# Microwave Sensor with Arduino for humans and objects detection behind walls

**A CAPSTONE PROJECT REPORT**

*Submitted in partial fulfillment of the requirement for the award of the Degree of*

**BACHELOR OF TECHNOLOGY**
**IN**
**ELECTRONICS AND COMMUNICATION ENGINEERING**

*by*


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*JANUARY 2023*

## CERTIFICATE

This is to certify that the Capstone Project work titled "**Microwave Sensor with Arduino for humans and objects detection behind walls**" that is being submitted by **Dhruva Rakesh (19BES7003)** is in partial fulfillment of the requirements for the award of Bachelor of Technology, is a record of bonafide work done under my guidance. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Dr. **Bharath Reddy Gudibandi**

Guide

**The thesis is satisfactory / ~~unsatisfactory~~**

**Internal Examiner**

Praveen

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School Of Electronics Engineering

## ACKNOWLEDGEMENTS

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Lastly we would like to thank our SENSE school respective HOD for giving us an opportunity to carry out our studies in the University.

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**Dulam Sai Varun Goud**

**Dhruva Rakesh B**

# ABSTRACT

In this paper, an efficient tool is presented that can detect humans behind an opaque wall and alert them by tracking their random motion. This is done with the help of a microwave sensor. Identifying the humans in a disaster situation is of the utmost priority, and motion detection plays a crucial role. Using technology to solve real-world problems is the actual use of technology. Among all the sensors available, the microwave sensor is a game changer. A microwave sensor broadcasts a variety of microwaves at various frequencies toward a detection area and then performs an object detection operation using the microwave waves that are reflected off an object that is present in the detection region. The hardware components are cost-effective, small in size, and have sufficient computational power for application-oriented components. The Arudino Nano functions as the system's brain, assisting with motion detection and alerting the system's status. The OLED display interfaces with the Arduino to display the randomness of the motion detected. The microwave sensor has a distance identification section for measuring the distance to an object in the detection area, a movement-distance identification section for measuring how far the object is moving over time in the detection area, and an object determination section that processes the output from the movement-distance identification section and distance identification section to determine the object detection.

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# CHAPTER 1

# INTRODUCTION

This module combines a digital microwave sensor with an Arduino to detect moving humans and objects behind walls. This digital microwave sensor uses doppler radar to detect moving objects using microwaves. The microwaves are sensitive to a variety of objects, and the amazing thing is that their sensor readings are not affected by ambient temperatures. So, that’s why this type of sensor is widely used in industrial, transportation, and civil applications such as measuring liquid levels, automatic washing, measuring a vehicle’s speed, automatic door motion detection, car reversing, production line material detection, automatic lights control systems, high-level security systems, and so on.

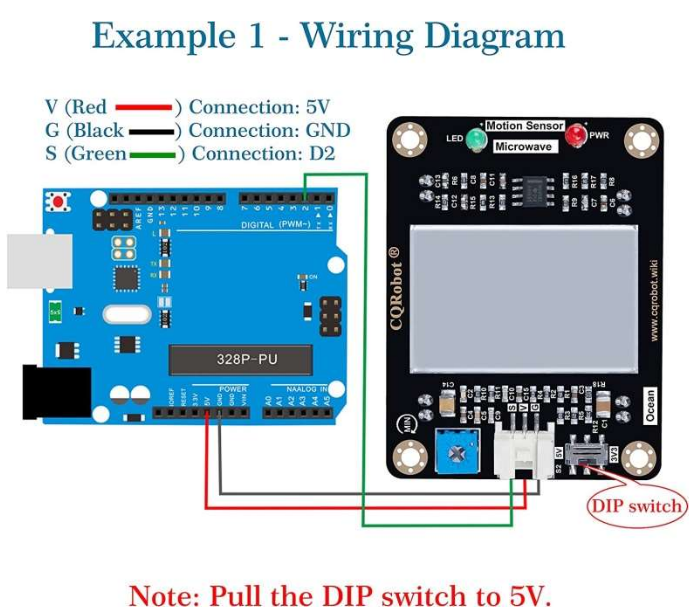



**Fig-1**

## 1.1 Objectives:

The following are the objectives of this project:

- The main objective of this project is build an efficient tool is presented that can detect humans behind an opaque wall and alert them by tracking their random motion.
- The randomness of the motion presented by the human behind the walls must always be displayed by the OLED module.
- In order to replicate the effectiveness of the human position, the module must be able to modify its visibility range based on user preferences.

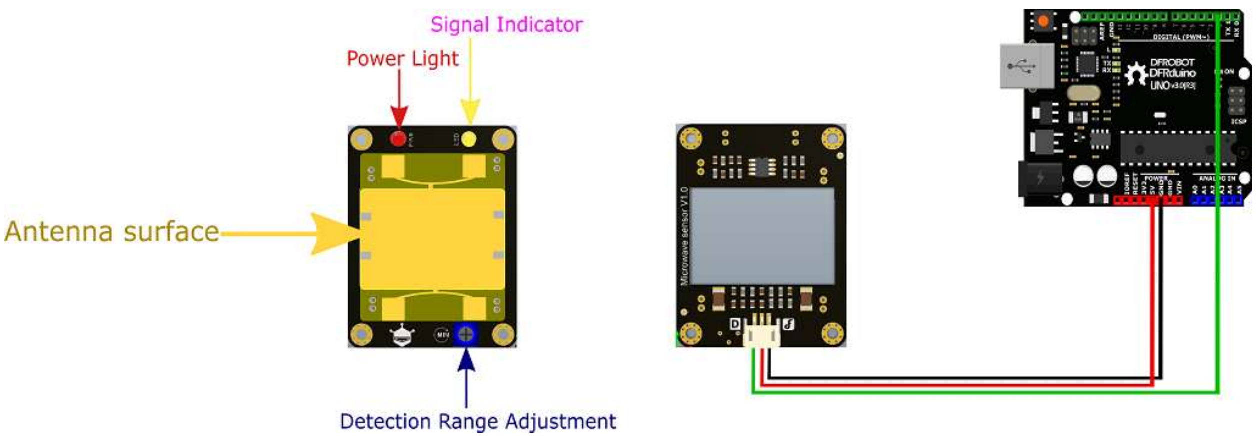
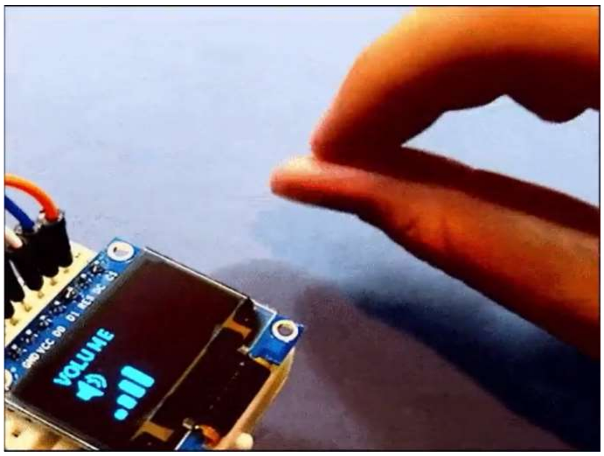



**Fig-2**

## 1.2 Novelty

In the real time scenario there are many projects based on object detection.
Some of them are : Easy Motion and Gesture Detection by PIR Sensor & Arduino, Motion Controlled Color Changer!, Motion Activated Night Light, Alarm clock that really gets you out of bed in the morning.



