

**SMART FOOD SPOILAGE DETECTION USING
RASPBERRY PI & COMPUTER VISION TECHNOLOGY**

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering

By

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(DEEMED TO BE UNIVERSITY)**

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MAY - 2022



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bona fide work of **MOHANA A (38130141), MATAM VENNELA PRIYANKA (38130131)** who carried out the project entitled **SMART FOOD SPOILAGE DETECTION USING RASPBERRY PI & COMPUTER VISION TECHNOLOGY** under my / our supervision from December 2021 to May 2022.

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We **MOHANA A (38130141)**, **MATAM VENNELA PRIYANKA (38130131)** hereby declare that the Project Report entitled **SMART FOOD SPOILAGE DETECTION USING RASPBERRY PI & COMPUTER VISION TECHNOLOGY** done by us under the guidance of **Dr. M. SUGADEV, MTech., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

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ABSTRACT

In recent days kitchen-based accident had been increased in both commercial kitchens and domestic kitchens. Most of the fire-breakouts in industries are due to gas leaks. These cause dreadful damage to the equipment, human life leading to severe injuries, deaths, and harmful environment. Currently available leakage detectors warn the people around using on-site alarms. So, this project proposes a leakage detector which sends the warning to the concerned people through SMS. This detector senses the presence of harmful gases particularly, LPG, Methane and Benzene. These accidents can be avoided using IOT technologies like monitoring the entire kitchen from remote areas. The present aims to highlight the various aspects of IOT and its role in smart kitchen and food spoil detection. In addition to this a special coverage has been made regarding Smart Kitchen. The description of various appliances and their application in the smart kitchen has been enumerated. To implement this research both hardware and software will be utilized. From the hardware side gas sensor, PIR sensor, Exhaust fan has been used. From the software side integrated cloud application and What App message has been used. All these sensors will be integrated with Raspberry pi board for cloud data transfer. In added with log reports can be generated using the same methods.

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CHAPTER 1

INTRODUCTION

1.1 EMBEDDED SYSTEMS

An embedded device is a collection of computer hardware and software that is designed to perform a specific task. Embedded systems can work as part of a larger system. The systems can be either programmable or fixed in operation. An embedded system could be used in industrial machinery, consumer electronics, agricultural and processing industry products, cars, medical equipment, cameras, digital watches, household appliances, aircraft, vending machines, and toys, as well as mobile devices.

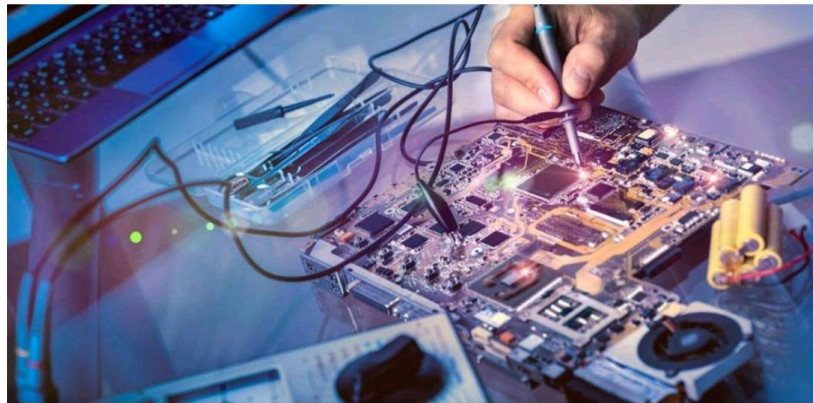


Fig: 1.1: Embedded systems

Firmware is the term used to describe the software used in embedded systems. Rather than being stored on a disc, where several programs can be stored, an embedded system's single programs is typically stored on a chip and is known as firmware.

Embedded systems are special-purpose computer systems that offer specialized support and are embedded in application environments or other computing systems. The development and implementation of embedded computing systems in a wide variety of application environments has been helped by the declining cost of processing power, memory, and the ability to build low-cost systems on chip. Network adapters for computers and cell phones, control systems for air conditioning, industrial systems, and vehicles, and surveillance systems are only a few examples.

Infrastructure (core network) systems and end systems are two types of embedded systems for networking that are necessary for end-to-end service provision. All systems needed for the core network to run, such as switches, bridges, and routers, fall into the first group, while systems visible to end users, such as cell phones and modems, fall into the second. Because of the wide range of applications in which embedded systems are used, their significance is growing all the time. Embedded systems have long been used in a variety of important applications, including avionics and traffic control systems. Their widespread use emphasizes the significance of embedded systems, especially when considering the implications of their failure.

Embedded systems are made up of two main components:

- Embedded system hardware
- Embedded systems software

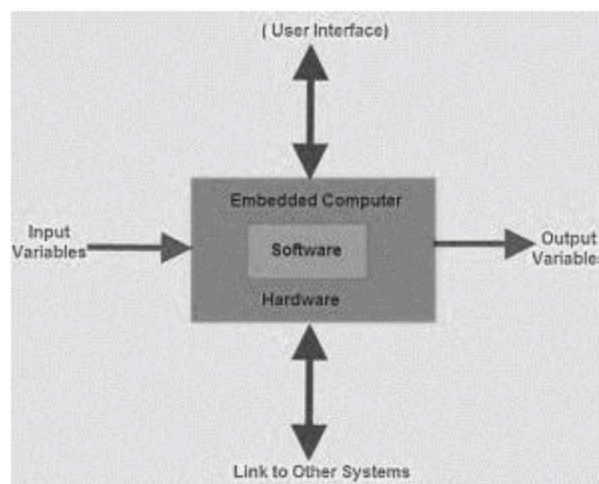


Fig: 1.2: Embedded system components

An embedded system, like any other electronic system, needs a hardware platform to operate on. A microprocessor or microcontroller would be used as the hardware. Memory, input output (I/O) interfaces, as well as the user interface and the monitor, will all be part of the embedded device hardware.

The embedded device software is designed to perform a specific task. It's usually written in a high-level language and then compiled into code that can be

stored in the hardware's non-volatile memory. Fig:1.2 Embedded systems components

A microcontroller is a central processing unit (CPU) or processor with integrated memory or peripheral devices. Embedded systems with microcontrollers are more commonly used because they require fewer external components.

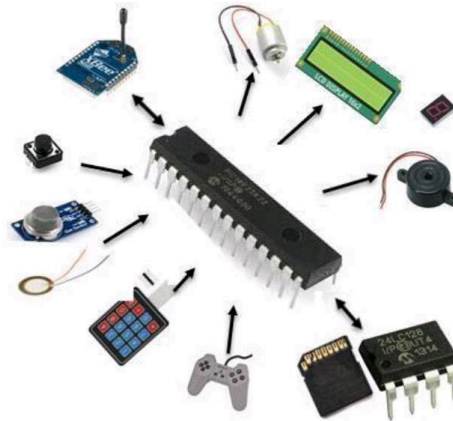


Fig: 1.3: Microcontroller based systems

Microprocessors have a CPU, but memory and peripheral interfaces are handled by external chips. This approach is typically used for larger embedded systems because it requires more devices on the board but allows for more expansion and customization of specific peripherals, etc.

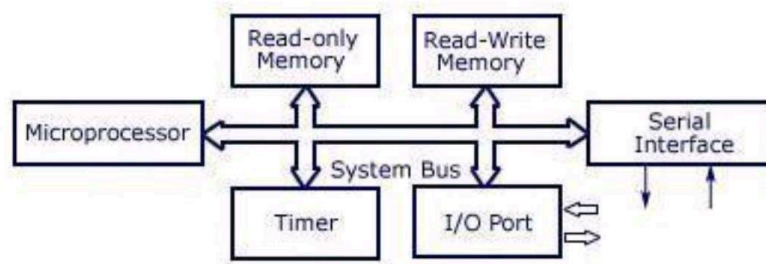


Fig: 1.4: Microprocessor based systems

It may be a very general-purpose processor or one of the many highly specialized processors designed for a specific application, depending on the type of processor used in the embedded device. Custom-designed chips can be feasible

for a specific application in certain cases if the amounts are large enough. The digital signal processor, or DSP, is a typical example of a standard class of dedicated processor. This form of processor is primarily used to process audio and image files. As they can be used in applications such as cell phones and the like, fast processing is needed.

The program that runs the microcontroller is one of the most critical aspects of any embedded device. A system driver is a piece of embedded software designed to work with a specific piece of hardware. Device drivers allows the high-level computer programs to interact with other hardware devices. They are the integral components of the operating system.

RTOS (Real-time operating systems), handheld embedded, stand-alone, and network embedded systems are among the operating systems available for embedded systems.

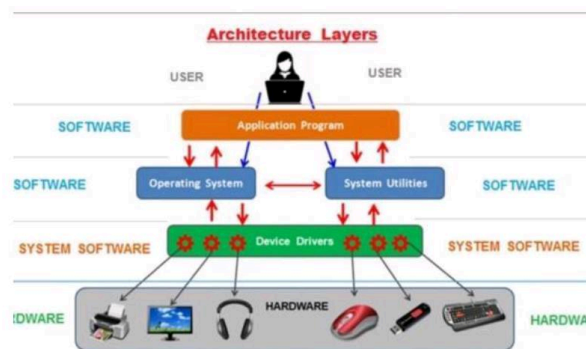


Fig: 1.5: Operating system architecture

1.1.3 Machine code:

The most basic code for the processor unit is called machine code. The code is usually written in hexadecimal and contains the basic instructions for each processor operation. These days, this type of code is rarely used in embedded systems.

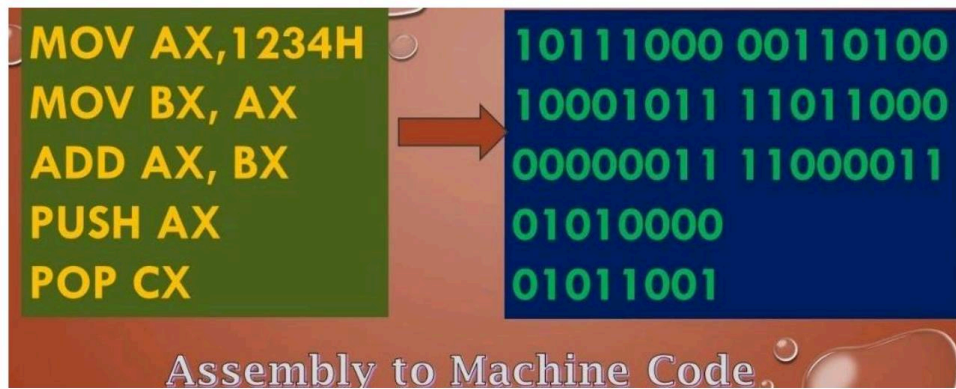


Fig: 1.6: Machine code conversion

1.1.4 Programming language:

It takes a long time and a lot of work to write computer code. It's difficult to comprehend and troubleshoot. High-level programming languages are widely used for solving this. C, C++, and other programming languages are widely used. The embedded system's code would most likely be stored on a non-volatile memory chip on the processor board. The code is known as firmware, and the theory is that it is not modified like software because it is stored in the embedded device and cannot be changed by the user. It is always possible to upgrade the program but doing so can necessitate changing the memory card on which the firmware is stored or upgrading it in another manner.

