HOME AUTOMATION USING IOT

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ABSTRACT

The home monitoring and control system leverages the Internet of Things (IoT) to enhance security and convenience. IoT enables the interconnection of devices embedded with sensors, electronics, and software to collect and exchange data. This system monitors doors and windows, notifying users of unauthorized access and capturing intruder images, which are sent to the user via the internet. Using an embedded micro-web server, the system provides a cost-effective and flexible solution for remotely accessing and controlling home devices and appliances. Unlike similar systems, it eliminates the need for a dedicated server PC and offers advanced functionalities beyond basic switching.

The primary goal is to reduce human effort by providing automated control of electrical appliances through handheld mobile devices. This IoT-enabled system allows users to control appliances from anywhere in the world, offering robust security and seamless connectivity without distance limitations.

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INTRODUCTION

The home monitoring and control system is designed using the Internet of Things (IoT), which connects physical devices like sensors, actuators, and appliances to exchange data through the internet. This system enhances home security by monitoring doors and windows, notifying users of unauthorized access, and capturing and sending images of intruders online. The use of IoT facilitates advanced interconnectivity, enabling users to control and monitor devices remotely.

This system employs an embedded micro-web server with IP connectivity for cost-effective and flexible home automation. Unlike traditional systems, it eliminates the need for a dedicated server PC and provides novel communication protocols for functionalities beyond simple switching. Home automation involves managing electrical devices in homes or offices, providing convenience and security.

Although various home automation systems exist, interoperability and integration remain challenges. A user-friendly interface is crucial to simplify setup and control for end-users. Smart home systems leverage the internet for remote management, making tasks like monitoring and controlling devices seamless.

The proposed system is highly versatile and applicable in places like banks, hospitals, and labs, where security is critical. It aims to save time, reduce manpower, and improve convenience while addressing modern security and automation demands efficiently.

EXISTING SYSTEM

The existing system for home automation involves controlling home appliances using an Android smartphone. Users log into a smartphone interface and send command messages by tapping buttons. These commands are transmitted to the home information center via the GSM network. A PIC processor recognizes the commands and controls appliance switches using wireless radio frequency to enable remote control.

However, this system does not utilize the Internet of Things (IoT) for appliance control, limiting its adaptability to modern technological advancements. Since IoT allows seamless control from anywhere in the world, the proposed system in this project adopts IoT technology for more advanced and versatile home automation.

DISADVANTAGES OF THE EXISTING SYSTEM:

1. **Lack of Remote Control Functionality**
   The existing system does not support remote operation, limiting users to control appliances only within a specific range. This reduces flexibility and convenience for users who are away from home.
2. **Dependence on Others for Operation**
   Users may require assistance from others to operate the system due to its lack of advanced automation or user-friendly interfaces. This can lead to inefficiency and delays.
3. **Absence of Muscle Contraction Sensing**
   The system does not incorporate sensors to detect physical movements or gestures, restricting its usability in specialized scenarios like assistive technologies.
4. **Requires Direct PC Interaction**
   The system relies on direct interaction with a PC for operation,

making it less portable and inconvenient compared to modern mobile-based solutions.

5. **High Cost and Complexity of Similar Technologies**
   Existing solutions are often expensive and complicated to set up and maintain, making them inaccessible for a broader audience.
6. **Limited Functionality with Voice Recognition and Microcontroller Intelligence**
   The system offers minimal integration of voice recognition and microcontroller-based smart functionalities, limiting automation and user interaction options.

