A

Mini Project Report

On

SMART WASTE SEGREGATION SYSTEM USING IOT

Submitted to JNTU HYDERABAD

In Partial Fulfilment of the requirements for the Award of Degree of

BACHELOR OF TECHNOLOGY
IN
INFORMATION TECHNOLOGY

Submitted
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CMR ENGINEERING COLLEGE
(UGC AUTONOMOUS)

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(Kandlakoya, Medchal Road, R.R. Dist. Hyderabad-501 401)

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CERTIFICATE

This is to certify that the project entitled **"SMART WASTE SEGREGATION"** is a bonafide work carried out by

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in partial fulfilment of the requirement for the award of the degree of **BACHELOR OF TECHNOLOGY** in **INFORMATION TECHNOLOGY** from CMR Engineering College, affiliated to JNTU, Hyderabad, under our guidance and supervision.

The results presented in this project have been verified and are found to be satisfactory. The results embodied in this project have not been submitted to any other university for the award of any other degree or diploma.

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DECLARATION

This is to certify that the work reported in the present project entitled **“SMART WASTE SEGREGATION SYSTEM USING IOT”** is a record of bonafide work done by us in the Department of Information Technology, CMR Engineering College, JNTU Hyderabad. The reports are based on the project work done entirely by us and not copied from any other source. We submit our project for further development by any interested students who share similar interests to improve the project in the future.

The results embodied in this project report have not been submitted to any other University or Institute for the award of any degree or diploma to the best of our knowledge and belief.

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We will be failing in duty if we do not acknowledge with grateful thanks to the authors of the references and other literatures referred in this Project.

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ABSTRACT

The amount of waste has been increasing due to the increase in human population and urbanization. In cities, the overflowed bin creates an unhygienic environment. Thus degrades the environment, to overcome this situation "Automatic Waste Segregator" is developed to reduce to work for the ragpickers the wastes are segregated by the human beings which leads to health problems to the workers. The proposed system separates the waste into three categories namely wet, dry and metallic waste. This developed system is not only cost efficient also makes the waste management productive one. Each of the wastes are detected by the respective sensors and gets segregated inside the bins which is assigned to them the details of amount of waste disposal is updated in the server regularly.

- **Keywords**— Segregation, Arduino, Metal detector, Moisture sensor.

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1. INTRODUCTION

1.1 Introduction

Improper waste segregation leads to a cascade of environmental and operational problems that significantly impact both ecosystems and urban infrastructure. When waste is not correctly sorted, recyclable materials such as paper, plastics, and metals often end up in landfills, where they do not decompose easily and contribute to the growing problem of landfill overflow. This mismanagement not only reduces recycling rates but also contaminates recyclable materials, making them unsuitable for processing and recycling. Additionally, wet waste mixed with dry waste can cause increased leachate production, which potentially pollutes soil and groundwater. The contamination of organic waste with non-organic materials further exacerbates this issue, creating hazardous conditions in composting facilities and diminishing the quality of compost produced. Moreover, improper segregation complicates waste collection and processing operations, leading to higher costs and inefficiencies in waste management systems. This inefficiency can also result in increased greenhouse gas emissions and adverse health impacts due to improper handling of hazardous or decomposing waste. Overall, the failure to segregate waste correctly undermines recycling efforts, strains waste management infrastructure, and exacerbates environmental pollution.

Effective waste management is a pressing global issue, exacerbated by rising urban populations and increased consumption. Traditional waste segregation methods often fail to efficiently separate various types of waste, such as dry, wet, and metal materials, leading to contamination and inefficient recycling processes. To address these challenges, the Smart Waste Segregation Using IoT project introduces an innovative solution designed to automate and enhance the separation of these waste categories through advanced technology.

This project aims to develop a comprehensive IoT-based waste segregation system capable of accurately sorting dry waste (e.g., paper, plastics), wet waste (e.g., food scraps, organic matter), and metal waste (e.g., cans, aluminum). The system utilizes a combination of sensors, machine learning algorithms, and data analytics to ensure precise waste classification and improve overall recycling efficiency.

The core components of the system include smart bins equipped with various sensors that detect the physical and chemical properties of the waste materials. These sensors analyze parameters such as weight, moisture content, and metal composition to classify the waste into the appropriate categories. For instance, capacitive sensors identify moisture levels to distinguish wet waste from dry waste, while metal detectors and optical sensors sort metal materials.

Data from the sensors is transmitted in real-time to a cloud-based platform, where it is processed and analyzed. This central system not only manages the waste classification but also provides actionable insights into waste generation patterns and bin fill levels. Users receive notifications through a mobile app, which helps them understand proper disposal practices and encourages correct waste segregation.

1.2 Project Objectives

The objective of this project is to develop a cost-effective smart waste segregation system using Internet of Things(IoT) and ensure the proper waste segregation which foster a more effective and environmentally-friendly approach to urban waste management.

1.3 Purpose of the Project

The purpose of this project is to enhance waste segregation by developing a system that effectively detects and segregates the waste. This system aims to enhance recycling efficiency, reduce contamination, and optimize waste management operations. Ultimately, it seeks to promote sustainable waste practices and improve environmental impact.

1.4 Existing System with Disadvantages

In many areas, garbage collection occurs on a fixed schedule, which often proves inefficient. The cleaning of garbage bins is frequently neglected, leading to further issues. Recent estimates indicate that, on average, each person in India generates approximately 1.3 pounds of waste per year. In developing countries, over 377 million urban residents live in towns and produce more than 62 million tonnes of municipal solid waste annually. However, only about 43 million tonnes of this waste are collected by municipal services, leaving the remaining waste scattered on the streets due to inadequate maintenance of garbage bins. This lack of effective planning for waste collection results in unhygienic conditions in cities and towns.

Disadvantages

- Traditional systems often lack effective mechanisms for segregating different types of waste at the source. This can lead to inefficient recycling and disposal processes, with recyclable materials ending up in landfills.
- Traditional systems may resist incorporating new technologies and practices that could improve waste management. This can hinder progress toward more sustainable and efficient waste management solutions.
- Traditional systems generally lack the sophisticated sensors and automated mechanisms needed for precise waste categorization. As a result, dry, wet, and metal wastes are often mixed together, leading to inefficiencies in recycling and disposal processes.

1.5 Proposed System with Features

In The proposed smart waste segregation system leverages Internet of Things (IoT) technology to enhance the efficiency and accuracy of waste management by categorizing waste into dry, wet, and metal categories. This advanced system incorporates smart sensors and automated mechanisms embedded in waste bins and collection points. The IoT sensors are designed to detect and analyze the type of waste being deposited, using technologies such as optical recognition, weight sensors, and material composition analysis. Data from these sensors is transmitted in real-time to a central management system, which processes the information to ensure that waste is accurately sorted.