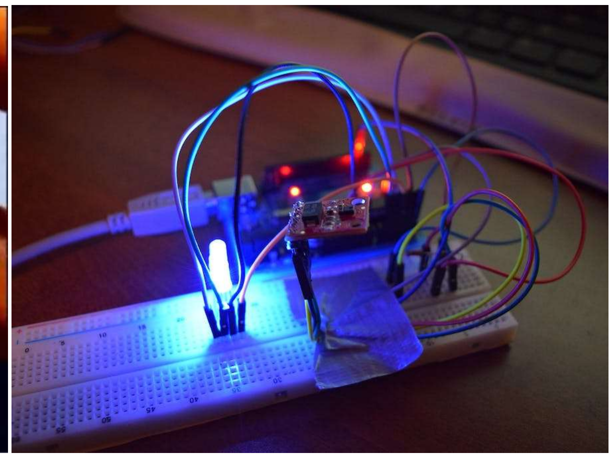



**Fig-3** **Fig-4**

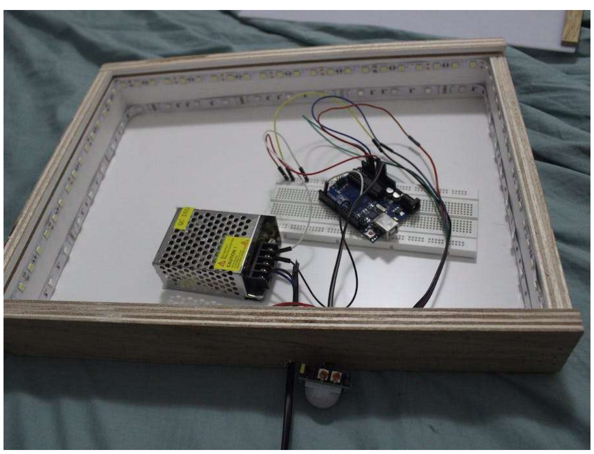


**Fig-5** **Fig-6**

Our project is distinct from many that have come before it.

A microwave sensor transmits a variety of microwaves at different frequencies toward a detection area, and then uses the microwave waves that are reflected off an object that is present in the detection area to perform an object detection operation.
We utilised an Arduino and this digital microwave sensor to look for moving people and things behind walls.
This digital microwave sensor detects moving objects by employing doppler radar. The remarkable thing about the microwaves is that they can detect a wide range of things, and their sensor readings are unaffected by the surrounding temperature. This is the reason why industrial, transportation, and civic applications frequently use this kind of sensor.

## 1.3 Motivation:

Accurate human presence detection offers seamless background functions and quick security alarms. When you walk into the kitchen, the light turns on, and when you leave, it turns off. Your personal computer prevents unauthorised access.

But achieving that level of accuracy comes with difficulties. Making the distinction between sensing motion and real human presence is one of the biggest hurdles. Imagine if your house alarm went off every time a rabbit jumped past your front door if the device or system just relied on motion sensing. It would not only be more irritating, but also defeat its main goal. You'd be so used to false alarms that you would overlook a genuine threat.

This is just one little illustration of the significance of accurate human presence detection. And it is possible with the aid of sensor-fusion software, the proper sensor configuration, and a solid understanding of the context.
More sophisticated microwave sensors can also determine whether a person is moving randomly or toward or away from the sensor. These detectors are useful for detecting and separating normal movement from intruder movement. These sensors are quite trustworthy because of this attribute.

The usage of microwave sensors is entirely secure. They can be used both inside and outside of a building and spread out across rather huge areas. They can also be set up to detect other kinds of activity, such as disregarding activity in particular parts of the house, such as those where kids or pets might congregate.

## 1.4 Background and Literature Survey:

A similar project on UWB radar was carried out by Ashith Kumar , Zhuo Li,ZhuoLi, QilianLiang, BaojuZhang, XiaorongWu, Department of Electrical Engineering, University of Texas at Arlington, Arlington, TX 76019-0016, USA. This is our base paper; the title of our base paper is "Experimental study of through-wall human detection using ultra-wideband radar sensors". Rescue, surveillance, and security operations are all focused on locating human targets that are concealed by walls or confined inside buildings. Using the ultra-wideband (UWB) radar PulsOn 220 in monostatic mode, investigations on through-wall human detection are conducted in this study in two scenarios: through a gypsum wall and through a wooden door. The normalised difference square matrix approach, reference moving average method, and EMD from Hilbert Huang

Transform method are utilised to measure the weak signals brought on by respiratory movement of the human target.

We also referred to paper published by Norbert Pałka; Marek Życzkowski; Jarosław Młyńczak; Mateusz Karol; Piotr Markowski; Mieczysław Szustakowski, Krzysztof Cichulski, Agnieszka Wiśniewska, Sebastian Brawata, , titled as "**Microwave sensors for detection of floating objects on rivers**".In this paper they examined how microwave sensors work to find floating things in rivers. For testing, three different types of sensors—FMCW perimeter radar, microwave barrier, and monostatic Doppler detector—were selected. Selected items (boats, goods, and swimmers) repeatedly crossed a 45-m wide river during tests. Finding the likelihood and range of detection for various environmental factors and detector-object distances was the aim of the investigation.

### 1.5 Organization of the Report

The remaining chapters of the project report are described as follows:

- Chapter 2 contains the proposed system, methodology, hardware and software details.
- Chapter 3 gives the cost involved in the implementation of the project.
- Chapter 4 discusses the results obtained after the project was implemented.
- Chapter 5 concludes the report.
- Chapter 6 consists of codes.
- Chapter 7 gives references.

# CHAPTER 2

## Microwave Sensor with Arduino for humans and objects detection behind walls

This chapter focuses on the proposed system, methodology, hardware and software details.

### 2.1 Motion Detection

Motion can be detected through various means such as infrared, sound, and vibration. Motion detectors are primarily used for detecting moving objects (especially people), and gathering data regarding position, acceleration, and velocity**.**

#### 2.1.1 Techniques:

**Motion detection Techique:**

**1.Detection Using PIR Sensors:**

PIR sensors detect heat signals coming from objects in their area of vision. When a threshold limit is reached, the sensor will activate whatever it is attached to, be it a light, an alarm, or a camera. The sensor detects variations in the amount of infrared radiation it picks up.While the functionality of this straightforward technology is good, the design's inherent flaws make it problematic. For starters, the sensor's output is a fairly straightforward yes or no (e.g., turn on the light or don't). To find heat energy in the surrounding environment, passive infrared (PIR) sensors use a pair of pyroelectric sensors. The sensor will activate if a human enters the room, for example, or if the signal differential between the two sensors changes. These two sensors are placed next to one another. That might imply that it starts an alarm, alerts the police, or switches on a floodlight. Using a set of lenses that serve as the sensor's housing, IR radiation is focused on each of the two pyroelectric sensors. These lenses increase the sensing area of the apparatus.

**Fig-7**

**2. Video Motion Detection:**

The VMD option combines security camera picture output with software that can analyze photos as they are being taken. This is similar to a camera operator watching a video stream while seated, but since it is automated, it has some advantages. It is simple to imagine some of this technology's drawbacks. Operating in the visible light spectrum, the camera is susceptible to blinding if there is too much backlighting and is blind if there is insufficient light. Even when employing a sensor-activated light, shadows will always be an issue. On the plus side, adding a layer of analytics is quite inexpensive and video is a widely used security option.If you've integrated the motion detectors into home security systems including emergency lighting and home security cameras, the motion sensors will trigger these to turn on, or to start recording security footage.This method of motion detection largely depends on two crucial elements: the caliber of the camera's captured image and the caliber of the used analytics software. There are several different types of VMD technologies available; some allow you to adjust settings, such as to only detect motion inside specific boundaries, while others simply detect movement. Once more, it's critical to pick equipment that is appropriate for the environment in which it will be used.