PROPOSED SYSTEM

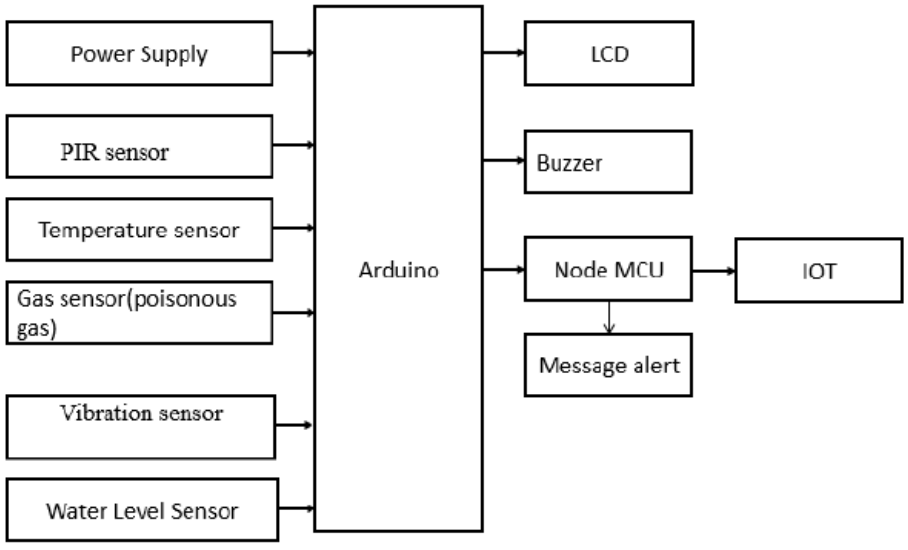
The proposed system is designed for security and home monitoring using an Arduino module and various sensors. It employs IoT technology with a NodeMCU module connected to the internet, integrating PIR, Vibration, Gas, and LDR sensors for efficient monitoring. The system allows users to control electrical devices like bulbs, fans, and motors remotely through the Internet of Things (IoT). Additionally, it captures and sends intruder images to users, providing advanced connectivity and security.

ADVANTAGES OF THE PROPOSED SYSTEM:

1. **Long-Distance Coverage**
   The system enables users to monitor and control home appliances from anywhere in the world using IoT. It ensures seamless operation without location restrictions.
2. **Real-Time Controlling and Monitoring**
   Users can instantly control and monitor home devices and sensors, ensuring quick responses to potential threats or needs.

3. **Control Through Mobile, PC, and Phablets**
   The system offers flexibility by supporting multiple devices, including smartphones, PCs, and phablets, for enhanced accessibility.
4. **Low Cost and Expandable**
   Designed to be cost-effective, it allows users to add and control various devices as needed, ensuring future scalability.
5. **Saves Money and Energy**
   By automating tasks and optimizing energy usage, the system helps reduce electricity bills and operational costs.
6. **All-in-One User-Friendly System**
   The integrated interface is simple and intuitive, allowing users to monitor and control devices effortlessly.
7. **Noise-Free System**
   The system operates silently, ensuring no disturbances in the household environment.
8. **Highly Secured**
   With advanced sensors and IoT connectivity, it provides robust security, safeguarding the home from unauthorized access or threats.

BLOCK DIAGRAM OF PROPOSED SYSTEM



HARDWARE USED:

- Node MCU
- Temperature sensor
- PIR sensor
- Gas sensor
- Vibration sensor
- Arduino Nano
- Water Level Sensor

SOFTWARE USED:

- Arduino IDE
- Proteus simulator
- Embedded C Programming

ARDUINO NANO AND ITS PROGRAMMING

Arduino is a tool that helps create small, programmable computers to interact with the physical world. It's an open-source platform made up of a simple hardware board and software to write programs for it.

Arduino can connect to sensors or switches to receive inputs and control outputs like lights, motors, and other devices. Projects can work independently or communicate with software on your computer. The hardware can be built manually or bought preassembled, and the software used to program it is free to download. Arduino's programming language is based on Wiring, which is a simplified version of the Processing language.

Overview

The Arduino Nano is a small, easy-to-use microcontroller that is popular among beginners and professionals. It’s affordable because it’s open-source, and the software for programming it is free.

This guide introduces the Arduino Nano board, which costs around $30 and is perfect for students and educators. It allows you to write programs to read inputs (like sensors or buttons) and control outputs (like motors or LEDs). The Nano has a USB port to connect to your computer for programming, and it can also run programs independently when powered by a battery.

The Nano is powered by an ATmega328 microcontroller. It has:

- 14 digital pins (6 can be used for PWM, which helps control motors and LEDs).
- 6 analog input pins to read sensor data.
- 32 KB memory for storing programs.
- 16 MHz clock speed, making it fast enough to execute about 300,000 lines of code per second.

Programming the Arduino is simple, even if you don’t know C/C++. Once programmed, it can run without being connected to a computer. For example, you can write and test your program on a PC, load it onto the Arduino Nano, and then power it with a battery or adapter. The program will automatically start every time the board is powered up.

The Nano also includes a built-in USB-to-serial converter, making it easier to connect to computers and upload programs. It's compact and designed for easy use in various projects, especially for beginners.