1.2 PROCESSOR

A microprocessor designed specifically for the needs of an embedded device is known as an embedded processor. Since embedded systems use less power, these processors are small and draw less power from the power supply. Ordinary microprocessors and microcontrollers are the two main types of embedded processors. Embedded processors are used in systems that do not need the computing power of traditional devices like desktop computers, laptop computers, or workstations.

An embedded processor can be configured to do exactly what it's supposed to do. As a result, it can accommodate a wide variety of CPU architectures. In these processors, the Harvard architecture is often used. They frequently use RISC and non-RISC architectures. The 8–16-bit word length is the most popular in these processors. Clock speed, storage capacity, and voltages are all factors that

distinguish embedded processors. Embedded processors typically have storage capacities ranging from 4 kB to 64 kB, although some devices need more. Microcontrollers are commonly thought to be more useful than microprocessors since they need fewer help circuitry.

1.3 WORKING OF EMBEDDED SYSTEMS

Embedded devices are often part of a larger unit, which is what the word "embedded" implies. They are small computers that are embedded in other mechanical or electrical systems at a low cost and with low power consumption. A processor, power supply, memory, and communication ports are all common components. Embedded systems use communication ports to send data via a communication protocol between the processor and peripheral devices, which are often other embedded systems. With the aid of minimal software stored in the memory, the processor interprets this data. The embedded system's software is normally unique to the role it performs.

A microprocessor or a microcontroller may be used as the processor. Microcontrollers are simply microprocessors with integrated peripheral interfaces and memory. Instead of using memory and peripherals on the chip, microprocessors use separate integrated circuits. Both can be used, but microprocessors usually need more support circuitry than microcontrollers since the microprocessor have less integrated circuitry. Multiple processors and interfaces are integrated on a single chip. They are frequently employed in high-volume embedded systems.

1.4 EMBEDDED AND IOT INTERFACE

A device's embedded system gathers data from a sensor and sends it to the cloud via a Wi-Fi module. In other words, you can transform your embedded device into an IoT device by simply supplying it with Internet access. Embedded devices are usually part of a larger system and perform a particular task for that device. Embedded systems will also serve as the foundation for many Internets of Things (IoT) solutions, especially in some industry verticals and Industrial Internet of Things (IIoT) applications.



Fig: 1.7: Interfacing with IoT

1.5 IOT

From an engineering standpoint, the Internet of Things refers to a network of embedded, microprocessor-controlled devices that are connected to the internet either directly or indirectly. As a result, the three foundations of IoT are:

- Embedded programming
- Network technology
- Information technology

The internet of things, or IoT, is a network of interconnected computing devices, mechanical and digital machines, objects, animals, and people with unique identifiers (UIDs) and the ability to transmit data without needing human-to human or human-to computer interaction.

A human with a heart monitor implant, a farm animal with a biochip transponder, an automobile with built-in sensors to warn the driver when tire pressure is low, or any other natural or man-made object that can be given an Internet Protocol (IP) address and can transmit data over a network are all examples of objects on the internet of things.

1.6 FOOD SPOILAGE DETECTION:

Food wastage due to spoilage is one of the key global problems in the world, the quantity of food loss and spoilage per year is 40-50% for root crops, fruits and vegetables, bakery, and dairy products. This project proposes an edge IOT & machine learning based approach for food quality monitoring.

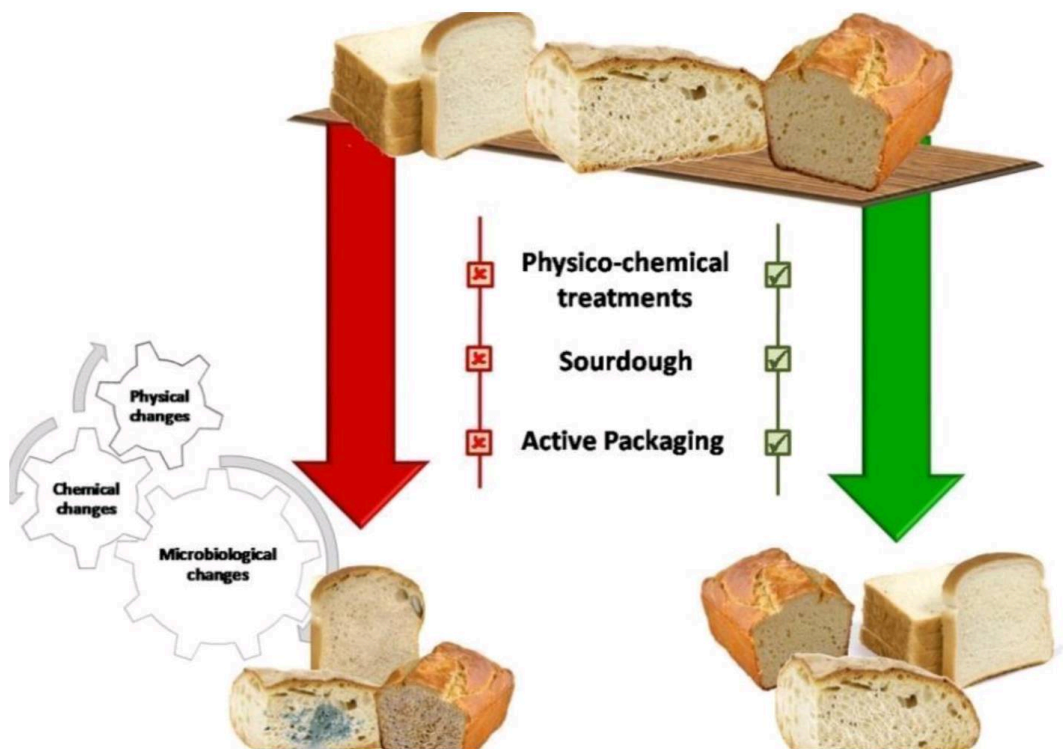


Fig: 1.8: various factors that causes damage to the food products

As Fig: 1.8 depicts, there are numerous factors that causes damage to the food products. The need for this type of system is to correctly classify the bakery products like bread in three categories fresh, semi-fresh & spoiled, further, to alert about environmental conditions, whether it is favorable or not by using the expert algorithm developed under standard environmental data.

The uniqueness of the system is, it uses edge IOT, and its software is programmable. Hence, it could be used to preserve any type of food items by just adding some credentials in the settings section in GUI. The design and construction of an IOT based Smart Kitchen System are indicated here.

Different types of sensors were used to detect gas leakages in the kitchen. Its outputs are then interfaced with a Raspberry pi MCU controller programmed in

python language. This gas leaking situation Using IOT, we can detect in the remote areas and to prevent Kitchen based accidents with a motion detection. Continuous monitoring of services in the kitchen is performed by this system.

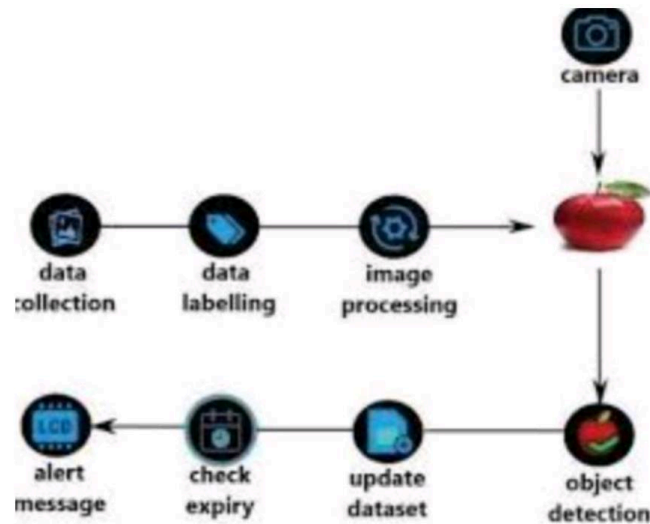


Fig: 1.9: Food spoilage detection

Most of the fire-breakouts in industries are due to gas leaks which cause dreadful damage to the human life leading to injuries, deaths, and environment. Currently available leakage detectors warn the people around using on-site alarms. So, this project proposes a leakage detector which sends the warning to the concerned people through SMS. This detector senses the presence of harmful gases particularly, LPG, Methane and Benzene. LPG and Methane gases catch fire easily resulting in blasts. Benzene is carcinogen effecting the health of workers, if inhaled in higher concentrations. Hence, detection of these gases is essential. This low-cost project includes MQ6, MQ4 and MQ135 gas sensors which detect LPG, Methane and Benzene gas leaks respectively and uses ESP-32 as a Wi-Fi module. The concentration levels of the above-mentioned gases are uploaded in the UBIDOTS cloud, and the login details are included in the alert message so that the user can check, if needed. The prototype of the proposed system generates a sound alert using buzzer on detection of a dangerous leakage and sends an SMS to the concerned person using the web service.

1.7 OBJECTIVES

The following are the objectives of this project:

- The main objective of the project is to identify the quality of bakery products like Bread in industries by predicting the color and texture of the bread.
- Usually, we need to store the manufactured breads for long time which will cause them to get spoiled easily.
- While packing for Distribution, we will be manually testing the quality of breads where some misevaluations could happen which could spoil all other breads too.
- This system proposes an IOT & machine learning based approach for food quality monitoring where the above problem could be solved.
- The project also proposes the smart kitchen with LPG and motion detection along with food quality monitoring.

1.8 EXISTING SYSTEM

There are numerous techniques available to detect any gas leakage or spilling of gas from the cylinders. The basic principle behind the technique is that change in concentration of LPG is associated it activates an audio-visual alarm once it exceeds an explicit threshold. Further it sends another message through radio frequency system to the receiver

Hence the receiver module can be of mobile unit that will be placed among the premises of house therefore the alarm area unit typical detected and detected at where gas flows. The Arduino reads the voltage from the detector and uses it to calculate the modification in concentration. The gas detector is sensitive to many gases and gas kind cannot be determined.

CHAPTER 2

LITERATURE SURVEY

Nachi keta Heber et al presented the paper on Freshness of Food Detection using IoT and Machine Learning (2020), which proposed the system that aims at detecting the spoiled food using machine learning algorithms and monitor the gas leakage using appropriate sensors in order to prevent kitchen based accidents. uses the machine learning based approach to detect the freshness of the food product especially bakery products as consuming spoiled food is harmful for consumers. A micro controller-based device that senses the spoilage, delivers the alert using internet of things. So that appropriate measures can be taken. The system has widescale application in food industries where food detection is done manually.

Deep learning, especially Convolutional Neural Networks (CNN), has been successfully implemented in face recognition applications. There are many variations of CNN based models that successfully improved the face recognition performance. However, most of the models have very deep layers and are trained with large scale face image datasets that need a lot of computational resources. In this research, a light-CNN based on a modified VGG16 model is proposed to recognize faces with a limited dataset. The proposed light-CNN is compact yet produces satisfactory performance with 94.4% accuracy.