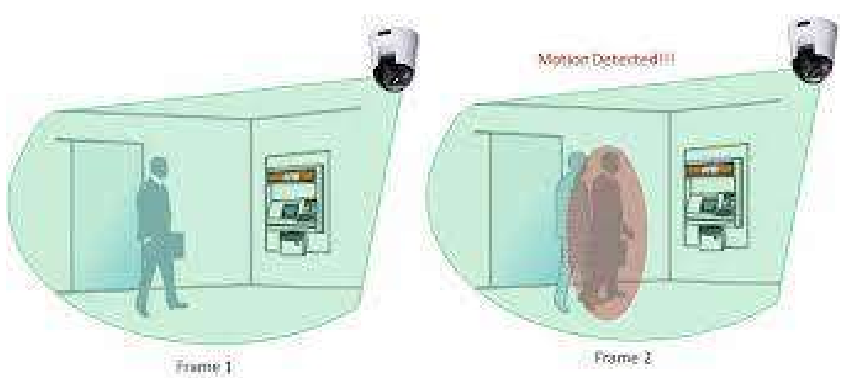



**Fig-8**

**3. Ultra-Wideband Radar for Motion Detection:**

Ultra-wide-band (UWB) radars are used for sensing and imaging applications, and they generate extremely brief radio-frequency (RF) pulses in the sub-nanosecond order range. UWB pulses may penetrate dielectric materials and have good spatial resolution.Through-wall imaging, target location, and indoor communications are just a few of the industries where ultra-wideband (UWB) signalling is finding many uses. Since different building materials have variable attenuation and dispersion qualities that affect UWB signal propagation, signal propagation through walls must be precisely characterized. The lower frequency components of a UWB signal are what give it its intriguing ability to pass through walls and other obstructions. However, the signal weakens, slows down, and disperses when it passes past these obstructions. In this article, we describe experimental findings from measurements of the transmission and reflection of UWB signals in the frequency domain over a range of 1–18 GHz.

**4. Motion Detection using Ultra Sonic Sensor: PIR Sensors**

In many automated manufacturing and processing facilities, ultrasonic sensors can identify targets in motion and determine their distance from the sensor. Sensors can produce an analog output proportional to distance or an on-or-off digital output for sensing the movement of objects. As a component of a web guiding system, they are able to detect the material's edge.To help drivers reverse into parking spaces, ultrasonic sensors are frequently employed in automobiles as parking sensors. They are also being tested for a number of other automotive applications, including helping autonomous UAVs navigate and using ultrasonic person detection. Ultrasonic sensors can be used in situations where photoelectric sensors may not be since they sense sound rather than light. For applications where photoelectric fail due to target translucence, such as clear object recognition and liquid level measurement, ultrasound is a fantastic alternative. Additionally, ultrasonic sensors are unaffected by target colour or reflectivity and can function dependably in conditions with high levels of glare.


**Fig-9**

**5. Microwave:**

The microwave sensor applies the Doppler effect to detect moving objects using microwaves. This differs from the method used by a regular infrared (IR) sensor as microwave is sensitive to a variety of objects that are microwave-reflective, and its sensor readings are not affected by the ambient temperature.

- The microwave detection method has the following advantages compared to other methods:
- Non-contact detection
- Readings not affected by temperature, humidity, noise, air, dust or light - suitable for harsh environments
- Strong resistance to radio frequency interference
- Low output, unharmful to human
- Wide detection range and high velocity
- Supports non-living object detection

**Fig-10**

**2.1.2 Techniques comparison:**

Each of these motion detecting methods has advantages and disadvantages, and how effective they are will depend on the circumstances in which they are applied as well as the supporting elements. You probably wouldn't instal a sophisticated radar in a 4x4 office, and a PIR sensor would be of little help detecting intruders in a wildlife sanctuary. A visible light camera would be ineffective at night on its own, but the addition of a motion sensor-triggered light would dramatically increase performance (unless you wanted to detect wildlife).

The digital microwave sensor detects moving objects by combining microwaves and doppler radar. This is different from how a typical infrared (IR) sensor works since the microwave is sensitive to a wide range of items that can reflect its wave and because its sensor values are unaffected by the surrounding temperature.

The microwave detection method has the following advantages compared with other detection methods:

1. Able to detect objects without physical contact
2. Readings not affected by temperature, humidity, noise, air, dust or light - suitable for harsh environments
3. Strong resistance to radio frequency interference
4. Low output, not harmful to the human body
5. Microwaves have a wide detection range and velocity equal to the speed of light
6. Supports non-life-class object detection

## 2.2 Proposed System

The following block diagram (figure 11) shows the system architecture of this project.

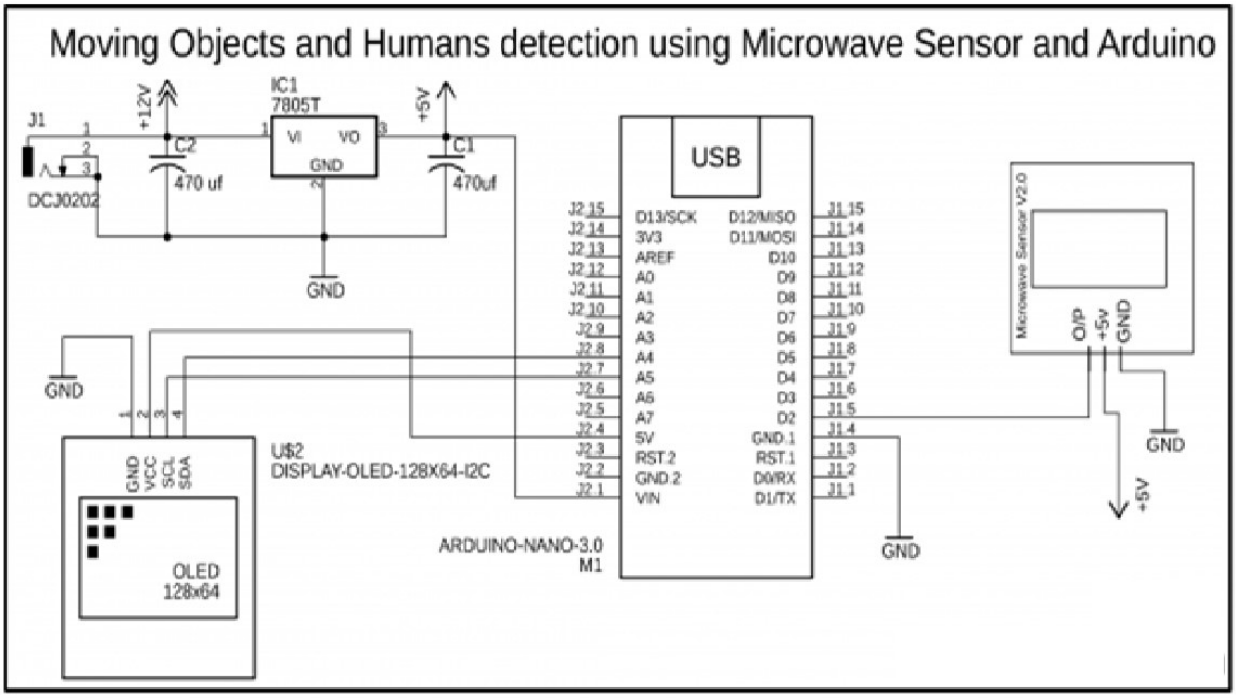



**Fig-11**

## 2.3 Working Methodology

There are two components to the system: hardware and software. The hardware consists of an Arduino Nano, an OLED module, and a digital microwave sensor. A microwave sensor continuously tracks any movement inside its field of view, and an OLED aids in the display of the findings.

With the help of doppler radar, this digital microwave sensor can detect moving objects using microwaves. Because microwaves can penetrate walls and are sensitive to a variety of objects, we will employ our digital microwave sensor for people and objects. It uses 5 volts as its operating voltage. The maximum and minimum operating currents are 60 and 37 milli amperes, respectively.

The output pin of the microwave sensor is linked to the Arduino's digital pin d2, and the positive 5 volt and ground pins on the top left side of the board are connected to the regulated 5 volt output of the 5 volt power supply. Through the LM7805 voltage regulator, javen, which is situated on the right side of the solar panel, the 12 volt relay module is connected to digital pin 13 of the Arduino. The solar panel is connected to the 12 volt adaptor battery here.

## 2.4 Standards

The basic elements in our project are:

Arudino Nano,OLED module and Digital microwave sensor.

- **Arudino Nano:**

  The Arduino Nano is a compact, comprehensive, and breadboard-friendly board based on the ATmega328. It comes in a different packaging but has roughly the same capabilities as the Arduino Duemilanove. It only lacks a DC power jack and uses a Mini-B USB cable rather than a conventional one to operate.