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

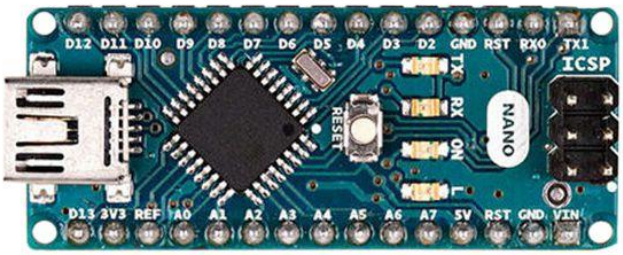


Fig: Arduino nano

NODE MCU

NodeMCU is an open-source development board and firmware designed for IoT (Internet of Things) applications. It is built around the ESP8266 Wi-Fi chip, which allows it to connect to the internet and control IoT devices. Programming the NodeMCU is simple and can be done using the Arduino IDE, a beginner-friendly tool that makes it accessible for developers.

The NodeMCU board includes built-in Wi-Fi, making it perfect for IoT projects. It is based on the ESP-12 module, a small but powerful chip with a built-in antenna and Wi-Fi support. This board uses the Lua scripting language for its firmware, but you can also program it using Arduino's C/C++ programming, making it convenient for those already familiar with Arduino.

Features of NodeMCU Development Board:

- **Wi-Fi Capability**: Easily connects to the internet.
- **Analog and Digital Pins**: Allows connection to sensors and devices.
- **Serial Communication Protocols**: Enables data communication between devices.

Why Use NodeMCU?

- It's affordable and widely used in IoT projects.
- The hardware design is open-source, so anyone can modify or build on it.
- It's compatible with the Arduino IDE, so you can use the same tools and skills you would with an Arduino board.

How to Start with NodeMCU:

1. **Prepare the Arduino IDE**: Install and configure the IDE to support NodeMCU.

2. **Set Up Firmware**: Download and install NodeMCU firmware. You can customize the firmware online based on your project needs.
3. **Write Code**: Use the Arduino IDE to write and upload your code to the NodeMCU.

Coding for NodeMCU with Arduino IDE:

You can use the Arduino IDE to write programs for NodeMCU instead of learning a new language or tool. This is especially helpful for Arduino users, as the process is similar. Once the code is uploaded, NodeMCU can run IoT applications, making it a great choice for beginners and experts alike.

In summary, NodeMCU combines powerful features, simplicity, and affordability, making it an ideal platform for creating IoT projects with Ease.

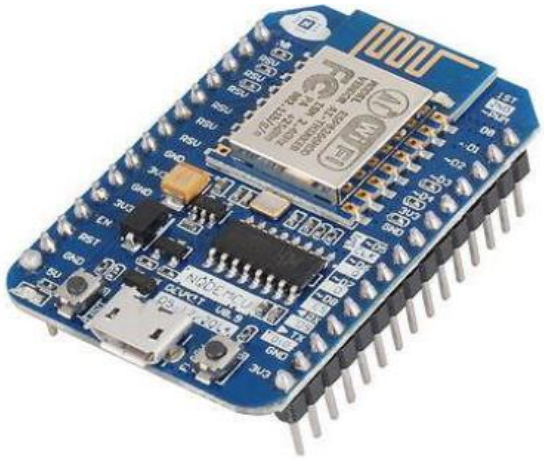


Fig:4.7: Wifi module

Communication

Microcontrollers, like Arduino, rely on a host computer to develop and compile programs. The software used on the computer for this is called an Integrated Development Environment (IDE). For Arduino, the IDE is built on the open-source Processing platform (www.processing.org), which is designed for programming images, animations, and interactions.

The Arduino programming language is based on an open-source project called Wiring (wiring.org.co), which is a simplified version of C.

The Arduino Nano has several ways to communicate with a computer, other Arduino boards, or different microcontrollers. These communication methods are important for connecting the Arduino to sensors, other devices, or even the internet, allowing you to control and gather data for your project.

Motion Sensor (PIR Sensor)

A **PIR sensor** (Passive Infrared Sensor) is a device that detects movement by sensing heat emitted by living bodies, like humans or animals. These sensors are commonly used in security lights, so the lights turn on automatically when someone approaches.

The sensor is called **passive** because it doesn't emit any energy (like a laser or microwave). Instead, it only detects the infrared radiation (heat) emitted by living beings. When an intruder walks into the sensor's field of view, it detects a sudden increase in infrared energy.