Identification and verification systems nowadays utilize biometric technology such as face recognition, retina scan, and fingerprint mapping to recognize a person's identity. For face recognition technology, the traditional methods usually consist of four stages: face detection, face alignment, feature extraction, and classification. Recently, deep learning has gained popularity in the face recognition task due to its performance that outperforms the traditional methods and its simplicity that combines features extraction and classification in a single architecture.

Face recognition in a shallow learning pipeline consists of four stages, and the most important step is the feature extraction step. One of the advantages of deep learning is that it does not need a complicated method to extract the features. However, the deep convolutional networks need more resources for the

computation while the light convolutional networks do not spend too much time training the model. Our experiment shows that shallow networks such as light-CNN also produces high accuracy which is 94.4% and performs better in limited dataset and small number of labels.

Ravi Kishore Kodali et al presented the paper IOT Based Industrial Plant Safety Gas Leakage Detection System (2018) proposed the system which uses the PIR sensor and MQ6 sensor connected to the raspberry pi board to monitor the domestic kitchen area to prevent kitchen-based accidents and detecting the spoiled food using machine learning based approach and alerting the user using IOT. Most of the fire-breakouts in industries are due to the gas leaks.

These causes dreadful damage to the human life leading to injuries, deaths, and environment. Currently available leakage detectors warn the people around using on-site alarms. So, this project proposes a leakage detector which sends the warning to the concerned people through SMS. This detector senses the presence of harmful gases particularly, LPG, Methane and Benzene. LPG and Methane gases catch fire easily resulting in blasts. Benzene is carcinogen effecting the health of workers, if inhaled in higher concentrations. Hence, detection of these gases is essential. This low-cost project includes MQ6, MQ4 and MQ135 gas sensors which detect LPG, Methane and Benzene gas leaks respectively and uses Raspberry pi which has its own Wi-Fi module. The concentration levels of the above-mentioned gases are uploaded in the UBIDOTS cloud, and the login details are included in the alert message so that the user can check, if needed. The prototype of the proposed system generates a sound alert using buzzer on detection of a dangerous leakage and sends an SMS to the concerned person using web service.

Syawal Fikre Bin Mohd Khairul et al presented the paper Fruit size and color maturity identification using Raspberry pi in which determining the size of the fruit maturity of the color using the images of fruits. In recent years, Image processing techniques have been discovered progressively helpful in the fruit industry, especially for applications in grading or ripeness of fruits. Studies show that utilizing image processing able to improve the product quality while helping people from traditional evaluation for fruits.

Color and size are the most important aspect of agricultural and food products because high quality products are significant for success in today's highly competitive market. In agricultural applications, the quality of a product especially fruits, which are often classified by their texture, shape, and color. These elements utilize humans' vision specifically as a part of deciding the quality or ripeness of fruits. The process of evaluating is done manually, repetitive, and prone to human error.

During harvesting season, the process of evaluating the fruit maturity is tiring and time – consuming, so a lot of error can occur evaluating of a fruit. Therefore, this project will give a concept of idea to find the fruit size and maturity of the fruit. According to Federal Agricultural Marketing Authority, there are six indexes for fruits maturity. Therefore, fruit size, color maturity identification using Raspberry pi is about of using an image of fruits to determine the size of the fruit and color maturity.

Food wastage due to spoilage is one of the key global problems, the quality of food losses and spoilage per year is 40-50% for root crops, fruits, and vegetables. This paper proposes an edge IOT & Machine learning based approach for food quality monitoring. The need for this type of system is to correctly classify the vegetables and fruits in three categories fresh, semi fresh & spoiled, further, to alert about environmental conditions, either its favorable or not using the expert algorithm developed under standard environmental data.

Food spoilage is one of the greatest global challenges. It not only affects the economy of any country but also affects the environment & potentially responsible for the greenhouse effect. The main reason for food losses and wastage in low economy countries is mainly because of financial, managerial, and technical

limitations in storage, cooling facilities, lack of proper monitoring, climatic conditions, infrastructure, packaging and marketing system.

The proposed system with Raspberry pi is the main processing unit, temperature & humidity sensors along with three VOC gas sensors. To classify the vegetable and fruit, the sensed data were collected over a week & machine learning models Logic Regression, Linear, Random Forest with the accuracy of 99.1%, 99.9%, 99.96% have been used to classify the data. Further the classified and processed result was uploaded on the firebase cloud to make it to be monitored from anywhere in the world using a particular developed android application. the programmable so that it can be used to preserve type of food items by just filling up some credentials in the settings section of GUI.

Abeer Alshejari et al presented the paper on a fuzzy-wavelet neural network model for the detection of meat spoilage using an electronic nose in 2018 Food product safety is one of the most promising areas for the application of electronic noses. The performance of a portable electronic nose has been evaluated in monitoring the spoilage of beef fillet stored aerobically at different storage temperatures. This paper proposes a fuzzy-wavelet neural network model which incorporates a clustering pre-processing stage for the definition of fuzzy rules. The dual purpose of the proposed modeling approach is not only to classify beef samples in the respective quality class (i.e., fresh, semi-fresh and spoiled), but also to predict their associated microbiological population directly from volatile compounds fingerprints. Comparison results indicated that the proposed modeling scheme could be considered as a valuable detection methodology in food microbiology. The main objective of this paper is to associate acquired volatile fingerprints (snapshots) of odor profile with beef spoilage during aerobic storage at various temperatures through the development of an advanced intelligent-based decision support system. Datasets related to enose data as well as the associated microbiological analysis (i.e., TVC) from beef fillets, were provided by the Agricultural University of Athens, Greece. The achievement of this objective, however, involves the implementation of a number of sub-tasks, related to data analysis. Due to the multi-variable nature of enose data, a dimensionality reduction algorithm was applied on the data used for training purposes.

CHAPTER 3

PROPOSED WORK

3.1 AIM

The main aim of the project is to identify the quality of bakery products like Bread in industries by predicting the color and texture of the bread by utilizing the IOT in the food detection technology, it will help the individual to improve the life quality by detecting the condition of the food and environmental condition such as LPG leakage of the kitchen and reporting the client to prevent the domestic accidents and to save life.

3.1.2 SCOPE

In food industries, majorly bakery industry, our system could be installed to monitor the quality of the bakery products and the environmental condition to promote the production with more accuracy in the quality without any commercial kitchen-based accidents.

3.2 PROPOSED SYSTEM

We proposed the design and construction of an IOT based Smart Kitchen System are indicated here diverse types of sensors were used to detect gas leakages management system in a kitchen.

- Its outputs are then interfaced with a Raspberry pi MCU controller programmed in python language.
- We can get this and much more safety feature that can be integrated with the automation system includes temperature sensor.
- The gas leaking situation Using IOT we can detect in the remote areas.
- Continues monitoring of services in kitchen is performed by this system.

3.2.1 BENEFITS OF PROPOSED SYSTEM

- Self-controlled and operating facility
- Good working system
- Suitable for handicapped peoples
- Portability and mobility

3.2.2 ARCHITECTURE OF THE PROPOSED SYSTEM

The Architecture of the optical character recognition system on a grid infrastructure consists of the three main components. They are

- Camera
- Python
- Output Interface

3.2.3 PROBLEM STATEMENT

We proposed the design and construction of an IOT based Smart Kitchen System are indicated. Here different types of sensors were used to detect gas leakages management system in a kitchen. Its outputs are then interfaced with a Raspberry pi MCU controller programmed in python language.

We can get this and much more safety feature that can be integrated with the automation system includes temperature sensor. The gas leaking situation Using IOT we can detect in the remote areas. Continuous monitoring of services in kitchen is performed by this system.

3.3 BLOCK DIAGRAM

The following block diagram (Fig :3.1) shows the system architecture of this project

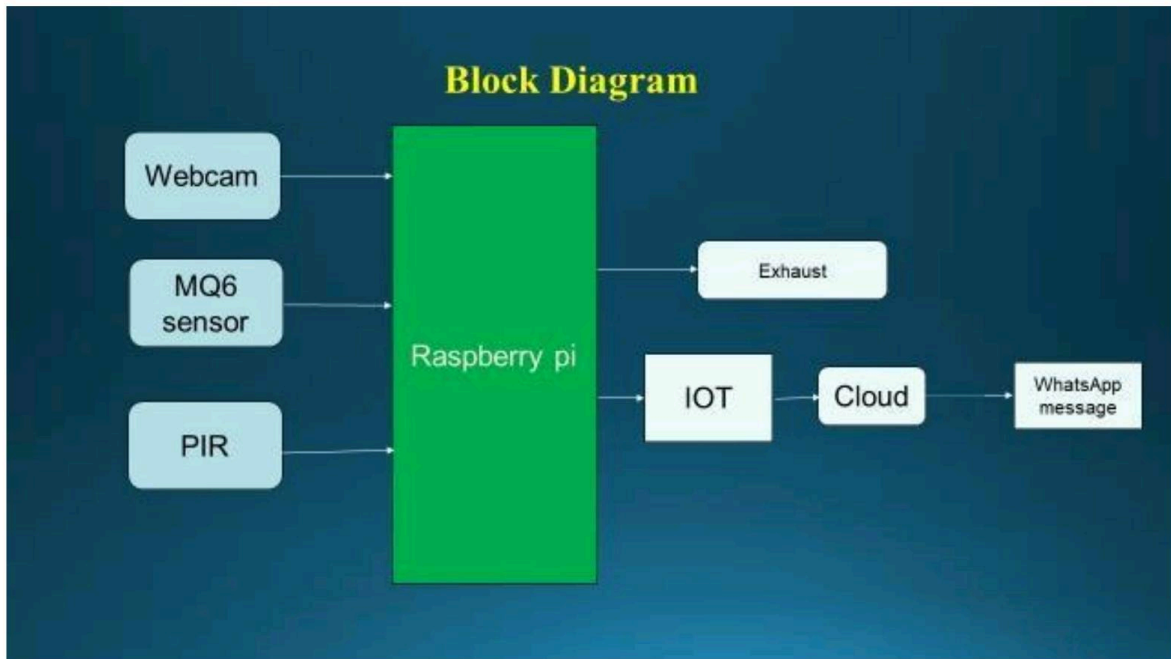


Fig: 3.1: Block diagram

3.3.1 WORKING METHODOLOGY

The system has two sections, the hardware, and the software. Hardware consists of Raspberry pi 4 which is connected through HDMI port to a monitor, USB port to a keyboard, Web Cam, and Mouse and through the GPIO pins to PIR sensor, MQ 6 gas sensor and the exhaust.

Raspberry pi acts as a hub for collecting data from the web cam and run's object identification process on it. It gathers data from the sensors and using python program, produces the output for the embedded part. The software predicts the model and generates the desired output with maximum accuracy.

The software is divided into two parts first one is for image analysis and other is for controlling hardware based on image processing results. The system is operated in two different scenarios in first the image is captured with camera that all the image

processing is done in the control module. All the processes are shown on monitor and then based on decision taken by control module.