The system is equipped with smart bins that automatically sort waste into separate compartments for dry, wet, and metal materials.

Features

- Integrated Sensors: The system utilizes various IoT sensors such as weight sensors, optical sensors, and material detection sensors to accurately identify and classify waste into dry, wet, and metal categories.
- Automated Sorting Mechanism: Smart bins are equipped with automated sorting technology that directs waste into separate compartments for dry, wet, and metal materials. This mechanism operates based on sensor data to ensure precise segregation.
- Compact Design: The bins are designed to be compact and user-friendly, making them suitable for urban environments and residential areas where space may be limited.
- Scalability: The system is adaptable to different scales, making it suitable for a range of settings from small residential areas to larger commercial or municipal environments, depending on the volume and variety of waste generated.

1.6 Input And Output Design

Input Design

The input design in the "Smart Waste Segregation Using IoT" project is crucial as it serves as the bridge between the physical waste and the system responsible for segregating it. The system relies on specific sensors to identify and classify waste into three categories: metal, dry, and wet. The design process includes setting up the sensors and ensuring that the data they collect is processed correctly and efficiently. The input design focuses on minimizing errors, reducing unnecessary steps, and ensuring ease of use. Key considerations include:

- **Data to be Collected**: The system needs to collect data from sensors such as a metal detector for metallic waste, a moisture sensor for wet waste, and an additional sensor to differentiate dry waste.

- **Data Arrangement:** Sensor data must be coded and arranged in a way that the microcontroller or processing unit can accurately interpret it. This may involve encoding signals from the sensors into digital data.

- **User Interaction:** Operators need to interact with the system to ensure proper calibration and maintenance. The input design should include intuitive interfaces for these tasks.

- **Validation Methods:** The system should validate the sensor readings to prevent misclassification of waste. For example, if the moisture content is ambiguous, the system might require re-validation.

Objectives

- **Accurate Data Collection:** Ensure that the sensors capture the correct type of waste with minimal errors.

- **User-friendly Interface**: Develop easy-to-use screens or interfaces for operators to monitor the system and make necessary adjustments.

- **Data Validation:** Implement checks to confirm the accuracy of the sensor data before proceeding with the segregation process.

Output Design

The output design for the "Smart Waste Segregation Using IoT" project focuses on the results generated by the system after processing the input data. The output includes the classification of waste into the correct categories and the actuation of mechanical components to deposit the waste into the corresponding bins. The output design must ensure that this information is clear, actionable, and meets the user's needs.

- **Output Information:** The system should output data indicating the type of waste detected and ensure that the corresponding bin is activated.
- **Presentation Methods:** Information should be presented via a user interface that shows the status of each waste bin.
- **Formats:** The output could also include logs or reports for maintenance purposes, such as how much waste has been processed and any errors encountered.

Objectives:

- Provide clear feedback to operators, ensuring they know the status of the segregation process.
- Trigger actions, such as the movement of waste to the correct bin.
- Signal any issues that need attention, such as sensor malfunctions.
- Confirm successful segregation and actuation, so operators know the system is functioning correctly.

2. LITERATURE SURVEY

Khajuria, T. Yamamoto, and T. Morioka, "Solid Waste Management in Asian Countries: Problems and Issues," Waste Management, vol. 30, no. 4, pp. 396-402, 2021. This paper discusses the challenges and issues related to solid waste management in Asian countries, focusing on the need for effective waste segregation at the source. The authors argue that proper segregation of waste into dry, wet, and metallic categories is essential for efficient recycling and waste processing. The study highlights the role of automated systems in achieving accurate segregation, thereby reducing the burden on manual labor and improving the health and safety of workers involved in waste management.

M. N. M. Zain, S. S. Sujod, and N. I. M. Zin, "Development of Automatic Waste Segregator Using Programmable Logic Controller," International Journal of Integrated Engineering, vol.11,no.7,pp.23-30,2020.

The authors present a system that automates the segregation of waste into dry, wet, and metallic categories using a programmable logic controller (PLC). The system is designed to reduce the health risks associated with manual waste sorting and improve the efficiency of waste management. The study concludes that the automated waste segregator is cost-effective, easy to implement, and can significantly reduce the workload of waste management workers. The use of PLCs also allows for easy customization and scalability of the system.

S. K. Gupta, R. Sharma, and A. Verma, "Automatic Waste Segregator and Monitoring System," International Journal of Engineering Research & Technology (IJERT), vol. 8, no. 6,pp.1-5,2021.

This paper presents an automatic waste segregator that uses a combination of sensors to classify waste into dry, wet, and metallic categories. The system is designed to operate in urban environments where the volume of waste is high, and manual segregation is not feasible. The authors highlight the system's ability to improve the efficiency of waste management by reducing the time and effort required for sorting. The study also emphasizes the environmental benefits of automated waste segregation, such as increased recycling rates and reduced landfill usage.

P. K. Sharma and S. Maheshwari, "Smart Waste Segregation System Using Sensors and AI," International Journal of Innovative Research in Science, Engineering and Technology, vol. 9, no.5,pp.4501-4505,2020.

This study explores the development of a smart waste segregation system that combines sensor technology with artificial intelligence (AI) to automatically sort waste into dry, wet, and metallic categories. The system uses various sensors to detect the properties of the waste, and AI algorithms to make decisions about the appropriate category. The authors conclude that the integration of AI enhances the accuracy and reliability of waste segregation, making the system suitable for large-scale implementation in smart cities. The paper also discusses the potential for the system to reduce the environmental impact of waste management.

L. Ramesh, B. Divya, and M. Nivedita, "Automatic Waste Segregation and Management System," International Journal of Computer Applications, vol. 175, no. 4, pp. 20-23, 2019.
This paper discusses the design and implementation of an automatic waste segregation system that uses a set of sensors to categorize waste into dry, wet, and metallic types. The authors focus on the technical aspects of sensor integration and the challenges of achieving accurate segregation. The study concludes that the automated system is highly efficient and can significantly reduce the manual labor involved in waste sorting. Additionally, the system's modular design allows for easy adaptation to different types of waste and varying environmental conditions.

R. K. Srivastava, P. K. Gupta, and S. Dutta, "Automated Waste Segregation System Using IoT and Sensor Technology," Journal of Environmental Management, vol. 256, pp. 109-118, 2022.
This study introduces an IoT-based automated waste segregation system that categorizes waste into dry, wet, and metallic categories using various sensors such as capacitive, inductive, and moisture sensors. The system aims to reduce human intervention in waste segregation and increase the accuracy of sorting processes. The authors discuss the integration of IoT technology for real-time monitoring and data collection, which can be used to optimize waste management strategies at a larger scale. The research concludes that such systems can significantly improve waste processing efficiency and support sustainable waste management practices.