PIR sensors are designed to react to moving people, not people who are standing still. This is because moving people cause a quick change in infrared energy, whereas stationary people produce a slower change, which is not detected by the sensor. The sensor avoids reacting to slow changes like temperature shifts from the environment, such as the cooling of a sidewalk at night.

Sensitivity

PIR sensors are more sensitive on **cold days** because the difference in temperature between a human body and the surrounding air is greater, making it easier for the sensor to detect the rise in temperature. However, if the sensor is too sensitive, it might detect small animals or other unwanted movements.

How PIR Works

- **Detection of Motion:** The PIR sensor detects motion when a warm object (like a human) passes in front of a cooler object (like a wall). All objects emit infrared radiation, but humans emit more heat, which the sensor can pick up.
- **Passive Functionality:** The term "passive" means the sensor doesn't send out any energy. It only "accepts" infrared radiation that enters through the front of the sensor.

Inside the PIR sensor, there are small pieces of material that are sensitive to infrared radiation. These are typically made from pyroelectric materials, which change their electrical properties when exposed to heat. These sensors are often arranged in pairs or groups to detect changes in infrared energy.

Working of PIR Sensors

When the PIR sensor detects a change in infrared energy (like when a person moves), it sends a signal. The sensor is designed to filter out small changes, like flashes of light or other environmental factors, to avoid false alarms.

PIR sensors are widely used because they are small, cheap, low-power, and don't wear out. They are commonly found in home appliances or security devices like motion-detecting lights.

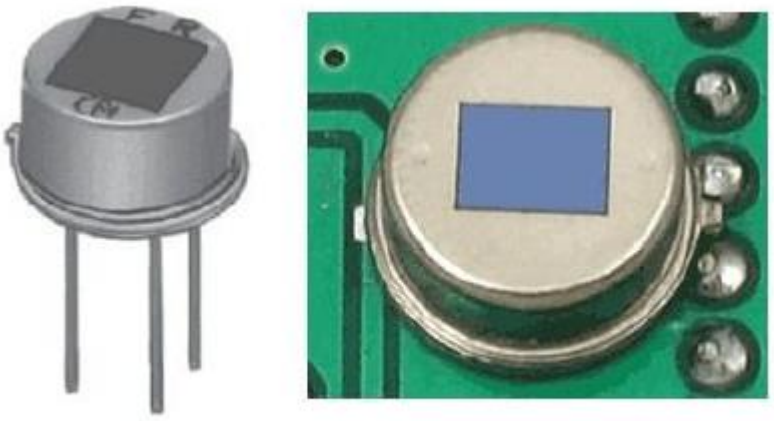


Fig.4.10 IR sensor in the PIR

Lenses in PIR Sensors

PIR sensors are fairly standard in design, differing mainly in price and sensitivity. However, the key to making them effective lies in the **lens**. The sensor itself is relatively inexpensive, but the lens, which is crucial for shaping the sensor's detection area, is much cheaper and can greatly change the sensor's effectiveness.

In a basic setup, the sensor's detection area is just two rectangles. To make the detection area larger or more focused, we use lenses, similar to camera lenses. These lenses help focus a wide area (like a large landscape) onto the sensor, enabling it to detect movement more accurately over a larger range. The lenses are often made from cheap plastic and are small and thin to keep costs down, although they can cause some distortion.

Connecting and Using PIR Sensors

Most PIR modules come with a **3-pin connection**, typically located on the side or bottom of the sensor. However, the pinout (how the pins are arranged) can vary, so it's important to check the specific model you're using. The three pins are:

- **Ground** (usually connected to the negative side of the power supply)
- **Signal** (the output pin that sends a signal when motion is detected)
- **Power** (usually requires 3-5V DC, but some models can go up to 12V)

Some larger PIR modules don't output directly but control a relay instead. In these cases, the sensor may require **a pullup resistor** on the signal pin for proper functioning. If you don't get a variable output, try connecting a 10K pullup resistor between the signal and power pins.

A simple way to test and prototype with a PIR sensor is to connect it to a **breadboard** (a platform for building circuits), as many PIR sensors have a standard 0.1-inch pin spacing, making them easy to attach. Some PIR modules come pre-equipped with headers for connecting wires.