3.3.2 WORKFLOW DIAGRAM

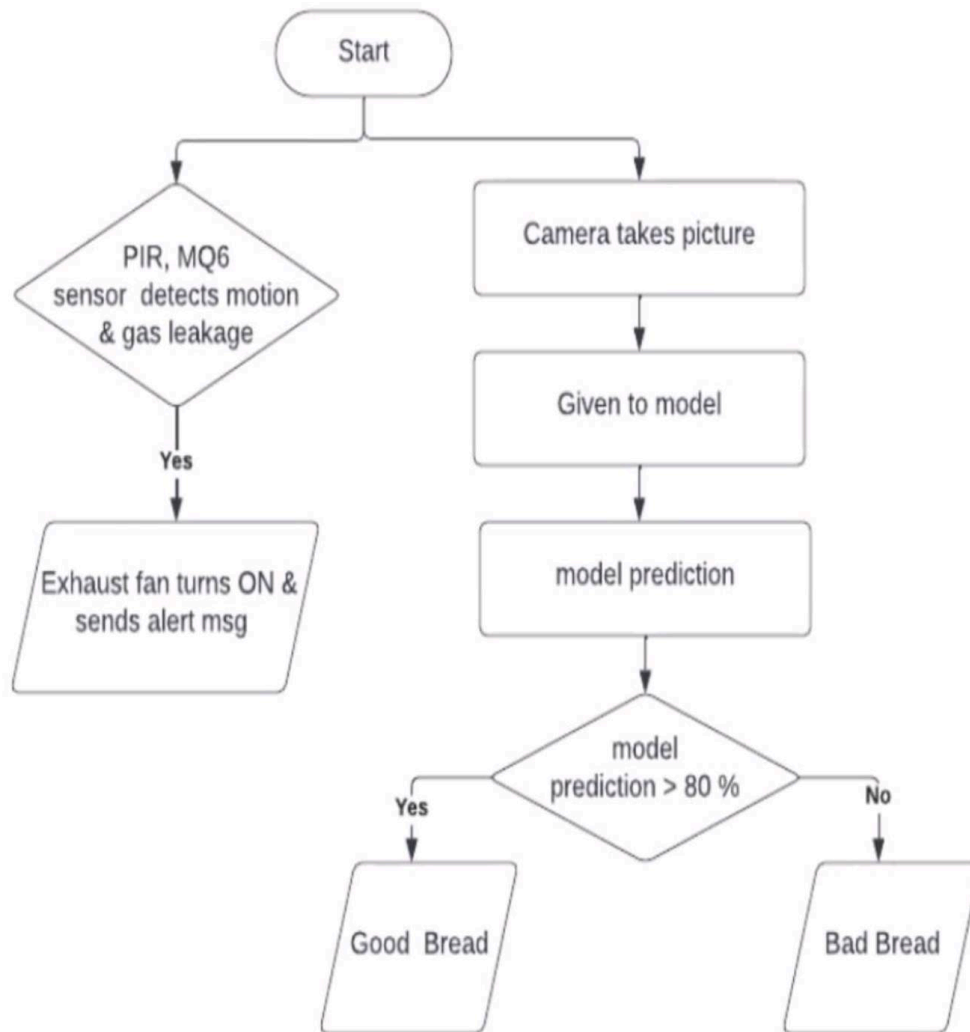


Fig: 3.2: Workflow diagram

3.3.3 HARDWARE DESCRIPTION

The required hardware components are

- Raspberry Pi
- Web Camera
- Gas sensor
- PIR sensor
- Exhaust
- Monitor
- Keyboard and Mouse with USB cable
- Cables and jumper wires

3.3.3.1 Raspberry pi

Raspberry Pi can be defined as a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It is a Quad Core Processor has powered Single Board Computer running at 900MHz, 1GB RAM and 4 Quad USB ports. It is the advanced version of Model B and is 6 times faster than Model B Raspberry Pi.

There are two models of Raspberry Pi, model A and model B. These two are bit similar with few advance features on model B compared to model A. Model B has 512 MB RAM, two USB port whereas Model A has 256 MB RAM and just a USB port. Besides, Model B has Ethernet port while Model A does not. Different components of the Pi are named in the Figure 5-1 and brief description on each component is given in following sections.

Raspberry Pi doesn't have the real hard drive as in laptop and computer, SD card is taken as solid-state drive (SSD). Secure Digital, officially abbreviated as SD, is a proprietary non-volatile memory card format developed by the SD Association (SDA) for use in portable devices. A family of compatible and very popular flash memory cards used primarily for storage in electronic devices. SD card may be 2GB, 4GB or 16GB.



Fig:3.3.3.1: SD card

The power port is a 5V micro-USB input and supply should be exactly 5v as it doesn't have onboard power regulator. So, power supply shouldn't exceed than 5V and this output port is used to connect the Raspberry Pi with a monitor via HDMI (High-Definition Multimedia Interface). Hence, any screen or TV can be connected to it which consists of HDMI port.

Both the Ethernet port and USB port on Model B are supplied via the onboard LAN9512 chip. It is a high-speed USB 2.0 hub with a 10/100 Ethernet controller. USB ports are used to connect the inputs (keyboard, mouse). Almost everything that can connect to computer via USB also can connect with Raspberry Pi.

Audio and RCA video jacks are present on the board for audio and video out. The Raspberry Pi does support sound over its HDMI output, but there is a standard 3.5-mm audio jack to plug in headphones, but USM mikes may work or not. For video, the RCA jack sends video to any connected RCA video device.

GPIO pins stands for general purpose of input output pins. These pins are used to connect any number of physical extensions with the Raspberry Pi. The most important component in a Raspberry Pi is chip that is Broadcom which is placed at the middle of the board. The chip consists of ARM11 processor running at 700 MHz and a Videocore4 GPU and can be over clocked to at least 800 MHz without a problem.

Raspberry Pi can't start alone; it needs many other peripherals (hardware).

- Power Supply
- Storage
- Monitor
- Webcam

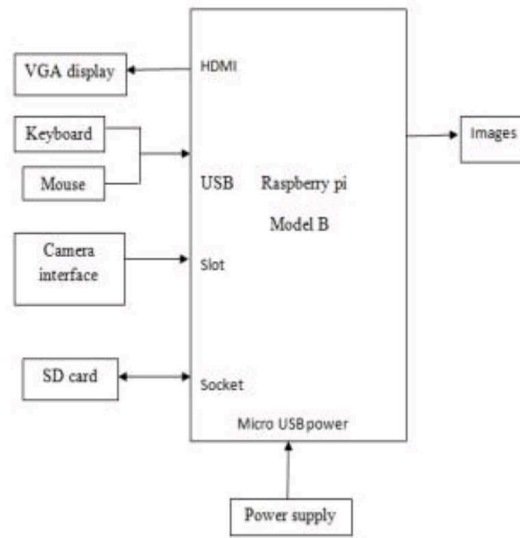


Fig: 3.3.3.2: Hardware Design

If the supply is 500 mA or less, it is likely to have the mal function of keyboard and mouse. It is not good idea to power the Raspberry Pi from USB port of computer and hub as they mostly provide current less than required.

Hence, the Raspberry Pi requires a Micro-USB connection which can supply at least 700 mA (or 0.7 A) at 5V. Storage

A separate hardware is required for the storage purpose in Raspberry Pi. For this, SD card is used, mostly 4 GB and 8 GB if needed. External keyboard and mouse are required to provide input to the Raspberry Pi. We can use monitor or TV with HDMI port or DVI inputs as the screen for the Raspberry Pi. For DVI inputs, HDMI-to-DVI converters are required which can be finding easily in a market.

A **webcam** is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet, or Wi-Fi. Webcams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound. Image sensors can be CMOS or CCD, the former being dominant for low-cost cameras, but CCD cameras do not necessarily outperform CMOS-based cameras in the low-cost price range. Most consumer webcams can provide VGA resolution video at a frame rate of 30 frames per second. The portability of Microsoft Windows XP SP2, Linux and Mac OS X (since October 2005) have UVC support built in and do not require extra device drivers, although they are often installed to add additional features.

Features of Quantum Hitech Webcam are

- The Image control color saturation, brightness, sharpness, and brightness is adjustable
- The Image resolution interpolated to 25 mega pixels with 6 light sensors
- It has range of 4cm to infinity



Fig: 3.3.3.3: Webcam

3.3.3.2 Basic concept of Image Processing

In general, any digital image processing algorithm consists of three stages: input, processor, and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.

The Raspberry Pi is a basic embedded system this platform is mainly based on python. Raspberry pi consist of Camera slot Interface (CSI) to interface the raspberry pi camera. Here, the Dark and Low contrast images captured by using the Raspberry Pi camera module are enhanced to identify the region of image. The MAVs are basically used to capture images and videos through the Raspberry pi camera module

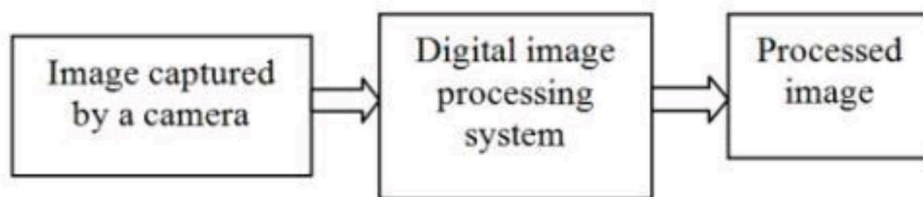


Fig: 3.3.3.4: General Block diagram of image processing.

3.3.4 Gas sensor

In present technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very pivotal. **Gas sensors** are very crucial part of such systems. Small like a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any modification that occur in the concentration of molecules at gaseous state.

Gas sensors are accessible in wide specifications depending on the sensitivity levels, type of gas to be sensed, physical dimensions and numerous other factors. This Insight covers a **methane gas sensor** that can sense gases such as ammonia which might get fabricated from methane. When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This

adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current.



Fig:3.3.4.1: Gas sensor

The **gas sensor module** consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it, the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it.

Image shows externals of a standard gas sensor module: a steel mesh, copper clamping ring and connecting leads.

The top part is a stainless-steel mesh which takes care of the following:

- Filtering out the suspended particles so that only gaseous elements can pass to insides of the sensor.
- Protecting the insides of the sensor.
- Exhibits an anti-explosion network that keeps the sensor module intact at high temperatures and gas pressures.
- To manage above listed functions efficiently, the steel mesh is made into two layers. The mesh is bound to rest of the body via a copper plated clamping ring.



Fig:3.3.4.2: Steel mesh

The connecting leads of the sensor are thick so that sensor can be connected firmly to the circuit and enough heat gets conducted to the inside part. They are casted from copper and have tin plating over them. Four of the six leads (A, B, C, D) are for signal fetching while two (1, 2) are used to provide sufficient heat to the sensing element. The pins are placed on a Bakelite base which is a good insulator and provides firm gripping to the connecting leads of the sensor

The top of the gas sensor is removed off to see the internal parts of the sensor: sensing element and connection wiring. The hexapod structure is constituted by the sensing element and six connecting legs that extend beyond the Bakelite base.

The hollow sensing element which is made up from Aluminum oxide-based ceramic and has a coating of tin oxide. Using a ceramic substrate increases the heating efficiency and tin oxide, being sensitive towards adsorbing desired gas' components (in this case methane and its products) suffices as sensing coating.