T. Singh, A. Kumar, and R. Raj, "A Low-Cost Automatic Waste Segregator Using Arduino," International Journal of Mechanical and Production Engineering Research and Development (IJMPERD),vol.10,no.3,pp.741-748,2020.
The authors present the development of a low-cost automatic waste segregation system using an Arduino microcontroller. The system is designed to segregate waste into dry, wet, and metallic types based on the input from various sensors. The study emphasizes the importance of affordability in making waste segregation technology accessible to a broader range of communities, especially in developing regions. The results demonstrate that the system can efficiently sort waste with

minimal human intervention, making it a viable solution for improving public health and environmental hygiene.

A. R. Jadhav and S. M. Jadhav, "Design and Implementation of Smart Waste Segregator and Bin Management System," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), vol. 8, no. 7, pp. 2315-2322, 2019. This paper details the design and implementation of a smart waste segregator that classifies waste into dry, wet, and metallic categories using a combination of sensors and microcontrollers. The system also includes a bin management feature that tracks the filling levels of different waste bins, although the main focus remains on segregation. The study concludes that the smart waste segregator can significantly reduce manual labor, enhance recycling efforts, and minimize environmental pollution. The authors also suggest potential improvements in sensor technology and software algorithms to increase the accuracy and speed of waste segregation.

N. R. Patel, R. K. Mehta, and P. Sharma, "IoT-Enabled Smart Waste Segregation and Disposal System," Journal of Innovative Research in Science, Engineering, and Technology (JIRSET),vol.8,no.5,pp.5524-5530,2021.

This research paper explores the development of an IoT-enabled smart waste segregation system that uses sensors to classify waste into dry, wet, and metallic types. The system is designed to automatically identify and sort waste, with the data being transmitted to a central server for monitoring and analysis. The study highlights the role of IoT in enhancing the efficiency of waste segregation and providing valuable data for waste management strategies. The authors conclude that the system can be easily integrated into existing waste management infrastructures, offering a scalable solution for urban areas.

V. K. Reddy, A. Prasad, and S. Narasimhan, "Automation of Waste Segregation at Source Using Smart Sensors and AI," Procedia Computer Science, vol. 172, pp. 130-135, 2020. The authors propose an automated waste segregation system that uses smart sensors and artificial intelligence (AI) to categorize waste into dry, wet, and metallic categories. The system is designed to operate autonomously at the source of waste generation, reducing the need for manual sorting and minimizing health risks for workers. The study also discusses the use of AI algorithms to improve the accuracy of waste classification and adapt to different types of waste materials. The results show that the system can achieve high accuracy rates and can be implemented in both residential and industrial settings to enhance waste management processes.

3. EMBEDDED SYSTEM

An embedded system is a computer system designed to perform one or a few dedicated functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today.

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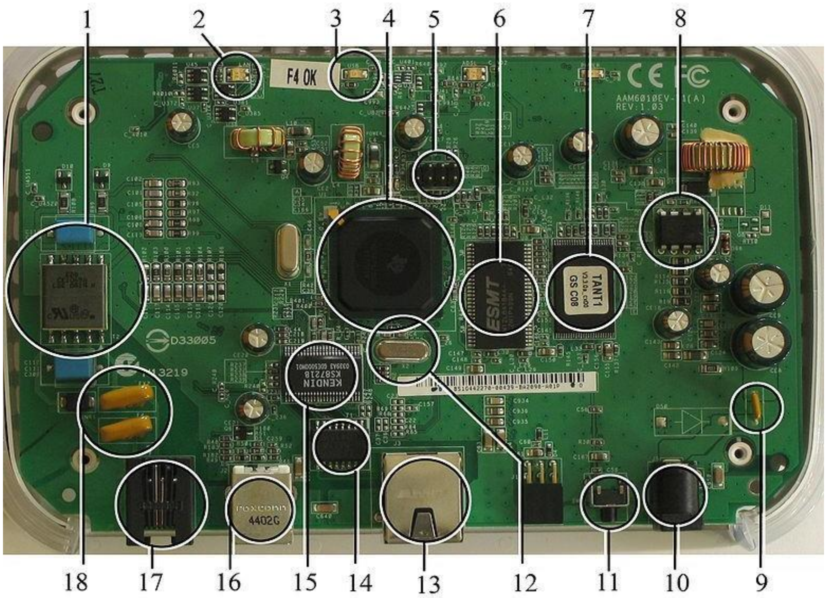


Fig 3: A modern example of embedded system

Labeled parts include microprocessor (4), RAM (6), flash memory (7). Embedded systems programming is not like normal PC programming. In many ways, programming for an embedded system is like programming PC 15 years ago. The hardware for the system is usually chosen to make the device as cheap as possible. Spending an extra dollar a unit in order to make things easier to program can cost millions. Hiring a programmer for an extra month is cheap in comparison. This means the programmer must make do with slow processors and low memory, while at the same time battling a need for efficiency not seen in most PC applications. There are several different types of software architecture in common use.

Simple Control Loop:

In this design, the software simply has a loop. The loop calls subroutines, each of which manages a part of the hardware or software

Interrupt Controlled System:

Some embedded systems are predominantly interrupt controlled. This means that tasks performed by the system are triggered by different kinds of events. An interrupt could be generated for example by a timer in a predefined frequency, or by a serial port controller receiving a byte. These kinds of systems are used if event handlers need low latency and the event handlers are short and simple.

Cooperative Multitasking:

A non-preemptive multitasking system is very similar to the simple control loop scheme, except that the loop is hidden in an API. The programmer defines a series of tasks, and each task getsits own environment to "run" in. When a task is idle, it calls an idle routine, usually called "pause", "wait", "yield", "nop" (stands for no operation), etc. The advantages and disadvantages are very similar to the control loop, except that adding new software is easier, by simply writing a new task, or adding to the queue-interpreter.

Primitive Multitasking:

In this type of system, a low-level piece of code switches between tasks or threads based on a timer (connected to an interrupt). This is the level at which the system is generally considered to have an "operating system" kernel. Depending on how much functionality is required, it introduces more or less of the complexities of managing multiple tasks running conceptually in parallel.

Microkernels And Exokernels:

A microkernel is a logical step up from a real-time OS. The usual arrangement is that the operating system kernel allocates memory and switches the CPU to different threads of execution. User mode processes implement major functions such as file systems, network interfaces, etc.

3.1 Need for Embedded systems

The uses of embedded systems are virtually limitless, because every day new products are introduced to the market that utilizes embedded computers in novel ways. In recent years, hardware such as microprocessors, microcontrollers, and FPGA chips have become much cheaper. So when implementing a new form of control, it's wiser to just buy the generic chip and write your own custom software for it. Producing a custom-made chip to handle a particular task or set of

tasks costs far more time and money. Many embedded computers even come with extensive libraries, so that "writing your own software" becomes a very trivial task indeed. From an implementation viewpoint, there is a major difference between a computer and an embedded system. Embedded systems are often required to provide Real-Time response. The main elements that make embedded systems unique are its reliability and ease in debugging.