- **OLED Module:**

  A relatively new technology called OLED, or Organic Light Emitting Diode, has the potential to replace LCD and LED displays seen in modern televisions, monitors, and cell phone displays. It uses organic, carbon-based semiconductor materials for the emission area rather than silicon or germanium and has a more sophisticated structural design than conventional LEDs.

- **Microwave Sensor:**

  The microwave sensor uses the Doppler effect to use microwaves to detect moving objects. This is different from the way a typical infrared (IR) sensor works because microwave is sensitive to a wide range of items that reflect microwaves and because its sensor values are unaffected by the surrounding temperature.

  The measurement of vehicle speed, liquid levels, automatic door motion detection, automatic washing, production line material detection, and car reversing sensors are only a few examples of the industrial, transportation, and civil uses for this type of microwave sensor.

## 2.5 System Details

This section describes the software and hardware details of the system:

### 2.5.1 Software Details:

**Arudino IDE:**

The Arduino Software (IDE), often known as the Arduino Integrated Development Environment (IDE), has a text editor for writing code, a message area, a text console, a toolbar with buttons for basic functions, and a number of menus. In order to upload programmes and communicate with them, it connects to the Arduino hardware.

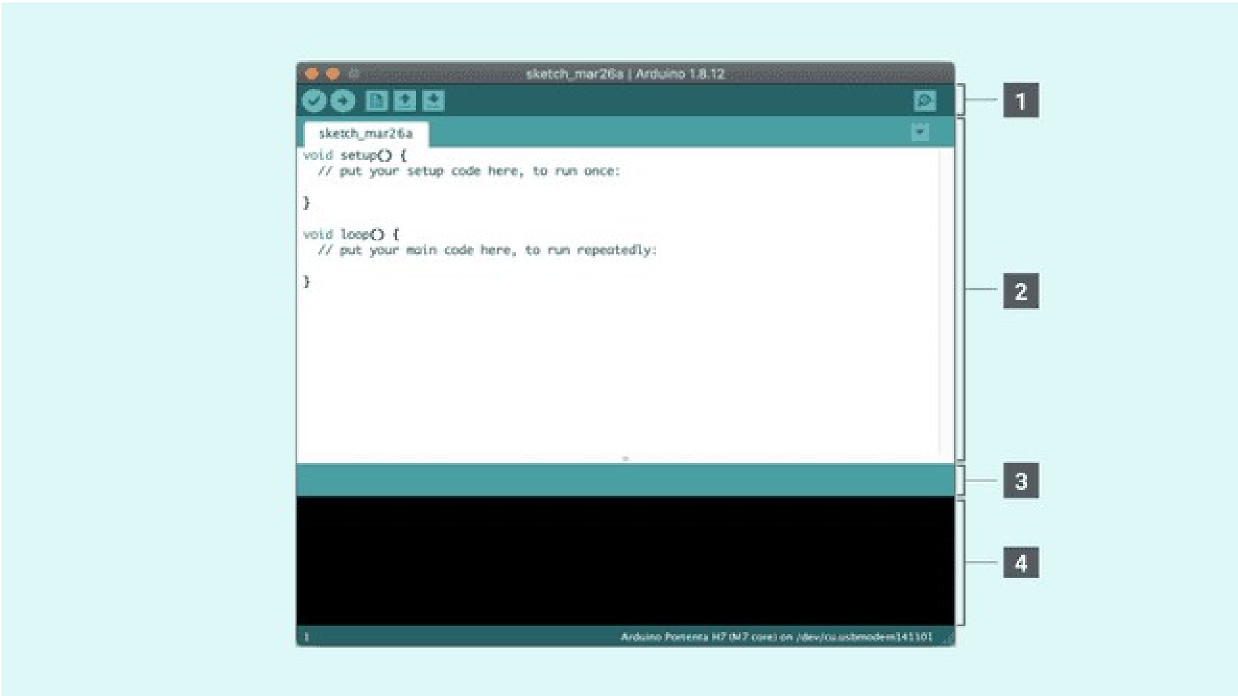



**Fig-12**

The Arduino Integrated Development Environment - or Arduino Software (IDE) - connects to the Arduino boards to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino.

- **Using the offline IDE 1.x.x :**

  The editor contains the four main areas:

  i) A Toolbar with buttons for common functions and a series of menus. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

  ii) The **message area**, gives feedback while saving and exporting and also displays errors.

  iii) The **text editor** for writing your code.

iv) The **text console** displays text output by the Arduino Software (IDE), including complete error messages and other information.

v) The bottom right-hand corner of the window displays the configured board and serial port.

vi) Now that you are all set up, **let's try to make your board blink!**

vii) **Connect your Arduino** or Genuino board to your computer.

viii) Now, you need to **select the right core & board**. This is done by navigating to **Tools > Board > Arduino AVR Boards > Board**. Make sure you select the board that you are using. If you cannot find your board, you can add it from **Tools > Board > Boards Manager**.

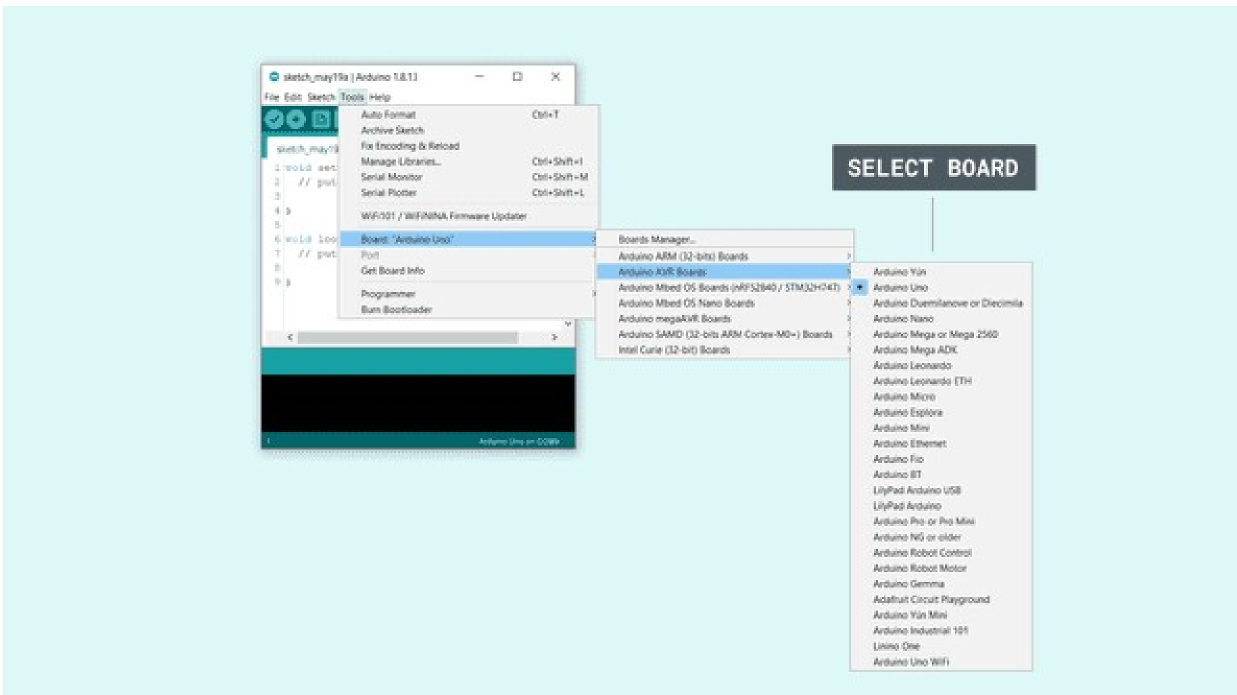



**Fig-13**

ix) Now, let's make sure that your board is found by the computer, by **selecting the port**. This is simply done by navigating to **Tools > Port**, where you select your board from the list.