The leads responsible for heating the sensing element are connected through Nickel Chromium, well known conductive alloy. Leads responsible for output signals are connected using platinum wires which convey small changes in the current that passes through the sensing element. The platinum wires are connected to the body of the sensing element while Nickel-Chromium wires pass through its hollow structure. While other wires are attached to the outer body of the element, Nickel-Chromium wires are placed inside the element in a spring shaped. Image shows coiled part of the wire which is placed on the inside of the hollow ceramic.

The ceramic with tin dioxide on the top coating that has good adsorbing property. Any gas to be monitored has specific temperature at which it ionizes. The task of the sensor is to work at the desired temperature so that gas molecules get ionized. Through Nickel-chromium wire, the ceramic region of the sensing element is subjected to heating current. The heat is radiated by the element in the nearby region where gases interact with it and get ionized. Once, ionized, they are absorbed by the tin dioxide. Adsorbed molecules change the resistance of the tin dioxide layer. This changes the current flowing through the sensing element and is conveyed through the output leads to the unit that controls the **working of the gas sensor**

3.3.5 Pir Motion Sensor

A PIR detector is a motion detector that senses the heat emitted by a living body. These are often fitted to security lights so that they will switch on automatically if approached. They are very effective in enhancing home security systems.

The sensor is passive because, instead of emitting a beam of light or microwave energy that must be interrupted by a passing person in order to “sense” that person, the PIR is simply sensitive to the infrared energy emitted by every living thing. When an intruder walks into the detector’s field of vision, the detector “sees” a sharp increase in infrared energy.

A PIR sensor light is designed to turn on when a person approaches but will not react to a person standing still. The lights are designed this way. A moving person exhibits a sudden change in infrared energy, but a slower change is emitted by a motionless body. Slower changes are also caused by gradual fluctuations in the temperature of the environment. If the light were sensitive to these slower changes, it would react to the sidewalk cooling off at night, instead of the motion of a burglar.

If you have a PIR light, you may notice that it is more sensitive on cold days than on warm days. This is because the difference in temperature between the ambient air and the human body is greater on cold days, making the rise in temperature easier for

the sensor to detect. This has drawbacks, though; if the sensor is too sensitive, it will pick up things you don't want it to such as the movement of small animals.

Passive infrared sensor is an electronic device, which measures infrared light radiating from objects in its field of view. PIRs are often used in the construction of PIR based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. This energy is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term 'Passive' in this instance means the PIR does not emit energy of any type but merely accepts incoming infrared radiation. Infrared radiation enters through the front of the sensor, known as the sensor face. At the core of a PIR is a solid-state sensor or set of sensors, made from approximately 1/4 inches square of natural or artificial pyroelectric materials, usually in the form of a thin film, out of gallium nitride (Ga N), cesium nitrate (CsNO_3), polyvinyl fluorides, derivatives of phenyl pyrazine, and cobalt Phthalocyanine. (See pyroelectric crystals.) Lithium tantalate (LiTaO_3) is a crystal exhibiting both piezoelectric and pyroelectric properties.

At the same time, this differential arrangement minimizes common-mode interference; this allows the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in that configuration and therefore this configuration is specialized for motion detectors.

In a PIR-based motion detector, the PIR sensor is typically mounted on a printed circuit board, which also contains the necessary electronics required to interpret the signals from the chip. The complete circuit is contained in a housing, which is then mounted in a location where the sensor can view the area to be monitored. Infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation (but only translucent to visible light). This plastic sheet prevents the introduction of dust and insects, which could obscure the sensor's field of

view. PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low power, easy to use and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

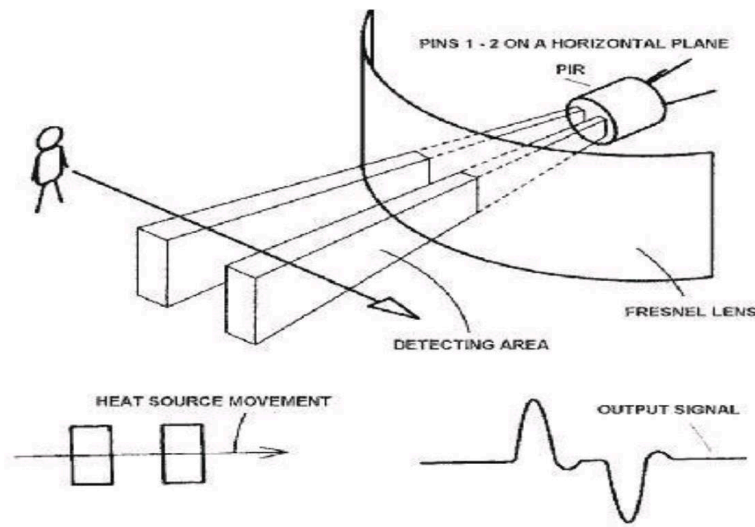


Fig: 3.3.5.1: Motion detection using PIR

The IR sensor itself is housed in a hermetically sealed metal can improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors.

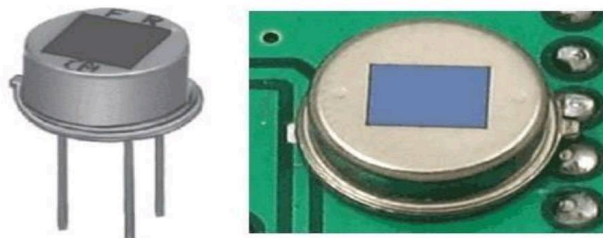


Fig: 3.3.5.2: Hermetically sealed metal housing of IR sensor

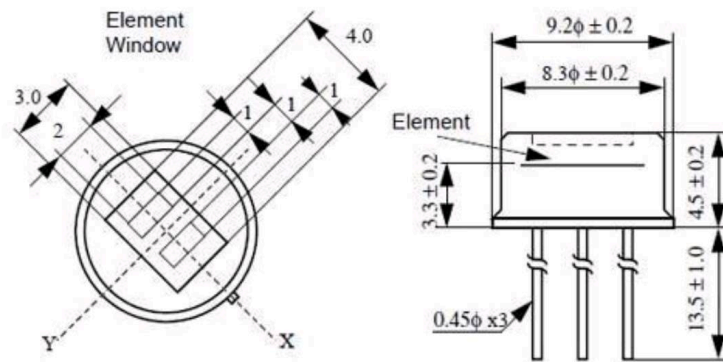


Fig: 3.3.5.3: Two pieces of sensing material of IR sensor

You can see above the diagram showing the element window, the two pieces of sensing material

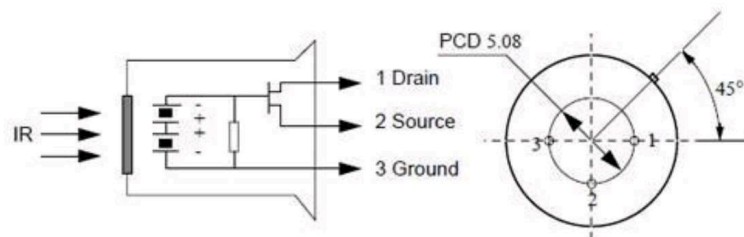


Fig:3.3.5.4: Internal Schematic of JFET

This image shows the internal schematic. There is a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedance of the sensors into something a low-cost chip (like the BIS0001) can sense.

PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily.

In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually, we'd like to have a detection area that is much larger. To do that, we use a simple lens (<http://adafru.it/aKq>) such as those

found in a camera: they condense a large area (such as a landscape) into a small

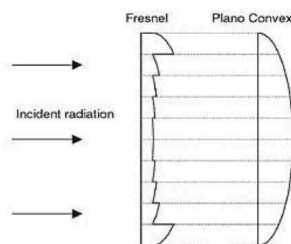


Fig: 3.3.5.5: Fresnel lens providing larger range

The Fresnel lens condenses light, providing a larger range of IR to the sensor.

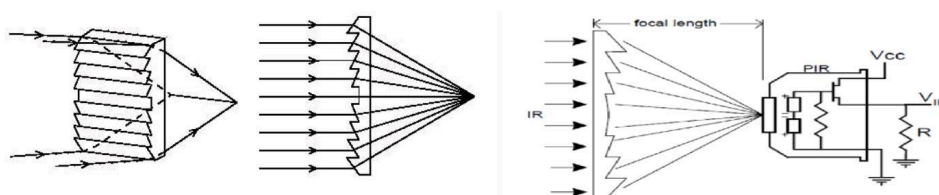


Fig: 3.3.5.6: Fresnel lens providing different ranges

So, what we do is split up the lens into multiple section, each section of which is a Fresnel lens. The different faceting and sub-lenses create a range of detection areas, interleaved with each other. That's why the lens centers in the facets above are 'inconsistent' - every other one points to a different half of the PIR sensing element

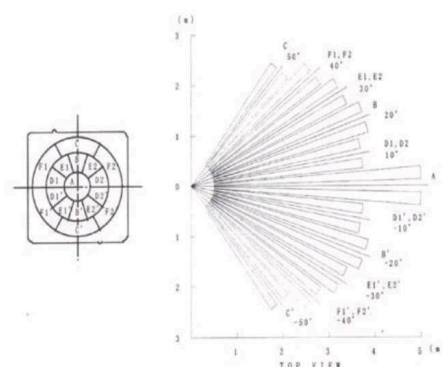


Fig: 3.3.5.7: Range detection using Fresnel lens

Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple check the pinout! It's often silkscreened on right next to the connection (at least, ours is!) One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V

Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections. The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins. One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections.

The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins.

An easy way of prototyping with PIR sensors is to connect it to a breadboard since the connection port is 0.1" spacing. For our PIR's the red cable is + voltage power, black cable is - ground power and yellow is the signal out.

Now when the PIR detects motion, the output pin will go "high" to 3.3V and light up the LED!

Once you have the breadboard wired up, insert batteries and wait 30-60 seconds for the PIR to 'stabilize'. During that time the LED may blink a little. Wait until the LED is off and then move around in front of it, waving a hand, etc., to see the LED light up!

3.3.5.1 Retriggering

There are a couple options you may have with your PIR. First up we'll explore the 'Retriggering' option.

Once you have the LED blinking, look on the back of the PIR sensor and make sure that the jumper is placed in the L position as shown below.

Now set up the testing board again. You may notice that when connecting the PIR sensor as above, the LED does not stay on when moving in front of it but actually turns on and off every second or so. That is called "non-retriggering".

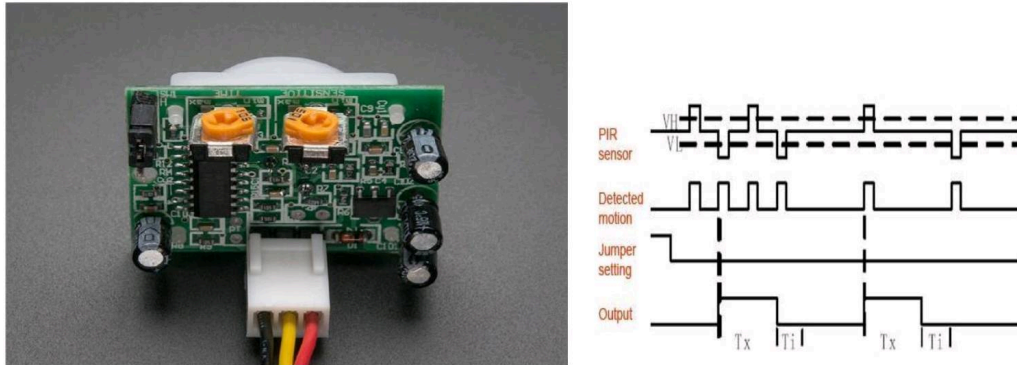


Fig:3.3.5.1.1: PIR sensor in non-retriggering mode

Now change the jumper so that it is in the H position. If you set up the test, you will notice that now the LED does stay on the entire time that something is moving. That is called "retriggering".