3.2 Real-time Embedded Systems:

Embedded systems which are used to perform a specific task or operation in a specific time period those systems are called as real-time embedded systems. There are two types of real-time embedded systems.

Hard Real-time Embedded Systems:

These embedded systems follow an absolute dead line time period i.e.., if the tasking is not done in a particular time period then there is a cause of damage to the entire equipment.

Eg: consider a system in which we have to open a valve within 30 milliseconds. If this valve is not opened in 30ms this may cause damage to the entire equipment. So in such cases we use embedded systems for doing automatic operations.

Soft Real Time Embedded Systems:

Eg: Consider a TV remote control system, if the remote control takes a few milliseconds delay it will not cause damage either to the TV or to the remote control. These systems which will not cause damage when they are not operated at considerable time period those systems comes under soft real-time embedded systems.

3.3 Network Communication Embedded System

A wide range network interfacing communication is provided by using embedded system.

- Consider a web camera that is connected to the computer with internet can be used to spread communication like sending pictures, images, videos etc.., to another computer with internet connection throughout anywhere in the world.
- Consider a web camera that is connected at the door lock. Whenever a person comes near the door, it captures the image of a person and sends to the desktop of your computer which is connected to internet. This gives an alerting message with image on to the desktop of your computer, and then you can open the door lock just by clicking the mouse. Fig: 3.3.1 show the network communications in embedded systems.
- In a healthcare scenario, embedded systems are used to create a network of sensors attached to a patient's body. These sensors continuously monitor vital signs such as heart rate, blood pressure, and glucose levels. The data is then transmitted over the internet to a remote server where healthcare professionals can access and analyze it in real-time. This enables doctors to provide timely medical interventions and monitor patient health without requiring the patient to be physically present at a healthcare facility.

Fig 3.3.1: Network communication embedded system

3.4 Industrial Automation

Embedded systems are increasingly being used in industries to monitor the condition of critical machinery in real-time. Sensors embedded within machines collect data on vibration, noise, temperature, and other operational parameters. This data is analyzed to predict potential failures before they occur, allowing for timely maintenance. By identifying issues early, industries can minimize downtime, reduce maintenance costs, and extend the lifespan of their equipment. This system can also send alerts to a centralized monitoring station for further analysis and action.

Fig 3.4.1: Robot

4. HARDWARE DESCRIPTION

4.1 Arduino Uno

Arduino UNO is an ATmega328P based totally microcontroller board. It has 14 input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, 16 MHz ceramic resonator, USB connection, energy enter, ICSP header and reset button. microcontroller; simply join it to a laptop with a USB cable or strength it with an AC-DC adapter or battery and you are geared up to head.
You may tamper with your Uno and not worry too much about doing some thing incorrect, you can update the chip for a couple of dollars and begin over. Arduino UNO is the high-quality development board for getting started out with electronics and coding. If that is your first enjoy with the platform, UNO is the most powerful board you can start playing with. UNO is the most available and quality model of the whole Arduino own family. "Uno", which means "Uno" in Italian, became used to mark the discharge of Arduino software program (IDE) 1.0. Uno board.

Arduino software program (IDE). zero is the consumer model of Arduino advanced for a new version. The Uno board is the primary of the USB Arduino board and is the reference board for the Arduino platform; See the Arduino Board Index for a complete list of present day, past or modern-day forums. The Uno differs from all previous forums in that it does not use a FTDI USB to UART serial chip, even as communicating the use of the original STK500 protocol. as an alternative, it uses an Atmega16U2 (Atmega8U2 from R2 upgrade) programmed as a USB.

Fig 4.1 Arduino

Pin Configuration of Arduino Uno.

• LED: Onboard LED driven by pin 13. When the pin is high the LED is on and when the pin is low the LED is off.

• VIN: Input voltage to Arduino board when using external power (about 5volts from USB connection or other power management). You can supply voltage from this pin, or if you are supplying voltage from a power supply, you can access it from this pin.

• 5V: This pin allows 5V from the on-board controller. The board can be powered by DC power supply (7 - 20V), USB connection (5V), or the board VIN pin (7-20V). Supplying power from the 5V or 3.3V pins will bypass
the controller and may damage the board.

• 3V3: 3.3 volt supply generated by the built-in voltage regulator. The maximum current is 50 mA.

• GND: START. • IOREF: The pin on the Arduino board provides the voltage on which the microcontroller operates. A properly configured circuit board can read the IOREF pin voltage and select the appropriate
input or output voltage to work with 5V or 3.3V.

• RESET: Usually used to add a reset button to the shield button on the shield.

Special pin capabilities

Every of the 14 virtual and six analog pins at the Uno may be used as an enter or output based totally on software program manage (the usage of the pinMode(), digitalWrite() and digitalRead() features).

They function at 5 volts. each pin can get preserve of or obtain 20 mA steady with the encouraged operation and has an internal pull-up of 20-50K ohms (unconnected through default). The most modern-day drawn from an I/O pin need to not exceed 40mA to keep away from eternal harm to the microcontroller.

The Uno has 6 analog inputs classified A0 thru A5; every offers 10-bit resolution (eg.1024 unique values). by means of default, they degree as much as five volts from floor, however the top restrict of the range may be modified using the AREF pin and the analogReference() function.

Further, a few pins have specialised functions:

• **Serial/UART: Pins zero (RX) and 1 (TX).** TTL is used to obtain (RX) and transmit (TX) serial facts. those pins connect to the corresponding pins at the ATmega8U2 USB-to-TTL serial chip.