Working with the PIR Sensor

1. **Wiring**: The typical wiring for a PIR sensor is:
    - **Red cable**: Power (usually +3.3V or +5V)
    - **Black cable**: Ground
    - **Yellow cable**: Signal output (indicates motion detection)
2. **Testing the PIR**: After connecting the PIR to a breadboard and powering it up, wait 30-60 seconds for the sensor to stabilize. The sensor might blink during this time, but once it stabilizes, you can test it by moving in front of it. The sensor will detect movement and activate the output, like lighting up an LED.
3. **Retriggering**: Some PIR sensors have a **retriggering option**. If the sensor detects movement, it can be set to either continue detecting or reset after a certain period. You can adjust this setting by moving a jumper on the back of the sensor to the "L" position.

How PIR Sensors Work

PIR sensors detect motion by focusing infrared (IR) energy onto the sensor surface. They use lenses or mirrors to direct this infrared energy onto the sensor. Common lenses used in PIR sensors are **Fresnel lenses** or **plastic segmented parabolic mirrors**. These lenses help focus infrared radiation from objects (like a person's body) onto the sensor, which can then detect changes in temperature.

- **Fresnel lenses**: These lenses are molded into the sensor's window and help focus the infrared energy onto the sensor's surface. The PIR sensor is sensitive to a range of infrared wavelengths, with a peak sensitivity around **9.4 micrometers**, which is the wavelength most strongly emitted by humans.
- **How Motion is Detected**: The PIR sensor works like an infrared "camera." It remembers the infrared energy focused on it. When a person enters the detection area, their body heat

(infrared energy) is detected, and the sensor reacts. As the person moves, the heat spot on the sensor changes, triggering the sensor to send a signal to activate the alarm or another device.

Common Usage and Placement Tips

- **Placement**: PIR sensors should be carefully placed to avoid false alarms. For example, avoid placing the sensor where it can see outside through a window, as reflections or headlights could trigger false detections. Also, avoid placing the sensor in areas where hot or cold air could affect it, such as near air conditioning vents.
- **Range**: Most PIR sensors in home security systems have a range of about **30 feet**, while larger sensors can detect motion up to **100 feet** away. Some PIR sensors have adjustable mirrors that allow you to choose between wide (110°) or narrow (curtain-like) coverage.
- **Direction Detection**: Some advanced PIR sensors have multiple internal sensing elements, allowing them to detect the direction of movement (e.g., left to right or up to down), providing more precise detection.

Gas Sensor

Overview: Gas sensors are crucial in various applications like home appliances, air conditioners, chimneys, and safety systems in industries for monitoring gases. These sensors detect the presence of specific gases by reacting to them, providing real-time data about the concentration of gas molecules in the air. They operate by ionizing the gas and then adsorbing the gas components, generating a potential difference that can be measured as a current.

Construction: The gas sensor module consists of a steel exoskeleton housing a sensing element. The sensing element is typically made from ceramic materials like Aluminium Oxide, coated with tin oxide. The sensor has thick connecting leads made of copper (with tin plating) for durability and efficient heat conduction. Four out of six leads are used for signal fetching, and the remaining two provide heating current to the sensing element.

Working Principle:

- The sensing element is heated through Nickel-Chromium wires, causing the nearby gases to ionize.
- The ionized gases are absorbed by the tin oxide coating, changing its resistance.
- This change in resistance alters the current flowing through the element, and the signal is conveyed through output leads to the control unit.
- The gas sensor is designed to ionize gases at specific temperatures, ensuring accurate detection.

Temperature Sensor (LM35)

Features:

- Directly calibrated in °C.
- Linear scale factor of 10 mV/°C.
- Accuracy of ±0.5°C at +25°C.
- Wide temperature range: −55°C to +150°C.
- Low current drain (< 60 µA).
- Low self-heating (0.08°C in still air).
- Suitable for remote applications.

Working Principle: The LM35 is a precision temperature sensor that provides an output voltage linearly proportional to the Centigrade temperature. It has excellent accuracy, does not require external calibration, and offers a typical error of ±¼°C at room temperature. Its low self-heating makes it suitable for precise temperature measurements in various applications.