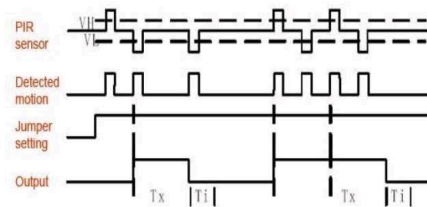


Fig:3.3.5.1.2: PIR sensor in retriggering mode

For most applications, "retriggering" (jumper in H position as shown below) mode is a little nicer.

If you need to connect the sensor to something edge-triggered, you'll want to set it to "no retriggering" (jumper in L position).

The Changing sensitivity of the PIR has a trim pot on the back for adjusting sensitivity. You can adjust this if your PIR is too sensitive or not sensitive enough - clockwise makes it more sensitive.

3.3.5.2 Operation of Pir Sensor

The PIR device can be thought of as a kind of infrared 'camera', which remembers the amount of infrared energy focused on its surface. Once power is applied to the PIR the electronics in the PIR shortly settle into a quiescent state and energize a small relay. This relay controls a set of electrical contacts, which are usually connected to the detection input of an alarm control panel. If the amount of infrared energy focused on the sensor changes within a configured time period, the device will switch the state of the alarm output relay. The alarm output relay is typically a "normally closed (NC)" relay; also known as a "Form B" relay.

A person entering the monitored area is detected when the infrared energy emitted from the intruder's body is focused by a Fresnel lens or a mirror segment and overlaps a section on the chip, which had previously been looking at some much cooler part of the protected area. That portion of the chip is now much warmer than when the intruder wasn't there. As the intruder moves, so does the hot spot on the surface of the chip. This moving hot spot causes the electronics connected to the chip to de-energize the relay, operating its contacts, thereby activating the detection input on the alarm control panel. Conversely, if an intruder were to try to defeat a PIR perhaps By holding some sort of thermal shield between himself and the PIR, a corresponding 'cold' spot moving across the face of the chip will also cause the relay to de-energize unless the thermal shield has the same temperature as the objects behind it.

Manufacturers recommend careful placement of their products to prevent false alarms. They suggest mounting the PIRs in such a way that the PIR cannot 'see' out of a window. Although the wavelength of infrared radiation to which the chips are sensitive does not penetrate glass very well, a strong infrared source (a vehicle headlight, sunlight reflecting from a vehicle window) can overload the chip with enough infrared

energy to fool the electronics and cause a false (non-intruder caused) alarm. A person moving on the other side of the glass however would not be 'seen' by the PIR.

They also recommended that the PIR not be placed in such a position that an HVAC vent would blow hot or cold air onto the surface of the plastic, which covers the housing's window. Although air has very low emissivity (emits very small amounts of infrared energy), the air blowing on the plastic window cover could change the plastic's temperature enough to, once again, fool the electronics.

PIRs come in many configurations for a wide variety of applications. The most common used in-home security systems have numerous Fresnel lenses or mirror segments and has an effective range of about thirty feet. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over one hundred feet away from the PIR. There are also PIRs designed with reversible orientation mirrors, which allow either broad coverage (110° wide) or very narrow 'curtain' coverage.

PIRs can have more than one internal sensing element so that, with the appropriate electronics and Fresnel lens, it can detect direction. Left to right, right to left, up or down and provide an appropriate output signal.

3.4 SOFTWARE DESCRIPTION

The software description of the system with different modules are described below

3.4.1 Keras

Keras is a high-level, deep learning API developed by Google for executive neural networks. It is written in Python and is nearly new to make the implementation of neural networks easy. It also braces multiple backend neural network computation.

Keras is relatively easy to learn and work with because it executes a python frontend with a high level of preoccupation while having the option of multiple backends for computation purposes. This makes Keras deliberate than other deep learning

frameworks, but extremely beginner friendly. Keras allows you to switch between different back ends. The frameworks supported by Keras are:

- TensorFlow
- Theano
- PlaidML
- MX Net
- CNTK (Microsoft Cognitive Toolkit)

Out of these five frameworks, TensorFlow has adopted Keras as its confidential high-level API. Keras is embedded in TensorFlow and can be used to perform deep learning fast as it executes inbuilt components for all neural network computations.

At the same time, computation imply tensors, computation graphs, sessions, etc. can be convention made using the TensorFlow Core API, which gives you total pliability and control over your application and lets you implement your ideas in a relatively short time.

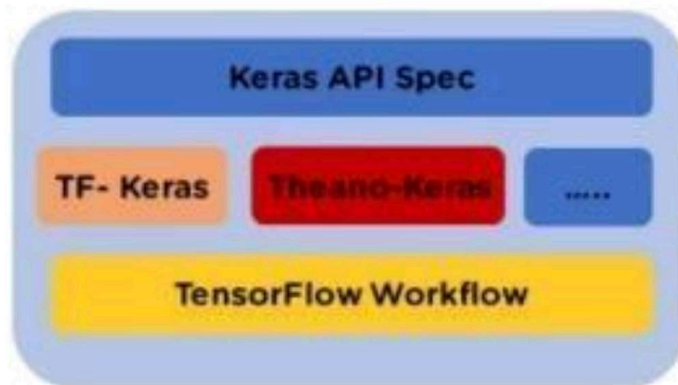


Fig: 3.4.1: KERAS

3.4.2 Scikit-learn

Scikit-learn is a library in Python that come up with many unsupervised and supervised learning algorithms. It's built over some of the technology you might already be intimate with, like NumPy, pandas, and Matplotlib! The functionality that scikit-learn provides include:

- Regression, including Linear and Logistic Regression
- Classification, including K-Nearest Neighbors
- Clustering, including K-Means and K-Means++
- Model selection
- Preprocessing, including Min-Max Normalization

3.4.3 Installation of operating system on Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs bring on a computer monitor or TV and uses a standard keyboard and mouse. It is a competent little device that enables people of all ages to survey computing, and to learn how to program in languages like Scratch and Python. It's competent of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word processing, and playing games.

The gadget uses the ARM processor which does nearly all of the hard work in order to run the Raspberry Pi. The main aim of Raspberry Pi is to pile up the data from various nodes i.e., Arduino and upload them to the firebase database.

The steps for Installation of Raspbian OS are

1. Setup the SD card - Anything that's stored on the SD card will be reset during formatting. Then, if the SD card on which you want to install Raspbian currently has any files on it, e.g., from a previous version of Raspbian, you may wish to back these files up first to not lose them permanently.

2. New Out of Box Software (NOOBS)- Using the NOOBS software is the easiest way to install Raspbian on your SD card.

- Download NOOBS- Overtake the Raspberry Pi downloads page.
- Extract NOOBS from the zip archive
- Next, you will need to extract the files from the NOOBS zip archive you downloaded from the Raspberry Pi website.
- Double-click on it to extract the files and keep the resulting Explorer/Finder window open.
- Select all the files in the NOOBS folder and drag them into the SD card window to copy them to the card.

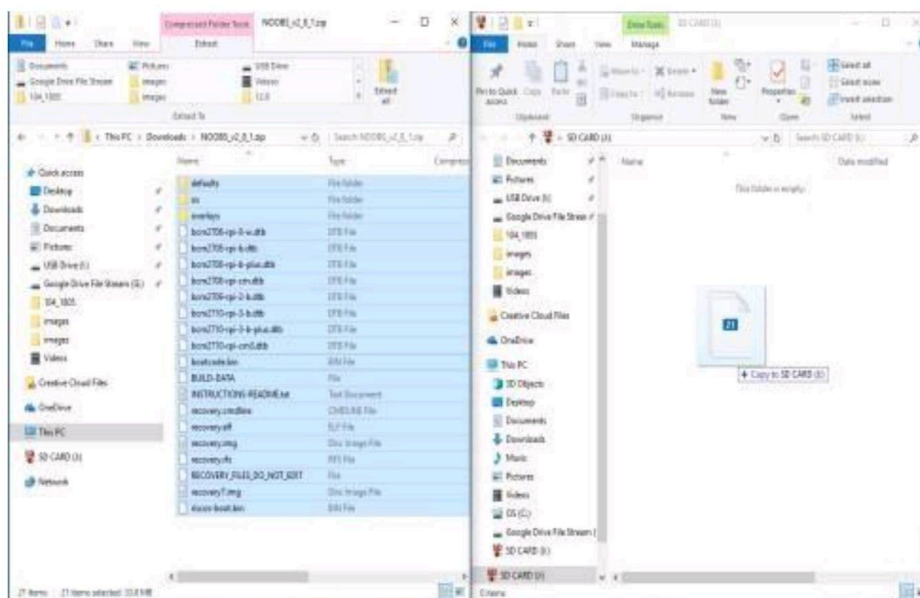


Fig: 3.4.2: Copying to Sim Card

3. Connect your Raspberry Pi

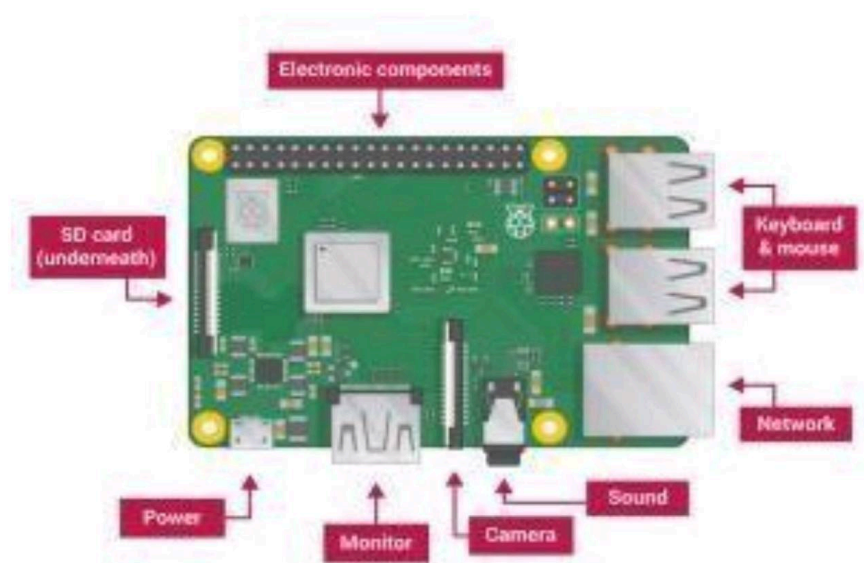


Fig: 3.4.3: Raspberry Pi

- Enclosure the SD card with Raspbian (via NOOBS) into the micro-SD card slot 14.
- Connect the mouse and the keyboard to a USB port on the Raspberry Pi.
- Use a cable to link a screen to the Pi's HDMI port uses an adapter if necessary.
- Startup Raspberry Pi.
- Connect a micro-USB power supply it to you Pi's power port.