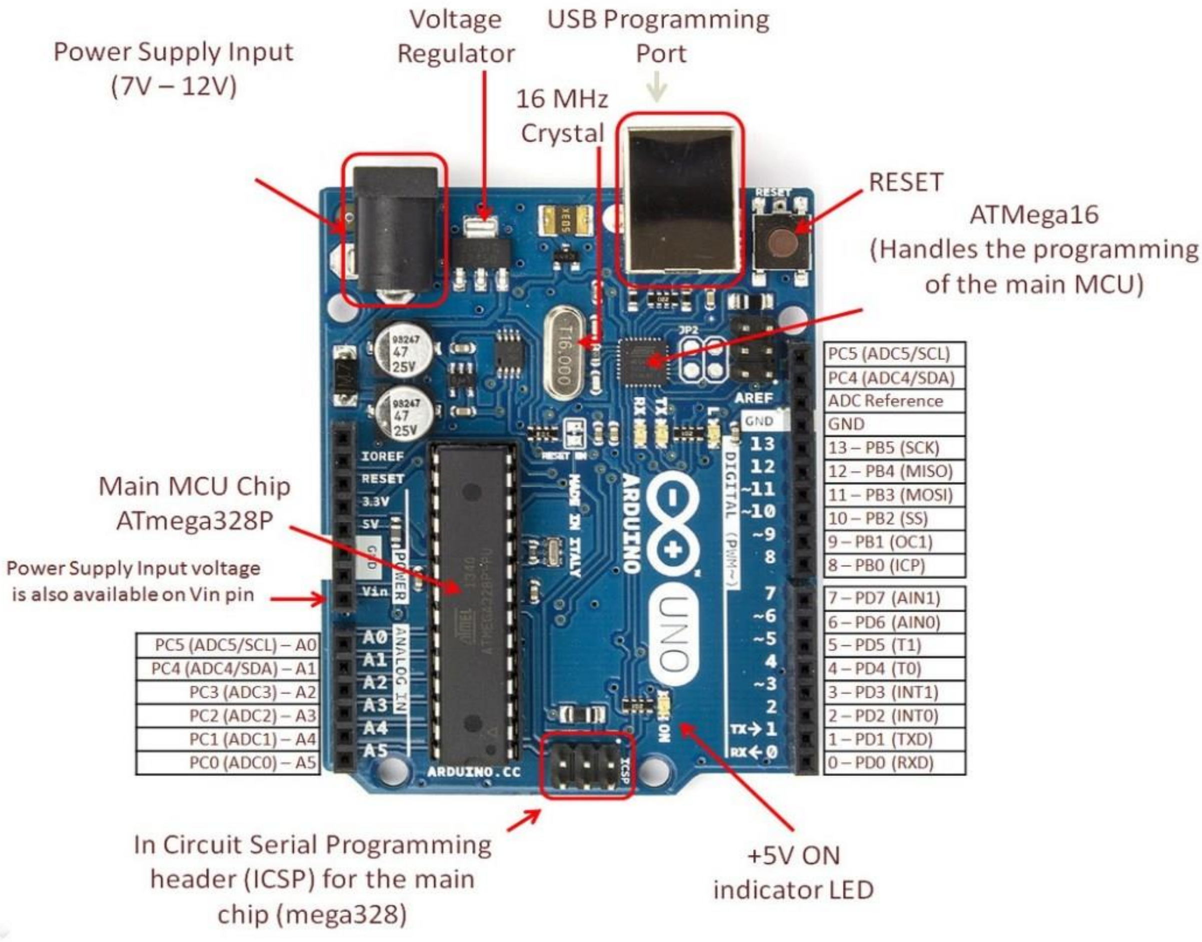
• **External interrupt**: Pins 2 and three. these pins can be configured to cause an interrupt on a low

price, rising or falling area, or value change. PWM (pulse-width modulation): pins 3, five, 6, 9, 10, and eleven. Can provide
eight-bit PWM output with the analog Write() characteristic.

• **SPI** (Serial Peripheral Interface): Pins 10 (SS), eleven (MOSI), 12 (MISO) and 13 (SCK). those pins help SPI communique using the SPI library.

• **TWI** (Two-Wire Interface)/**I2C**: pin SDA (A4) and pin SCL (A5). TWI communication is supported using Wire Library.

• **AREF** (Analog Reference): Reference voltage for analog input.



Communication

Arduino Uno has many tools for speaking with a laptop, every other Arduino board or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication placed on pins zero (RX) and 1 (TX). The ATmega16U2 on the motherboard takes the USB communication interface and looks as a digital port for computer software program. The 16U2 firmware makes use of general USB COM drivers and does not require outside drivers. however, on home windows a.

inf record is required.

The Arduino software (IDE) includes a controller that lets in smooth sending and receiving of records to and from the board. The RX and TX LEDs at the board will flash whilst sending information to the laptop through the USB-serial chip and USB connection (however now not for communication among pins 0 and 1).The serial software library allows conversation thru any of the Uno's digital pins. The board has two 5V pins, 3V3 pins and seven ground pins (0V).

Specifications of Arduino Uno

- Microcontroller: ATmega328P
- operating Voltage: 5V
- input Voltage (pom zoo): 7-12V
- input Voltage (restrained): 6-20V
- virtual I/O Pins: 14WM (6 Output four)
- PWM digital I /O pins: 6
- Analog input pins: 6
- DC modern-day in step with I/O pin: 20 mA
- DC full sim no rau three.3V pins: 50 mA
- Flash: 32 KB (ATmega328P) and its zero ,five KB bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock : 16 MHz
- operating Voltage: 5V
- enter Voltage (encouraged): 7-12V
- Inout Voltage (restrict): 6-20V
- digital I/O Pins: 14 (of which 6 offer PWM output)
- PWM virtual I/O Pins: 6
- Analog input Pins: 6
- DC cutting-edge consistent with I/O Pin: 20 mA
- DC cutting-edge for three.3V Pin: 50 mA
- Flash reminiscence: 32 KB of which zero.five KB utilized by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock pace: 16 MHz
- LED_BUILTIN: 13
- length: sixty eight.6 mm

- Width: fifty eight.4 mm
- Weight: 25 g

Infrared (IR) sensor

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in the surrounding environment. In 1800, astronomer William Herchel discovered infrared radiation. When measuring the temperature of each color of light (separated by prisms), only red light is found to have the highest temperature. Infrared is invisible to the human eye, as it has a longer wavelength than visible light (although still in the same electromagnetic spectrum). Anything that emits heat (anything with a temperature higher than five degrees Kelvin) emits infrared radiation. An infrared sensor, also known as an infrared sensor, is an electronic device that detects electromagnetic radiation in the environment. Infrared radiation is a type of radiation emitted by any material whose temperature is above zero. Infrared sensors are frequently used in many applications such as temperature measurement, motion detection and remote control. The Infrared Sensor works by detecting changes in the intensity of infrared radiation at a particular wavelength. They have emitters that produce infrared radiation and detectors that capture the radiation and convert it into an electrical signal.

Detection equipment is usually made of infrared radiation sensitive materials such as thermopiles or bolometers. The Infrared Sensor has many applications. For example, they can be used to measure the temperature of an object without touching its body, making them useful in applications such as industrial process control, medical imaging, and building automation. Infrared sensors are also used in security systems and motion detection devices, as they can detect people or objects based on changes in infrared radiation. Finally, IR sensors are often used in remote controls of electronic devices such as TVs and DVD players so that users can control them remotely.