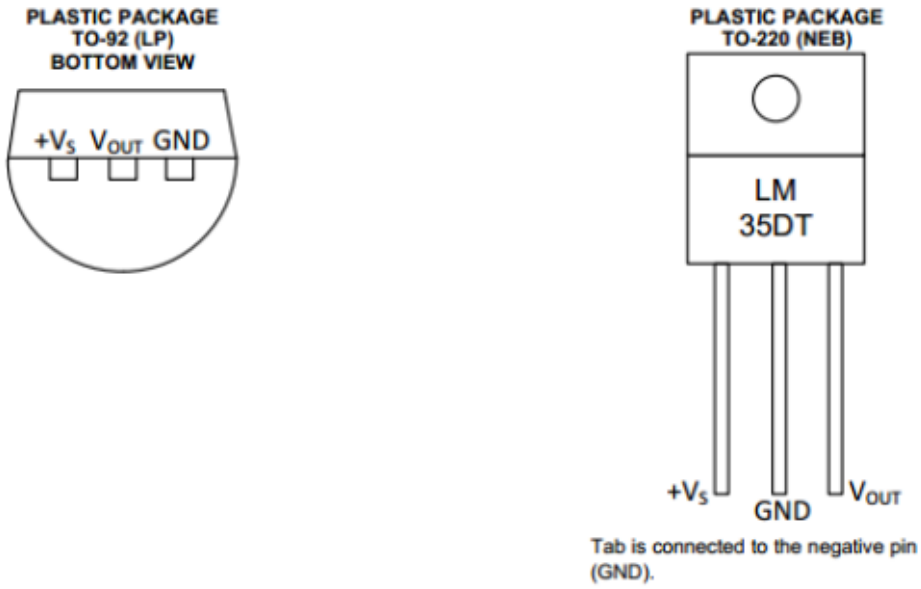


Fig.4.14: LM35 PIN DESCRIPTION

Vibration Sensors

Working Principle: Vibration sensors typically operate based on the **piezoelectric effect**, discovered by Pierre and Jacques Curie. When mechanical stress is applied to piezoelectric materials like quartz, they generate an electrical charge proportional to the pressure. These sensors are used for measuring vibrations, shocks, and forces in different mechanical systems, especially those that are sensitive to vibrations like electronic devices and machinery.

Applications:

- Detecting mechanical vibrations or shocks.
- Preventing damage to electronics due to excessive vibrations.
- Monitoring conditions in rugged environments where vibration is common.

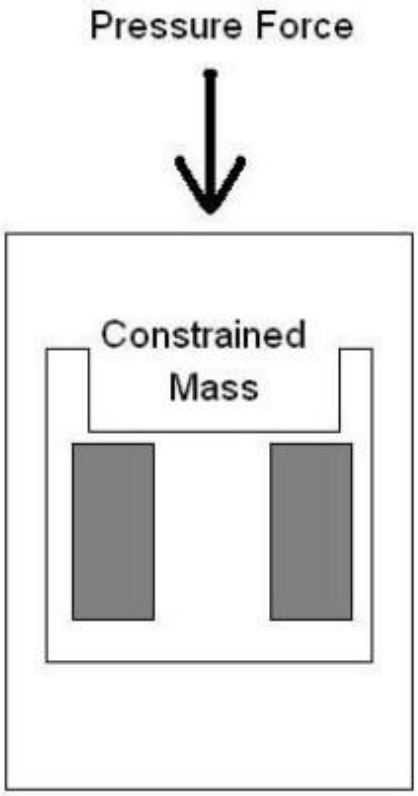


Fig:4.15.A constrained mass is allowed to deform the crystal sensor in one axis. This configuration is good for force and pressure.

Water Level Sensor

Overview: The water level sensor is a solid-state, continuous fluid level sensor designed for measuring the levels of water or other non-corrosive water-based liquids. It is often used in applications like tanks and containers where the fluid level needs to be monitored.

Working Principle:

- The sensor works by measuring the resistance change due to hydrostatic pressure.
- The sensor's resistance is inversely proportional to the liquid level: higher fluid levels decrease resistance, and lower fluid levels increase resistance.
- It provides a resistive output where the resistance varies according to the fluid's height.

Installation:

- The sensor must remain straight during installation for accurate measurements.
- It can be suspended in the liquid or installed inside a section of PVC pipe for stability.
- The sensor is temperature-compensated using a reference resistor.

These sensors provide critical data that can be used in various systems, ranging from environmental monitoring to industrial automation and safety systems.