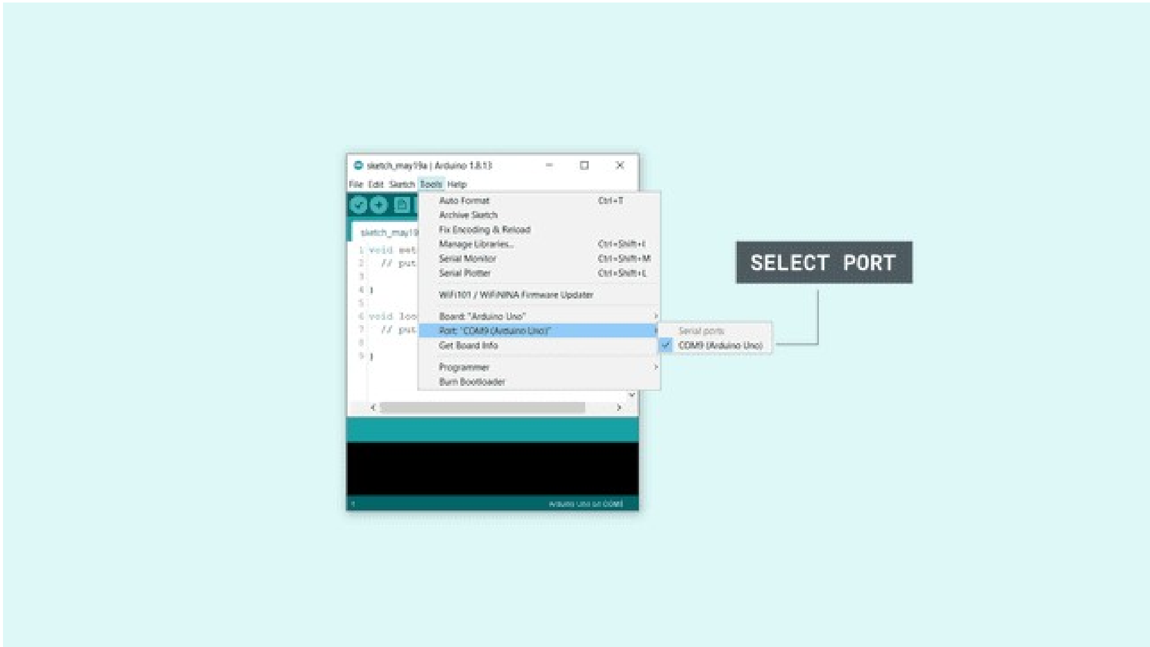



**Fig-14**

x) Let's **try an example**: navigate to **File > Examples > 01.Basics > Blink.**

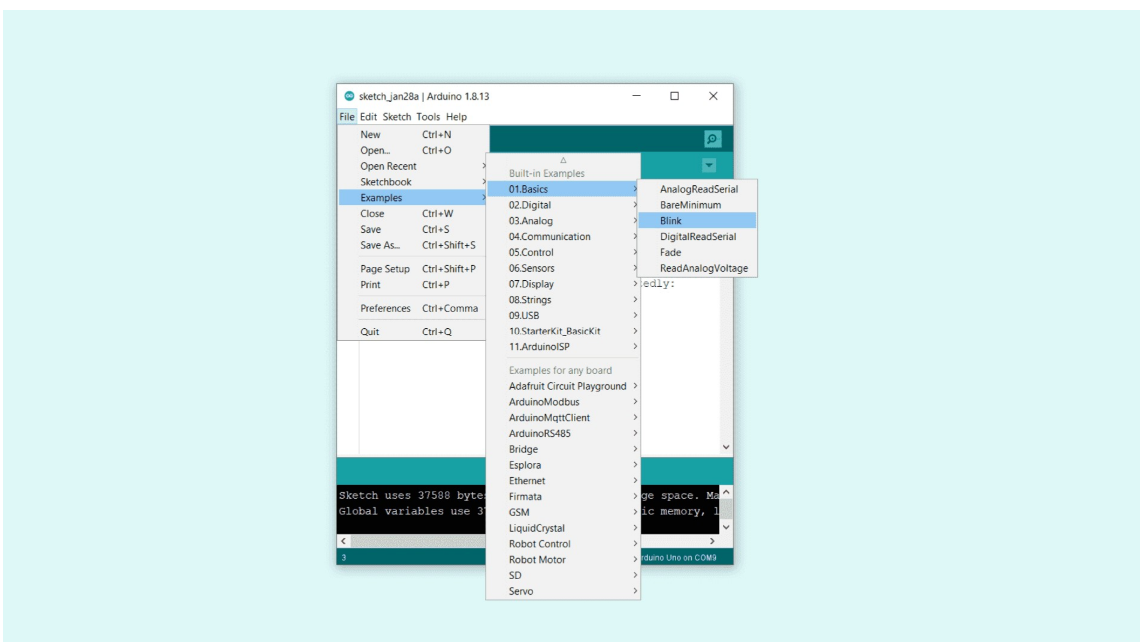



**Fig-15**

xi) To **upload it to your board**, simply click on the arrow in the top left corner. This process takes a few seconds, and it is important to not disconnect the board during this process. If the upload is successful, the message "Done uploading" will appear in the bottom output area.

xii) Once the upload is complete, you should then see on your board the yellow LED with an L next to it start blinking. You can **adjust the speed of blinking** by changing the delay number in the parenthesis to 100, and upload the Blink sketch again. Now the LED should blink much faster.

### 2.5.2 Hardware Details:

- **Arudino Nano:**

Based on the ATmega328P, the Arduino Nano is a compact, comprehensive, and breadboard-friendly board that was introduced in 2008. In a more compact design, it provides the same connections and specifications as the Arduino Uno board.

The Arduino Nano has 30 male I/O headers that are arranged in a DIP-30-like format and can be programmed using the Arduino Software integrated development environment (IDE), which is available both online and offline and is shared by all Arduino boards. The board can be powered by a 9 V battery or a type-B mini-USB connection.