The red LED light up on the Raspberry Pi, indicates that the Pi is connected to power. As its wader up raspberries will appear in the top left-hand of the screen.

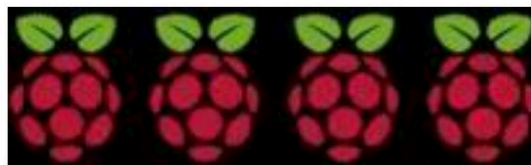


Fig:3.4.4: Powering Raspberry Pi

After a few seconds, the Raspbian Desktop will appear.

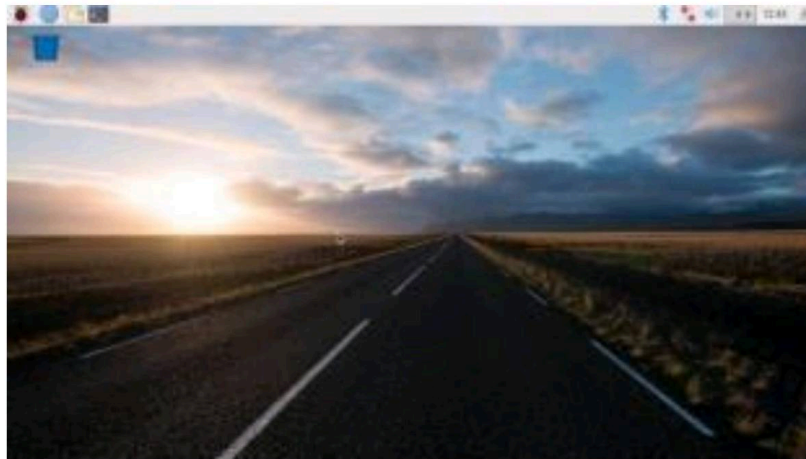


Fig:3.4.5: Raspbian Desktop

4. Finish the setup

When you setup your Raspberry Pi for the first time, the Welcome to Raspberry Pi application will pop up and guide you through the initial setup.



Fig: 3.4.6: Raspberry Pi Welcome Screen

- Click Next to start the setup.
- Click Done or Reboot to finish the setup.

Raspberry Pi is a small computer. In consequence operating system (OS) should be installed. For that, memory card (SD card) is used for the installation of operating system and all the required software and supporting files are stored in the same SD card.

There are different types of operating system, but we preferred to talk about NOOBS (New Out of the Box Software) as it is suitable for the beginners. In preinstalled SD card, NOOBS is already copied and ready to boot.

we can use keyboard and mouse of laptop as well for Raspberry Pi. For that, two software are needed to install in a laptop which screen is going to use for Raspberry Pi. Installation and layout of the software is discussed briefly in the following sections.

Xming

This is the primary software need to be installed which can be downloaded from the link, [Download_Xming](#) and install it in the laptop. After execution of installation, run the application called 'XLaunch' and verify that the settings are as shown in three following figures: Figure 3.4.4, Figure 3.4.5, and Figure 3.4.6.

Finally, click" Next" button shown in Figure 3.4.6, it goes to last configuration dialogue box where" Finish" button is needed to click for the execution of the setting. After execution of configuration, double click the application named as" Xming".

3.4.4 PuTTY

This is the central software need to be installed. For layout, double click the icon of PuTTY after the completion of installation and enter the IP address of Raspberry Pi as shown in Figure 3.4.4.1. Finally, click on "open" button and as a result; window will be displayed as shown in Figure 3.4.4.2

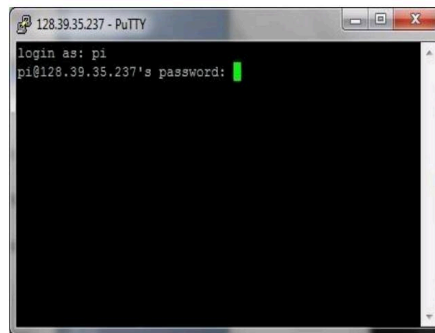


Fig:3.4.4.1: PuTTY login windows

In this aperture, username and password of the Raspberry Pi should be entered. The levant username for a Raspberry Pi is pi. Press 'enter' after entering correct username and password and you will see the windows where you should enter the text" lesson" as shown in Figure 3.4.4.3.

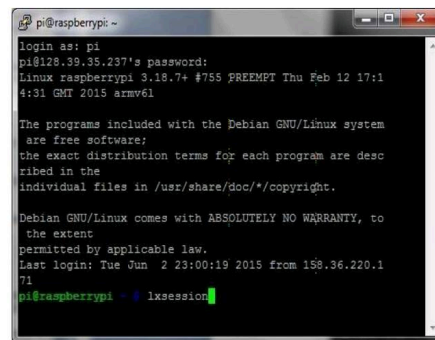


Fig:3.4.4.2: PuTTY success windows

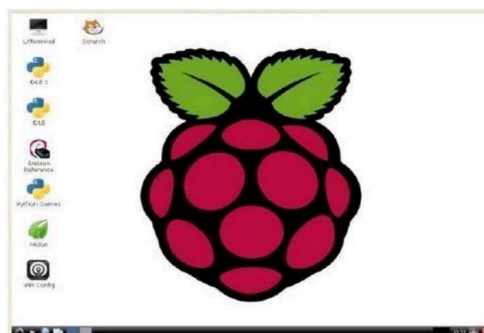


Fig:3.4.4.3: Raspberry Pi Desktop on your Laptop Display

3.4.5 User Interface

Raspberry Pi OS's desktop environment, PIXEL, looks similar to many common desktops, such as macOS, Microsoft Windows, and is based on LXDE. The scroll bar is positioned at the top which contains an application menu and shortcuts to Terminal, Chromium, and File Manager.

The Raspberry Pi documentation recommends at least a 4GB microSD card for Raspberry Pi OS Lite, an 8GB microSD card for Raspberry Pi OS, and a 16GB microSD card for Raspberry Pi OS Full.

3.4.6 Python

Python is a dynamic programming language which supports several different programming archetypes:

- Procedural programming
- Object oriented programming
- Functional programming

3.4.7 OpenCV

OpenCV is a cross-platform library using which we can evolve real-time computer vision applications. It mainly attentive on image processing, video capture and analysis including features like face perception and object detection.

Computer Vision can be elucidated as a discipline that explains how to reconstruct, intersperse. It deals with modeling and duplicate human vision using computer software and hardware.

Using OpenCV library, you can –

- Read and write images
- Apprehend and save videos
- Process images (filter, transform)
- Perform feature discernment
- Perception specific objects such as faces, eyes, cars, in the videos or images.

Following are the main library modules of the Open CV library.

This module payback the basic data structures such as Scalar, Point, Range, etc., that are used to setup Open CV applications.

3.4.8 Image Processing

This classwork covers various image processing operations such as image filtering, geometrical image transformations, color space conversion, histograms, etc. In the Java library of OpenCV, this module is included as a raft with the name `org.opencv.imgproc`.

This module covers the video analysis concepts such as motion evaluation, background subtraction, and object tracking. In the Java library of OpenCV, this module is included as a raft with the name `org.opencv.video`.

In the Java library of OpenCV, this module is incorporated as a package with the name `org.opencv.videoio`.

This component includes algorithms concerning basic multiple-point geometry algorithms, single and stereo camera calibration. In the Java library of OpenCV, this module is incorporated as a package with the name `org. OpenCV. calib3d`.

This component includes the concepts of feature detection and description. This module includes the detection of objects and instances of the predefined classes. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.objdetect`. This is an easy-to-use interface with simple UI capabilities. In the Java library of OpenCV, the features of this module is included in two different packages namely, `org.opencv.imgcodecs` and `org.opencv.videoio`.

The storing images of OpenCV is it could capture an image, we use devices like cameras and scanners. These devices record numerical values of the image (Ex: pixel values). This class comprises of two data parts: the header and a pointer

- Header: Contains information like size, method used for storing, and the address of the matrix (constant in size).
- Pointer: Stores the pixel values of the image (Keeps on varying).

3.5 ALGORITHM

Neural Networks are the subclass of machine learning which are at the heart of deep learning algorithms. It comprises of node layers which contains an input layer, one or more hidden layers, and an output layer.

Each node connects to another that has an associated weight and threshold. If the output of any individual node is more than the specified threshold value, that node will be activated, which sends data to the next layer of the network.

Convolutional Neural Network were often utilized for classification and computer vision tasks. Before CNN, there was a manual and time-consuming feature extraction methods which were used to identify the images of the objects.

Convolutional Neural Network provides more scalable approach to image classification and object recognition tasks, leveraging principles from linear algebra, specifically matrix multiplication, to identify patterns within an image. There can be computational demand, which requires graphical processing units (GPUs) to train models.

3.6 COST ANALYSIS

The costs of the various components used in this project are given below in the Table: 3.1.

Table 3.1 List of components and their costs

COMPONENT	Quantity number	in	COST
Raspberry Pi	one		₹ 6000
Motor	one		₹ 90
Camera	one		₹ 700
PIR sensor	one		₹ 70
MQ6 sensor	one		₹ 100
Monitor	one		₹ 3500
Keyboard and mouse with USB cable	Each one		₹ 1200
Miscellaneous			₹ 1000
TOTAL			₹ 12,660