This section of your document provides an in-depth look at the software requirements for a system involving the Internet of Things (IoT), highlighting its applications, technologies, and use cases. Here's a summary of the key points:

Software Requirements Overview

1. **Internet of Things (IoT)**
    - IoT connects physical devices and objects embedded with sensors, actuators, and network connectivity, allowing them to exchange data.
    - Key components include smart homes, smart grids, and smart cities, with an estimated 30 billion IoT devices by 2020.
    - The IoT is integral to improving efficiency, accuracy, and economic benefits by reducing human intervention.
2. **Applications**
    - IoT applications are wide-ranging, from environmental sensing (e.g., air and water quality monitoring) to smart city initiatives like intelligent transportation systems.
    - In business, IoT enables advanced marketing techniques, environmental monitoring, and infrastructure management.
    - Examples include smart home devices, automated billing, and location-based services.
3. **Media**
    - IoT is transforming the media industry by allowing targeted advertising based on consumer data, enabling personalized content delivery at optimal times and locations.

- The Internet of Things facilitates the collection of vast data sets, improving the way media and advertising target audiences.

4. **Environmental Monitoring**
    - IoT devices help monitor environmental factors, such as air and water quality, wildlife movements, and natural disasters like earthquakes.
    - IoT's wireless sensing technologies are key to revolutionizing environmental protection efforts.
5. **Infrastructure Management**
    - IoT helps monitor urban infrastructure like bridges and railways, improving safety, maintenance, and incident management.
    - Automated systems in infrastructure management help optimize operations and reduce costs.

Enabling Technologies for IoT

The technologies supporting IoT can be divided into:

- **Short-range wireless technologies**: Bluetooth Low Energy (BLE), Near-field communication (NFC), Radio-frequency identification (RFID), and Wi-Fi Direct, among others.
- **Medium-range wireless technologies**: HaLow, LTE-Advanced.
- **Long-range wireless technologies**: Low-power wide-area networking (LPWAN), Very small aperture terminal (VSAT).
- **Wired technologies**: Ethernet, Power-line communication (PLC), Multimedia over Coax Alliance (MoCA).

Results

- The system successfully controlled the sensors, with live updates on a dashboard displaying sensor activity.
- Features included monitoring the number of users, access privileges, voltage consumption, billing information, and live graphical data representation.
- The Tasker feature worked as intended, automating tasks based on specific dates and times.