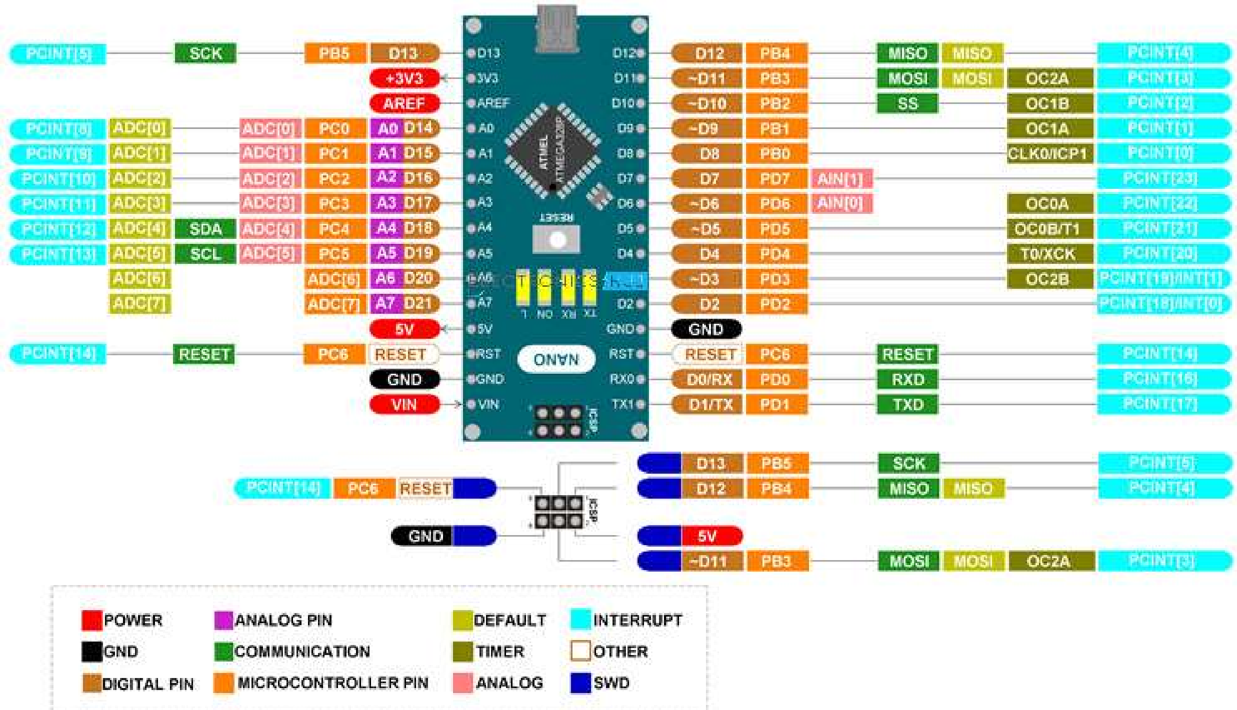



**Fig-16**

➤ **OLED Display Module:**

A relatively new technology called OLED, or Organic Light Emitting Diode, has the potential to replace LCD and LED displays seen in modern televisions, monitors, and cell phone displays. It uses organic, carbon-based semiconductor materials for the emission area rather than silicon or germanium and has a more sophisticated structural design than conventional LEDs.

An OLED module display is composed of several layers; the top or bottom are initially sealed by a transparent substance, typically glass or plastic. In order for the light to be efficiently emitted, one of the anodes or cathodes on each side must also be transparent. The organic LED compounds, referred to as an emissive layer on the cathode side and a conductive layer on the anode, are located inside the anode and cathode. A photon of light is created when a positive voltage is applied to the anode, causing holes to jump over the emissive conductive barrier and combine with electrons.

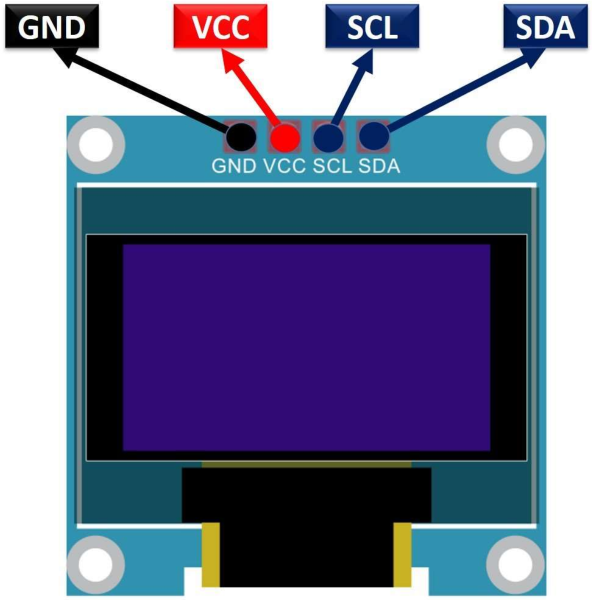



**Fig-17**

- **Digital Microwave Sensor:**

  The digital microwave sensor detects moving objects by combining microwaves and doppler radar. This is different from how a typical infrared (IR) sensor works since the microwave is sensitive to a wide range of items that can reflect its wave and because its sensor values are unaffected by the surrounding temperature. This kind of sensor is frequently used in commercial, industrial, and civil applications such as monitoring vehicle speed, liquid level measurement, automatic door motion detection, automatic washing, production line material detection, and car reversing sensors, among others.

**Fig-18**

### 2.5.3 List of components with their specifications:

*1)* **Arudino nano:**

The Nano Board R3 with CH340 chip without USB Cable chipboard is based on the famous Arduino platform and does all the functions of Uno, but with a smaller footprint.The Nano Board R3 with CH340 chip without USB Cable is vital for your small project where you don’t need much of a pin-outs but the small size is very important to make it look good**.**This Nano equips a low-cost USB-Serial Chip that makes it less in price than Nano with FTDI USB-Serial Chip used on older versions of Arduino Nano.The Nano Arduino is a small, complete, and breadboard-friendly board based on the **ATmega328** (Nano R3). It has more or less the same functionality of the **Uno** but in a different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.The Nano can be power via the mini-USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.The size of Nano V3.0 with CH340 Chip is only 43 mm x 18 mm; it comes with 6 PWM I/O from the total of 14 digitals I/O, 8 analog inputs, 16Mhz clock speed and 32kB of flash memory.

| Specifications | Arduino Uno | Arduino Nano |
|---|---|---|
| Processor | Atmega328P | Atmega328P |
| Input Voltage | 5V/7-12V | 5V/7-12V |
| Speed of CPU | 16 MHz | 16 MHz |
| Analog I/O | 6/0 | 8/0 |
| Digital IO/PWM | 14/6 | 14/6 |
| EEPROM/SRAM[ kB] | 1 / 2 | 1 / 2 |
| Flash | 32 | 32 |
| USB | Regular | Mini |
| USART | 1 | 1 |

**Fig-19**

### 2) OLED Display Module:

An organic film that is thin and multilayered that is sandwiched between an anode and a cathode makes up an OLED (Organic Light-Emitting Diode), a self-lighting technology. OLED technology does not require a backlight, in contrast to LCD technology. OLED is thought to be the best technology for the upcoming generation of flat-panel displays and has a great application potential for practically all types of displays. Any microcontroller can be connected to this 2.44 cm (0.96 inch) I2C/IIC 4-pin OLED Display Module

BLUE via the SPI, IIC, or I2C protocols. It has a 128x64 resolution. A display board, a screen, and a 4 pin male header are all included in the kit. OLED 128x64 dot matrix display module in monochromatic High brightness, self-emission, high contrast ratio, slim/thin outline, and wide viewing angles are the features of this display module.

| Comparison Example Character COB 16X2 | OLED | STN LCD | VFD |
|---|---|---|---|
| Technical | | | |
| Weight | 22g | 34g | 35g~130g |
| Thickness | 6.90mm (with component) | 12.0mm (with component) | 14.40mm (with component) |
| View Angle | 175(H) 175(V) | 60(H) 60(V) | 160(H) 160(V) |
| Contrast | > 10000 : 1 | 10 : 1 | 1000 : 1 |
| Resolution (Dot Gap) | 0.02 x 0.02 mm | 0.05 x 0.05 mm | 0.02~0.05 x 0.02~0.05 mm |
| Power Consumption | 200mW | 500mW | 680mW |
| Response Time | at+25°C ~ 10μ Sec<br>at-25°C ~ 10μ Sec | at+25°C ~ 0.3 Sec<br>at-25°C ~ 10 Sec | at+25°C ~ 10μ Sec<br>at-25°C ~ 10μ Sec |
| Operation Temp. | -40°C ~ +80°C | -20°C ~ +70°C | -40°C ~ +80°C |
| Driving Voltage | 3V ~ 5V | 3V or 5V | 35V |
| Lifetime | 50K ~ 100K hours | 30K ~ 50K hours | 30K hours |
| Character Font | 4 types in one IC | 1 type in one IC | Only 1 or 2 types in one IC |

**Fig-20**

3) **Microwave Sensor:**
    a) Working Voltage: 5V +/- 0.25V
    b) Working Current(CW): 60mA max., 37mA typical
    c) Size: 48.5x63mm
    d) Emission:

    Detection Distance: 2-16M continuously adjustable

    Emission Frequency: 10.525 GHz

    Precision Frequency Setting: 3MHz

    Output Power (Minimum): 13dBm EIRP

    Harmonic Emission: < -10dBm

Average Current (5�): 2mA typ.

