testing, Transparent box testing, Code-based testing, and Glass box testing since the code is viewable to the testers (Hamilton 2020b). An example of white box testing would be the internal flaws in security,  pathways in the process of coding that are inefficient or poorly organized, and the path taken by specified inputs through the program.

Results for Testing Strategy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test ID | Functional Requirement | Testing Category | Testing Steps | Expected Result | Actual Result |
| R001 | The system must have the ability to detect someone’s body temperature | Black Box | The user approaches the system to detect their body temperature | Their body will be detected |  |
| R002 | The system must allow entry if the person has the suitable temperature based on the threshold. | Black Box | Repetitive Testing with a suitable and unsuitable body temperature | The system will allow entry |  |
| R003 | The system shall not allow entry if the person’s body temperature is above 38 Degrees. | Black Box | Repetitive Testing with a suitable and unsuitable body temperature | The system shall remain locked due to unsuitable temperature |  |
| R004 | The system must be able to detect if someone has used hand sanitiser or not which is based on the threshold to determine the distance. | Black Box | A user will attempt to not use hand sanitiser | The system would grant entry if the user used hand sanitiser |  |
| NFR001 | The system should display the correct number 90% of the time at a minimum when detecting someone’s body temperature. | White Box | Repetitive Testing and Calculate the number of times that the correct temperature is displayed | The system should display the correct temperature at least 90% of the time in a test of at least 10 times. |  |
| NFR002 | The system should be impenetrable to manual tampering and should be secure | White Box | Various of attempts to breach security. | The system should be secure and impenetrable |  |
| NFR003 | The system should have an appropriate response time when unlocking the door (within 5 seconds). | White Box | Repetitive testing and calculating the average time for unlocking the door | The time for unlocking the door should be within 5 seconds. |  |

Conclusion

The system in development must be tested on a regular basis for modifications which have been implemented or modified. Testing is a method of ensuring that the system being produced fits the criteria. Black Box and White Box testing methodologies were also explored and noted.

# 

# Appendices

# Appendix A: References

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# Appendix B: Code Listing