Specifications

- 5V DC running voltage
- I/O pins 5v and three.3v
- variety upto 20cm
- Adjustable sensing variety
- built in ambient mild sensor
- 20mA deliver voltage

• Mounting hollow

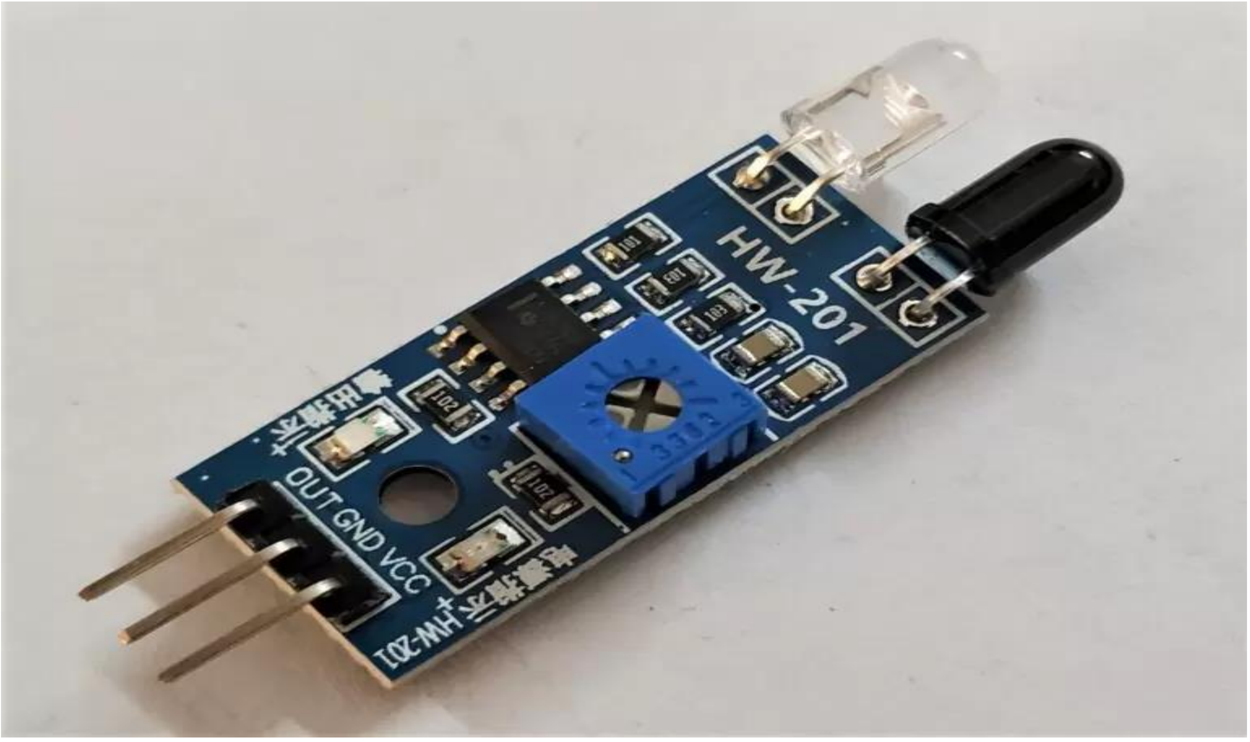


Fig 4.7 IR Sensor

Working of IR Sensor :

Active infrared sensors work in conjunction with radar technology, simultaneously emitting and receiving infrared radiation. These electrons hit nearby objects and return to the receiving device. With this technology, the sensor detects not only the movement of the environment, but additionally how near the object is to the device. this is in particular useful in robotics to govern proximity. Infrared radiation paperwork the lower quit of the electromagnetic spectrum and consequently is invisible to the human eye. The infrared part of the electromagnetic spectrum is among seen waves and microwaves. Infrared wavelengths range from zero.75 to one thousandμm and are divided into 3 zones. Infrared radiation is function of all materials with a temperature
above zero (zero Kelvin or -273 ranges Celsius). Those items are thermal and emit infrared waves. Infrared sensors commonly use infrared lasers and LEDs with infrared wavelengths. For thermal electricity to attain the
infrared scale, it ought to use a transmission medium. the published medium is air, vacuum or fiber optic.

Optical lenses made from a combination of metals and materials such as quartz, calcium fluoride, polyethylene, germanium, aluminum and silicon are used as electronic components. The light or spotlight is then detected by an infrared detector. Infrared detectors require a preamplifier to amplify the signal.

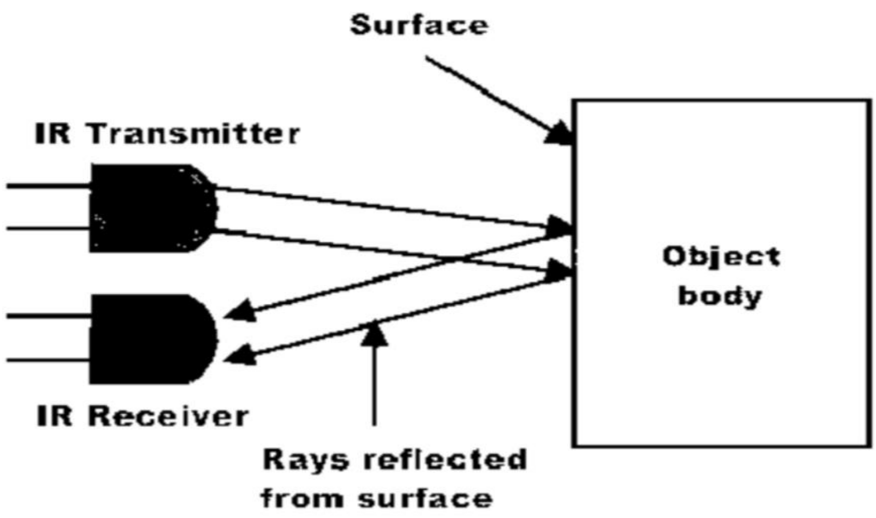


Fig 4.8 Working of IR Sensor

4.5 Servo Motor

A servo motor is a field device or power line that provides particular manage of attitude or immediately line, speed and velocity. It has a suitable frame connected to the sensor for the remarks feature. It additionally calls for a extraordinarily complex controller, commonly a unique module designed to be used with servo cars. It isn't always a specific motor elegance, however the time period servo motor is often used to consult automobiles appropriate to be used in closed loop manage systems. The Servo Motor is a powerful motor often used in many packages inclusive of robotics, production and automation. it is an digital field that offers unique manipulate of angular role, speed and acceleration. The servo motor operates by receiving a control signal that determines the desired position of the motor shaft. The control signal is usually in the form of a pulse width modulated (PWM) signal, in which the pulse timing determines the desired position. The servo motor then uses the feedback from the internal sensors to adjust the position of the motor until it matches the desired position.

Servo Motors are popular in robotic applications due to their ability to accurately control the position and speed of robotic joints. They are also frequently used in manufacturing and electronics, where they can be used to control the position of conveyor belts, robotic arms, and other mechanical systems. In addition to their precise control capabilities, Servo motors are known for their high electrical properties that

allow them to move heavy objects with ease.

They are available in various sizes and torque ratings for a variety of applications. In general, servo motors are a popular choice for applications that require precise control of motor position and speed. Their ability and versatility to deliver high output torque make them useful tools for a variety of industries and applications.