Pulse Width (Min.): 5uSec

Load Cycle (Min.): 1%

e) Reception:

Sensitivity (10dB S/N ratio) 3Hz to 80Hz bandwidth: -86dBm

3Hz to 80Hz Bandwidth Clutter: 10uV

Antenna Gain: 8dBi

Vertical 3dB Beam Width: 36 degrees

Level 3dB Beam Width: 72 degrees

| | **Microwave Sensor** | **IR Sensor** |
|---|---|---|
| **Trigger Mode** | Movement | Infrared Reflection |
| **Temperature Influence** | No Influence | Over 40 degrees C can inhibit function |
| **Object Penetration** | Able to penetrate any non-metallic Object | Unable to penetrate |
| **Ambient Environmental Requirements** | No requirements | Dusty or brightly lit Environments can inhibit function |
| **Working life** | More than 100,000 hours | About 1000 hours |
| **Stability** | Very reliable and stable | Induction distance will shorten over time |

**Fig-21**

4) **Power Supply:**

For this proposed model, power supply can be given through a laptop, power bank or an adaptor.

5) **Other Components:**

Keyboard and mouse are used to control the interface.

V3 cable is used as connector between the input and arudino nano through which source code is transferred.

**Fig-22**

# CHAPTER 3
# COST ANALYSIS

## 3.1 List of components and their cost

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

| COMPONENT | COST |
|---|---|
| Arudino Nano 3.0 | ₹ 500 |
| Gravity Digital Microwave Sensor V2.0 | ₹ 1200 |
| Display OLED 128 x 64 I2C | ₹ 120 |
| V3 cable | ₹ 100 |
| Bread board + Jumper Wires | ₹ 150 |
| 7805 Voltage Regulator IC | ₹ 65 |
| Miscellaneous | ₹ 500 |
| TOTAL | ₹ 2635 |

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Dicussion:

The 12 V DC adapter is used to provide input power after the circuit is connected. The prototype's top is where the microwave sensor is located. The detection procedure begins when the circuit is linked. The microwave sensor's antenna surface side must face the wall.

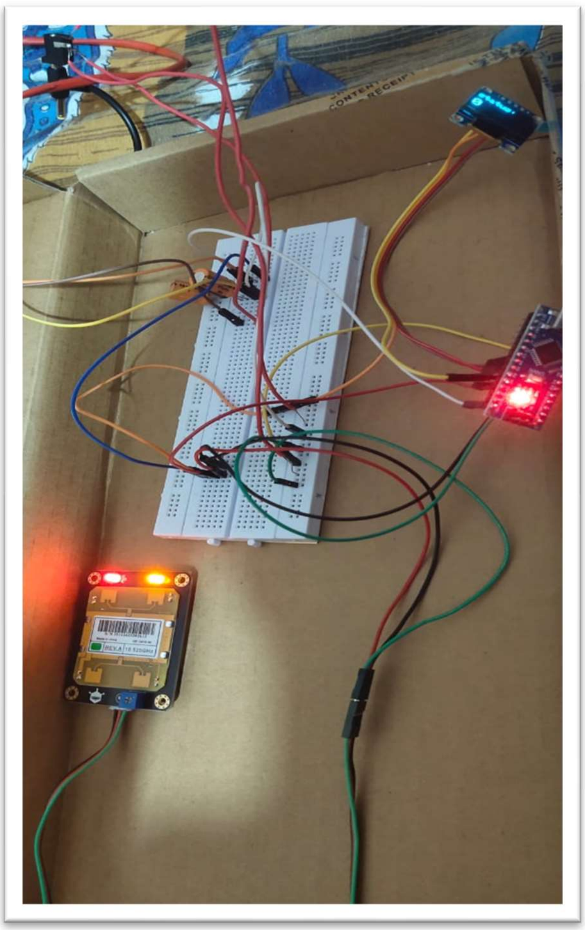


**Fig-23**

An OLED module will be used to display the results. It will be possible to detect the motion behind the wall and see the randomness of it as a number. "Status" is the phrase used to describe the degree of motion that has been detected. There has been no motion detected if Status is 0. As a result, nobody is hiding behind the wall. The status score will be lower if just very slight movement is found.

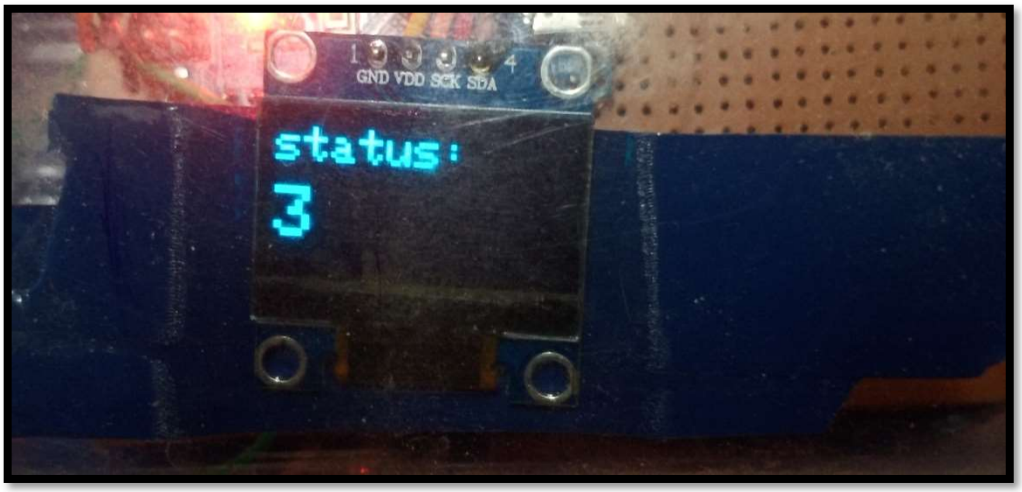



**Fig-24**

The status will be upgraded when the number of interruptions grows within the microwave sensor's detection range if the person or object behind the wall is moving more erratically. We can therefore assume that there is unquestionably a person or moving item there behind the wall if the status is significantly higher.

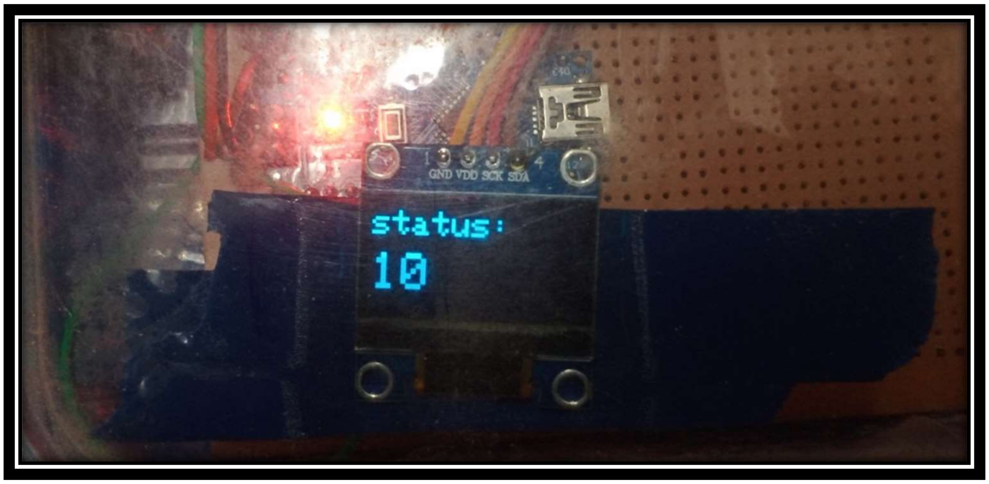



**Fig-25**

Then, we can determine whether or not someone is lurking behind the wall. As a result, the output can be used in circumstances when it is impossible for a person to go and look for other people.

## 4.2 Results:

To evaluate the machine's performance, we used two test cases. First, we have taken a thin wall that was 4 inches thick and extended it to 16 inches thick. Then I looked at what the OLED was producing. To provide Arudino with interruptions and gather the output, a person is randomly travelling to the opposite side of the wall.

**Test Case- 1:**

A person is standing behind a wall of 4-inch thickness, and at the start he stood still, so there is no motion detected by the microwave sensor present on the other side of the wall. Hence, we can see there is no update in the status value.

**Fig-26**

If there is motion detected, then the status will be incremented and can be concluded as "moving person."