CHAPTER 4

RESULTS AND CONCLUSION

4.1 RESULT

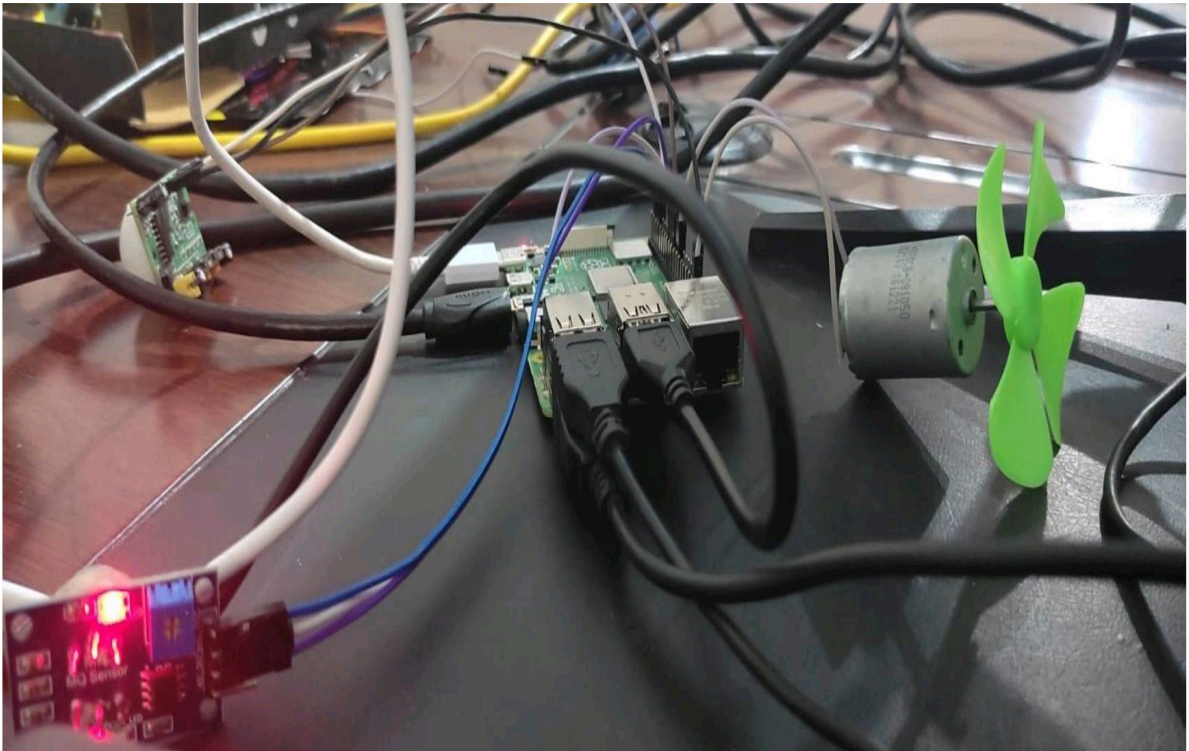


Fig: 4.1: Hardware parts

From the hardware side gas sensor, flame sensor, exhaust fan has been connected via jumper wires with Raspberry pi. From the software side integrated cloud application and WhatsApp messenger combined with AI and python has been used as shown in Fig:4.1. All these sensors will be integrated with Raspberry Pi board for cloud data transfer. If the gas leakage is detected by MQ6 gas sensor, the device gets on by displaying alert message through WhatsApp messenger in user mobile is displayed. Simultaneously, it switches ON the exhaust fan. PIR sensor also placed in the home to notify presence of human. If no person automatically the notification will be sent to user through mobile by messages along with the quality of food using an expert algorithm.

4.2 OUTPUT IMAGES

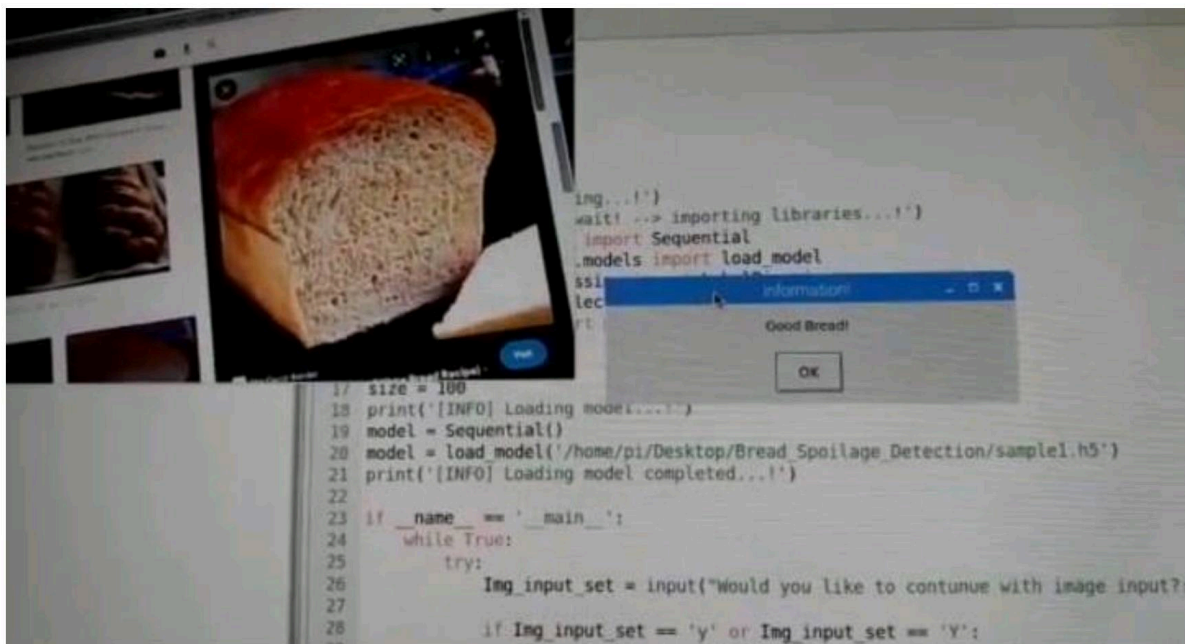


Fig: 4.2: The image of output pop-up window

The above Fig: 4.2 shows the pop-up window with the output as good bread.

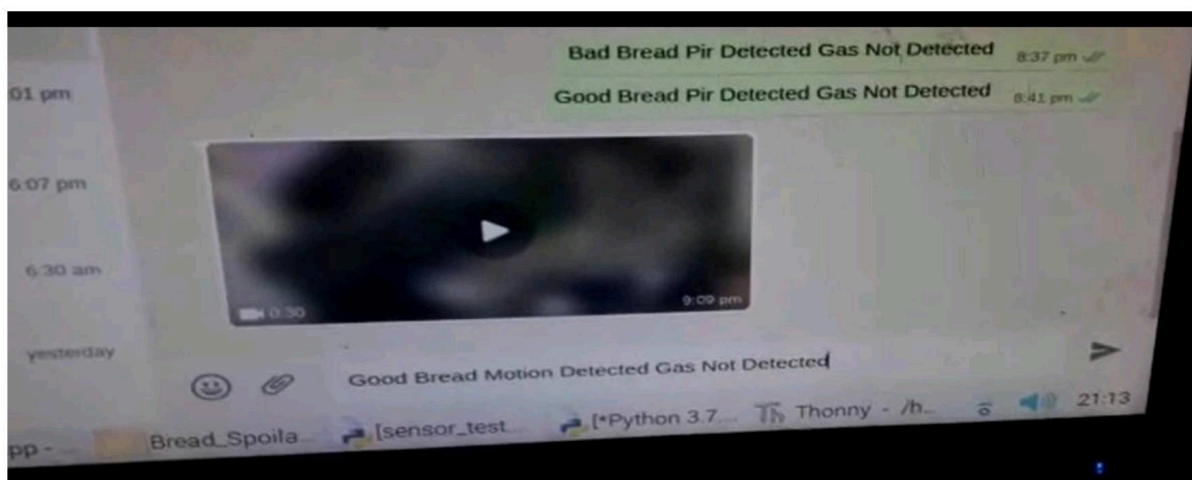


Fig: 4.3: The Output in WhatsApp messenger

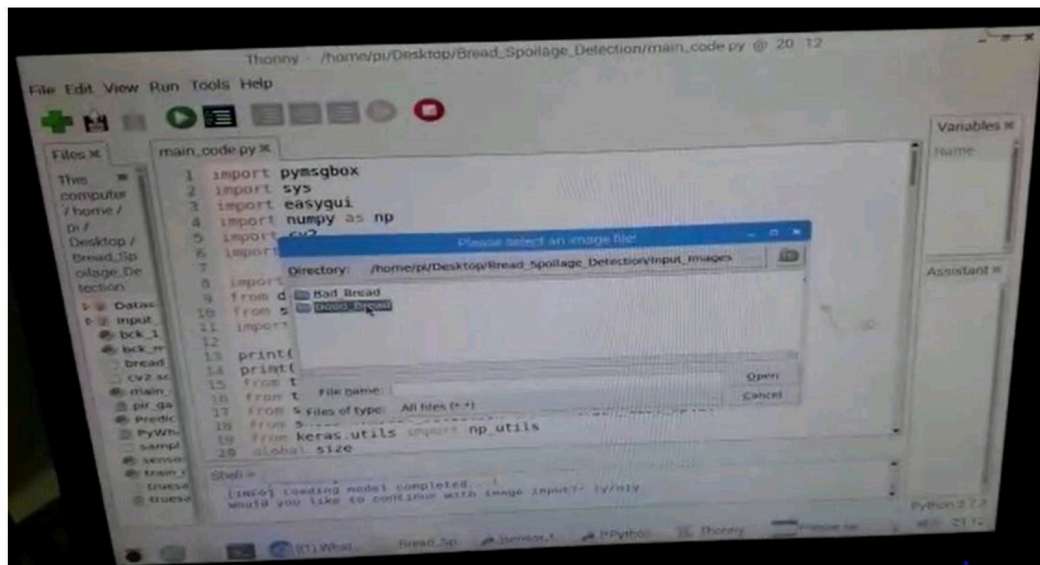


Fig. 4.4: selecting the input bread image

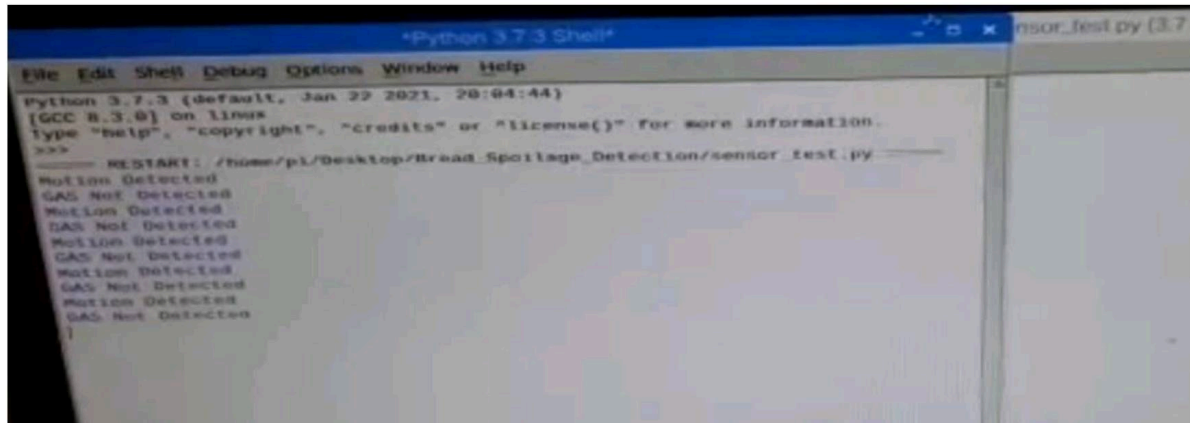


Fig. 4.5: The Output from sensors

4.3 CONCLUSIONS

In this project, the identification of good quality and bad quality bread based on quality using OPENCV/PYTHON is successfully done with accuracy. The use of image processing for identifying the quality can be applied not only to any bread. We can also apply this method to identify quality of vegetables and other food products with more accuracy. So, the system will enable the technology to be applied in many products. To replace manual inspection of food, computer vision system which is used which provide good quality, authentic, equitable and non-destructive rating. The image processing is done by software Open CV using a language python.

4.4 FUTURE WORKS

In future, the system could be enhanced by training n number of models for different varieties of food products with more accuracy. It could be planned to implement machine learning to this model in such a way that it could estimate how likely the food is going to get spoiled and in what duration, the food could get spoiled. So, that the production could be accelerated and retarded accordingly. This will create an environment to sell more healthy and fresh foods and create a safe world for all consumers alike.

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