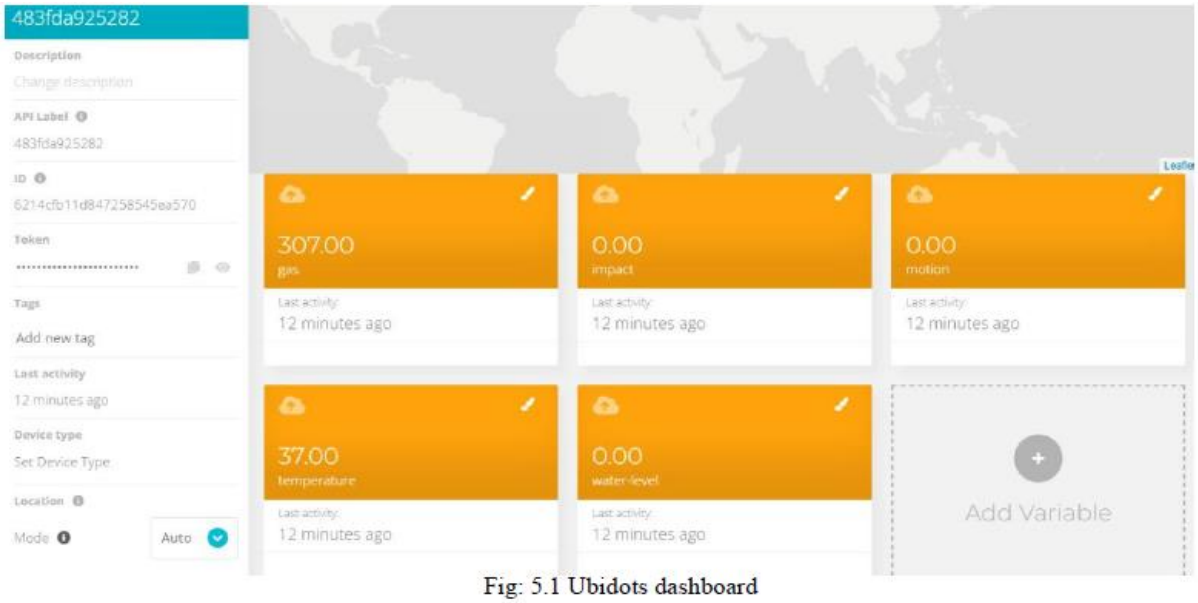


Fig: 5.1 Ubidots dashboard

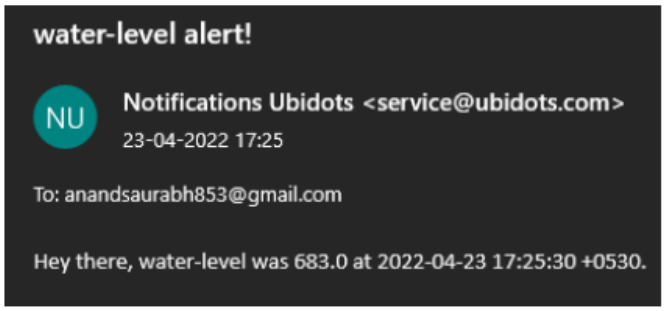


Fig: 5.2: Water level alert notification

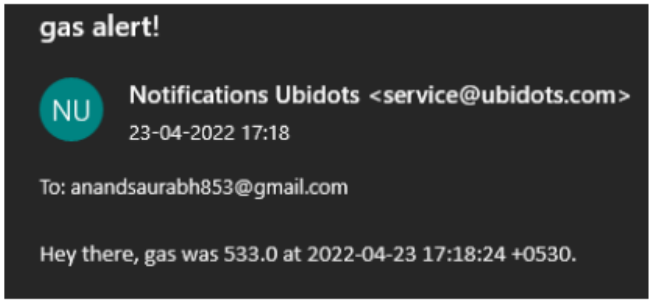
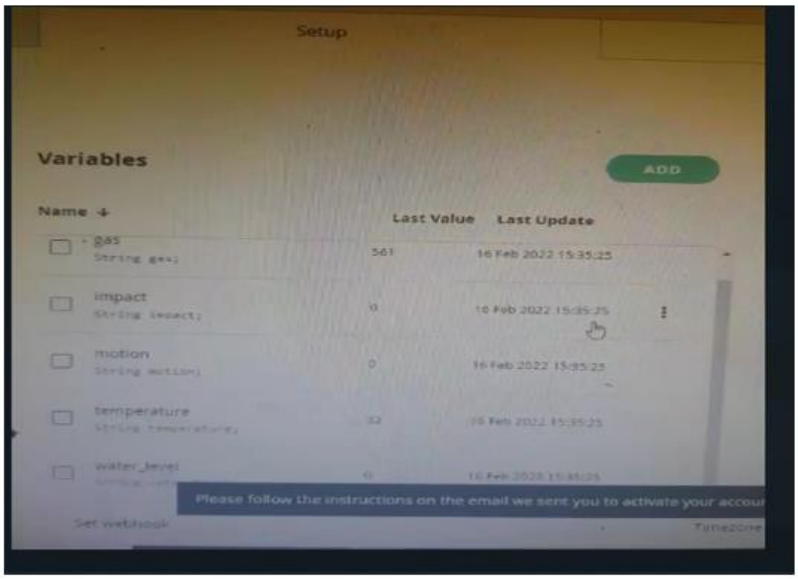


Fig: 5.4: Gas alert notification

Notification can be customized as jobs in the ubidots dashboard we can read the values of the sensor and assign a job such as message alert through sms or email. Email or sms is limited to 20 times use as these are small scale sensors and its for limited use.

Fig:5.4: Data as read by sensor



Chapter 6: Conclusion

In conclusion, the system developed demonstrates significant potential in automating and enhancing home security and management through IoT integration. The system's reliance on user discretion is an important aspect, particularly when determining whether an individual is a guest or an intruder. By incorporating a camera connected to the microcontroller, the system enables face detection, allowing users to make informed decisions about whether to activate the security system or welcome the guest.

Key Features and Future Enhancements:

1. **Face Detection and Security Integration:**
    - The addition of face detection allows for the identification of individuals entering the premises.
    - The captured image of the guest or potential intruder is sent to the user, providing them with real-time information about their home's security.
2. **Enhanced Communication and Response:**
    - The system could be further enhanced by integrating a voice call feature within the same smartphone application, allowing users to communicate more effectively without triggering an incoming call to their phone.
    - This would streamline the user experience, providing easy control over home appliances and security systems via voice commands.
3. **Emergency Communication:**
    - The captured image can be forwarded to the police station if the user deems it necessary, providing an additional layer of security in emergency situations.

By adding these features, the system would offer a more synchronized and responsive approach to home automation and security, blending both convenience and safety. The future scope of this system can expand to include even more advanced IoT technologies for improved user control and integration across smart home devices.