**Fig-27**

**Test Case- 2:**

A person is standing behind a wall of 16-inch thickness, and at the start he stood still, so there is no motion detected by the microwave sensor present on the other side of the wall. Hence, we can see there is no update in the status value.

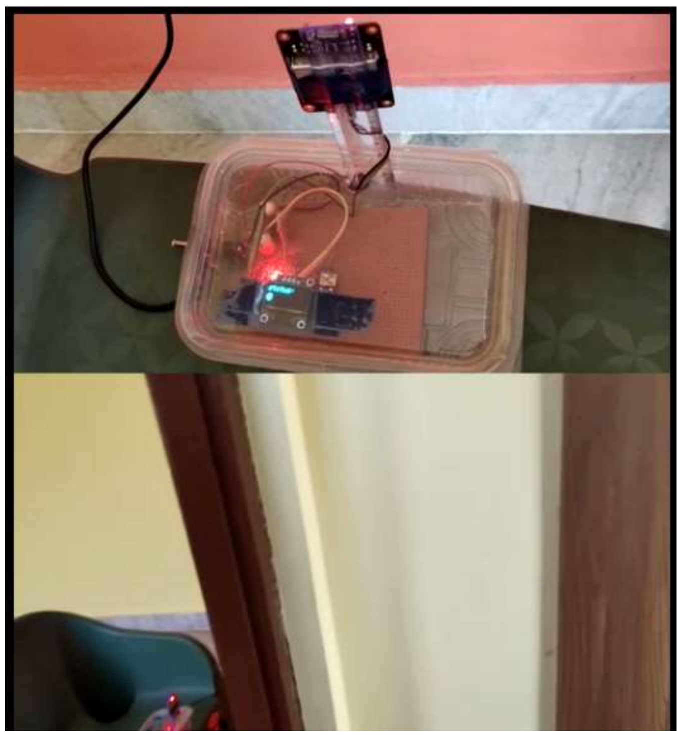


**Fig-28**

**Fig-29**

If there is motion detected, then the status will be incremented and can be concluded as "moving person."

**Fig-30**

If the person goes out of range, then the status also will decrease.

**Fig-31**

# CHAPTER 5

# CONCLUSION AND FUTURE WORK

In many areas, from ordinary living to urgent emergencies, human detection is essential. The use of sensor technology simplifies and improves everything. The approach outlined above is useful for discovering refugees in the event of a crisis as well as for detecting intruders in the home or neighborhood. A microwave sensor, for instance, could reduce the rate of false-fault reports in human motion detection. Additionally, it performs a superb job ensuring safety and security.

If the planned project includes an intruder alert system, the nearby police and emergency hotline service will be notified of the intrusion, and if the victim requires medication, this can also be accommodated. Military surveillance and rescue operations during terrorist attacks are the project's most underappreciated usage. Additionally, by extending the project's potential range, persons trapped in debris and damaged concrete buildings can be rescued, which may increase the cost but save a life. Microwaves are appropriate for use in challenging conditions since their measurements are unaffected by temperature, humidity, noise, air, dust, or light.

There are so many extra properties that can be retrieved. The information gathered by the microwaves can also be tracked and analysed to comprehend a comparable circumstance should it recur in the future. The addition of AI can be seen as a significant boost to expanding the use cases, which will enable the creation of numerous applications within the next few years.

# CHAPTER 6

# APPENDIX

## Arudino Code

### Microwave Sensor Arduino Programming:

```
#include <SPI.h>

#include <MsTimer2.h>           //Timer interrupt function library

#include <Adafruit_GFX.h>

#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128 // OLED display width, in pixels

#define SCREEN_HEIGHT 64 // OLED display height, in pixels


// Declaration for an SSD1306 display connected to I2C (SDA, SCL pins)

#define OLED_RESET     -1 // Reset pin # (or -1 if sharing Arduino
reset pin)

#define SCREEN_ADDRESS 0x3D

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);




int pbIn = 0;                    // Define interrupt 0 that is digital
pin 2

int ledOut = 13;                 // Define the indicator LED pin
digital pin 13

int number=0;                    //Interrupt times

volatile int state = LOW;         // Defines the indicator LED state,
the default is not bright


void setup()

{
```

```
     Serial.begin(9600);

     pinMode(ledOut, OUTPUT);//

     attachInterrupt(pbIn, stateChange, FALLING); // Set the interrupt
function, interrupt pin is digital pin D2,

                                                    //interrupt service
function is stateChange (),

                                                    //when the D2 power
change from high to low , the trigger interrupt.

     MsTimer2::set(3000, Handle); // Set the timer interrupt function,
running once Handle() function per 1000ms

     MsTimer2::start();//Start timer interrupt function


    display.begin(SSD1306_SWITCHCAPVCC, 0x3C);

    display.clearDisplay();

    display.display();

}


void loop()

{

 display.setTextSize(2);

  display.setTextColor(WHITE);

  display.setCursor(0,5);

 display.println("status: ");


  display.setTextSize(3);

  display.setTextColor(WHITE);

  display.setCursor(0,30);

 display.println(number);


  display.display();

  display.clearDisplay();
```

```
  delay(10);

 }



void stateChange()  //Interrupt service function
{
  number++;  //Interrupted once, the number + 1

}

void Handle()   //Timer service function
{
number = 0;
}
```

**Automatic Light Control, Arduino Programming:**

```
#include <MsTimer2.h>           //Timer interrupt function library
int pbIn = 0;                    // Define interrupt 0 that is digital pin 2
int ledOut = 13;                 // Define the indicator LED pin digital pin 13
int number=0;                    //Interrupt times
volatile int state = LOW;         // Defines the indicator LED state, the default is not bright

void setup()
```

```
{
     Serial.begin(9600);
     pinMode(ledOut, OUTPUT);//
     attachInterrupt(pbIn, stateChange, FALLING); // Set the
interrupt function, interrupt pin is digital pin D2,
                                                    //interrupt
service function is stateChange (), when the D2 power
                                                    //change
from high to low , the trigger interrupt.
     MsTimer2::set(1000, Handle); // Set the timer interrupt
function, running once Handle() function per 1000ms
     MsTimer2::start();//Start timer interrupt function


}


void loop()
{
Serial.println(number); // Printing the number of times of
interruption, which is convenient for debugging.
    delay(1);
    if(state == HIGH)  //When a moving object is detected, the
ledout is automatically closed after the light 2S,
                          //the next trigger can be carried out,
and No need to reset. Convenient debugging.
    {
        delay(2000);
        state = LOW;
        digitalWrite(ledOut, state);    //turn off led
    }
```

```
 }
void stateChange()  //Interrupt service function
{
  number++;  //Interrupted once, the number + 1


}


void Handle()   //Timer service function
{
    if(number>2)  //If in the set of the interrupt time the
number more than 2 times, then means have detect moving objects,
                   //This value can be adjusted according to the
actual situation, which is equivalent to adjust the threshold
                   //of detection speed of moving objects.
         {
                   state = HIGH;
                   digitalWrite(ledOut, state);    //light led
                   number=0;   //Cleare the number, so that it
does not affect the next trigger
         }
        else
              number=0;   //If in the setting of the interrupt
time, the number of the interrupt is not
                              //reached the threshold value,
                              //it is not detected the moving
objects, Clear the number.
}
```

**OLED module testing programming:**

```
#include <Wire.h>

#include <Adafruit_GFX.h>

#include <Adafruit_SH1106.h>


// Declaration for an SSD1306 display connected to I2C (SDA, SCL
pins)

#define OLED_RESET -1

Adafruit_SH1106 display(OLED_RESET);

void setup() {

  // put your setup code here, to run once:

  Serial.begin(9600);

  display.begin(SH1106_SWITCHCAPVCC, 0x3C);

  display.clearDisplay();


}


void loop() {

 display.clearDisplay();

display.setTextSize(1);

display.setTextColor(WHITE);

display.setCursor(1,20);

display.print("Hello World!");

display.display();

}
```

# CHAPTER 7

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