Fig 4.10 Servo Motor

A servomotor is a "servomotor-controlled" motor. Servos use sensors to track the position of the motor shaft and actuators to control the motor. Receives a signal indicating where the axis should be set. It then moves the motor to the desired position. When simulating a servo motor, we use a control signal whose pulse width is a PWM signal that determines the angle of the motor shaft. The motor itself is a simple DC motor with a lot of power to reduce speed and increase torque. In order for the servo

motor to work properly, it needs a sensor that can measure the position of the shaft. In some commercial and high-end servos this is done with an optical marking disc, but in most standard hobby servos the sensor is a potentiometer. This works well because the servos move between 180 and 270 degrees, which is usually within the range of the potentiometer.

LCD (Liquid Cristal Display)

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the contollers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines plus 6 extra lines(RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

Features:

(1) Interface with either 4-bit or 8-bit microprocessor.

(2) Display data RAM

(3) 80x8 bits (80 characters).

(4) Character generator ROM

(5) different 5 □□7 dot-matrix character patterns.

(6) Character generator RAM

(7) 8 different user programmed 5 □□7 dot-matrix patterns.

(8) Display data RAM and character generator RAM may be
 Accessed by the microprocessor.

(9) Numerous instructions

(10) Clear Display, Cursor Home, Display ON/OFF, Cursor ON/OFF, Blink Character, Cursor Shift, Display Shift.

(11) Built-in reset circuit is triggered at power ON.

(12) Built-in oscillator.

Data can be placed at any location on the LCD. For 16×1 LCD, the address locations are:

POSITION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ADDRESS	LINE1	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47

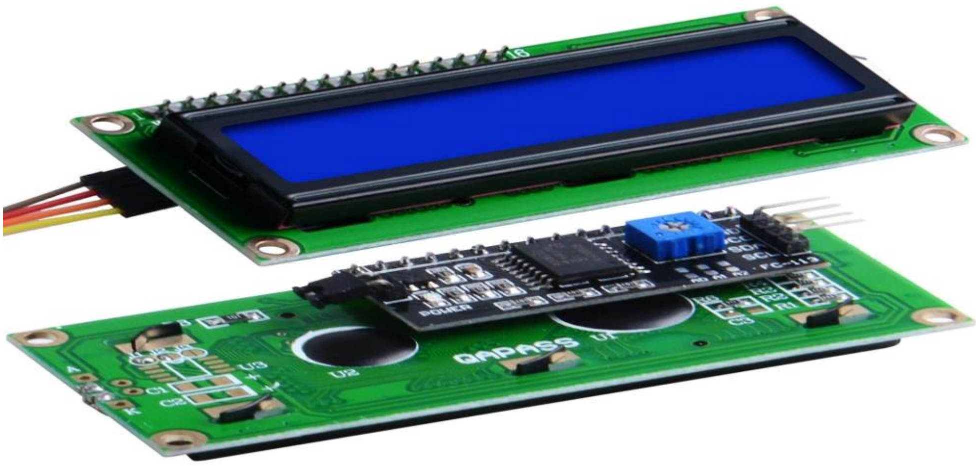


Fig : Address locations for a 1x16 line LCD

Even limited to character based modules,there is still a wide variety of shapes and sizes available. Line lenghs of 8,16,20,24,32 and 40 charecters are all standard, in one, two and four line versions.

Several different LC technologies exists. “supertwist” types, for example, offer Improved contrast and viewing angle over the older “twisted nematic” types. Some modules are available with back lighting, so so that they can be viewed in dimly-lit conditions. The back lighting may be either “electro-luminescent”, requiring a high voltage inverter circuit, or simple LED illumination.

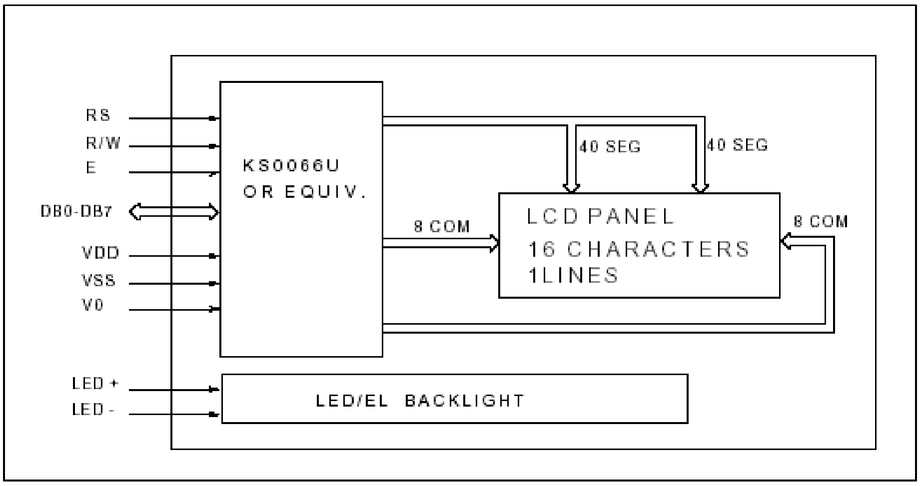


Fig 4.4.2: Electrical Block diagram

PIN Description

Most LCDs with 1 controller have 14 Pins and LCDs with 2 controllers has 16 Pins (two pins are extra in both for back-light LED connections).

Buzzer

The electric buzzer was invented in 1831 by Joseph Henry. They were mainly used in early doorbells and identification and alarm purposes across many major industries.

Fig 4.5.1: Buzzer

CUI's buzzer line utilizes two main technologies. Each technology has specific advantages and tradeoffs that must be taken into consideration depending on the application requirements.

Piezo Buzzer Characteristics

- Wide operating voltage: 3~250V
- Lower current consumption: less than 30mA
- Higher rated frequency
- Larger footprint
- Higher sound pressure level

Magnetic Buzzer Characteristics

- Narrow operating voltage: 1~16V
- Higher current consumption: 30~100mA
- Lower rated frequency
- Smaller footprint
- Lower sound pressure level

Fig 4.5.2: Structure of a Piezoceramic Element

At the heart of all piezo-type buzzers is the piezoelectric element. The piezoelectric element is composed of a piezoelectric ceramic and a metal plate held together with adhesive. Both sides of the piezoelectric ceramic plate contain an electrode for electrical conduction. Piezo materials exhibit a specific phenomenon known as the piezoelectric effect and the reverse piezoelectric effect. Exposure to mechanical strain will cause the material to develop an electric field, and vice versa.

When an alternating voltage is applied to the piezoceramic element, the element extends and shrinks diametrically. This characteristic of piezoelectric material is utilized to make the ceramic plate vibrate rapidly to generate sound waves.
There are two types of piezo buzzers - transducers and indicators. Transducers consist of a casing, a piezoceramic element and a terminal. In order to operate a transducer, the user must send a square wave signal to the buzzer. Indicators consist of a casing, a piezoceramic element, a circuit board and a terminal. In order to operate an indicator, the user must send the buzzer a specified DC voltage.

Rain Sensor.

A sensor that is used to notice the water drops or rainfall is known as a rain sensor. This kind of sensor works like a switch. This sensor includes two parts like sensing pad and a sensor module. Whenever rain falls on the surface of a sensing pad then the sensor module reads the data from the sensor pad to process and convert it into an analog or digital output. So the output generated by this sensor is analog (AO) and digital (DO).

Specifications

The specifications of rain sensors like different parameters with values are mentioned below.

- Operating voltage ranges from 3.3 to 5V
- The operating current is 15 mA
- The sensing pad size is 5cm x 4 cm with a nickel plate on one face.
- Comparator chip is LM393
- Output types are AO (Analog o/p voltage) & DO (Digital switching voltage)
- The length & width of PCB module 3.2cm x 1.4cm
- Sensitivity is modifiable through Trimpot
- Red/Green LED lights indicators for Power & Output

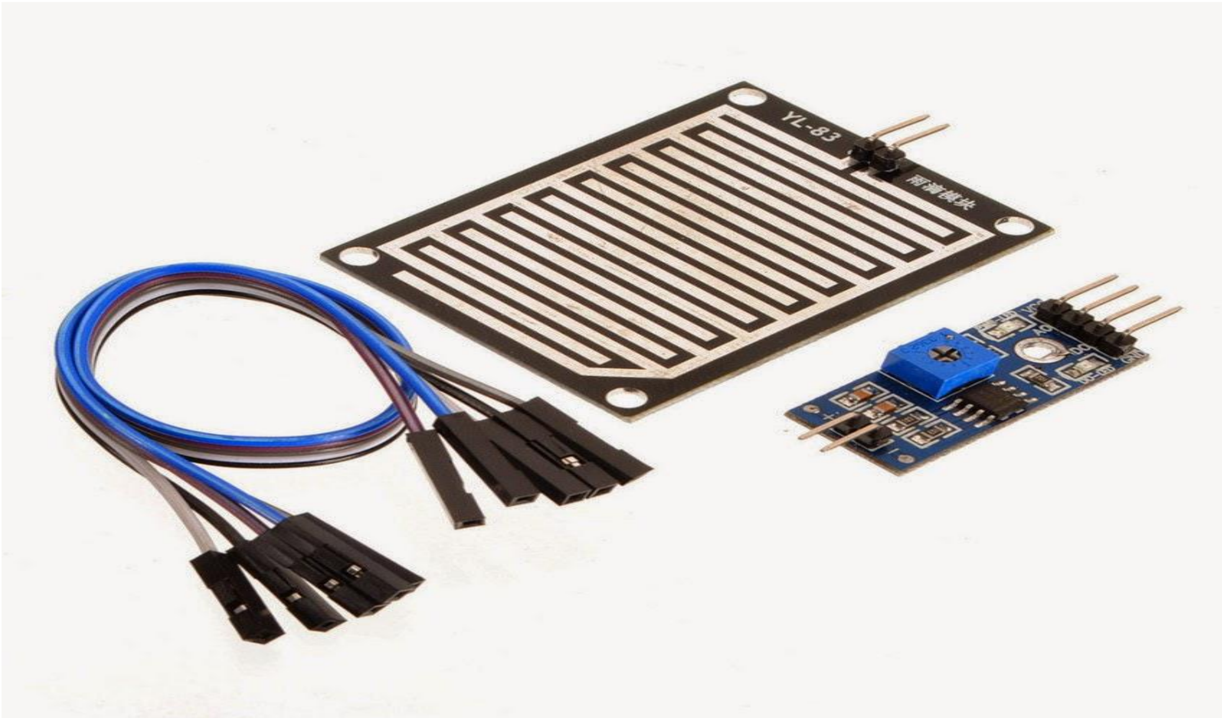


Fig 4.5.3: Rain Sensor

Working Principle

The rain sensor working principle is pretty simple. The sensing pad includes a set of uncovered copper traces which mutually work like a variable resistor or a potentiometer. Here, the sensing pad resistance will be changed based on the amount of water falling on its surface. So, here the resistance is inversely related to the amount of water.

When the water on the sensing pad is more, the conductivity is better & gives less resistance. Similarly, when the water on the surface pad is less, the conductivity is poor & gives high resistance. So the output of this sensor mainly depends on the resistance.

Rain Sensor Pin Configuration

The rain sensor is super easy to use and only has 4 pins to connect.

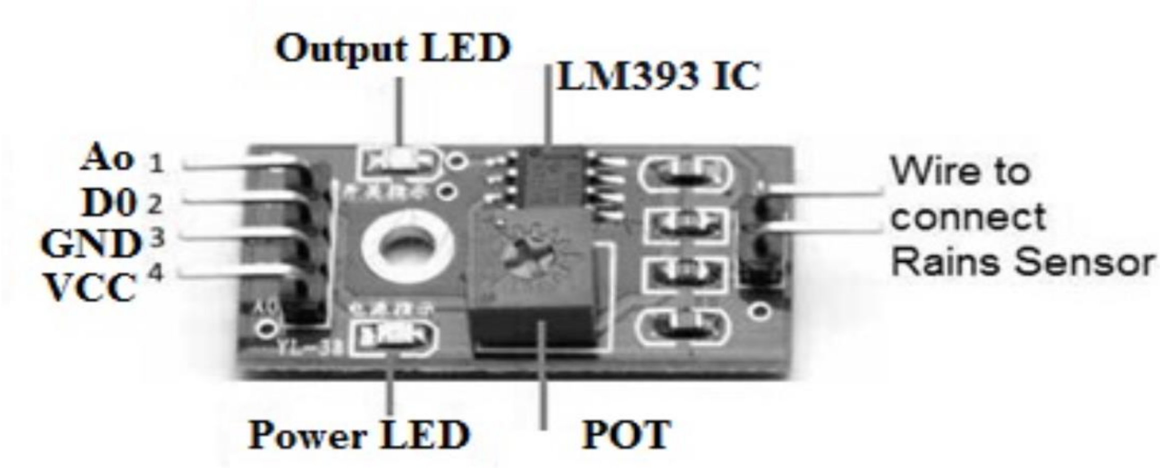


Fig 4.5.3: Rain Sensor Pin Configuration

Analog Output (AO) Pin: This pin gives an analog signal between the voltage supply from 5V to 0V.

Digital Output (DO) Pin: This pin gives digital o/p for the internal comparator circuit & it can be connected to an Arduino board otherwise to a 5V relay.

Ground Pin: It is a ground connection.

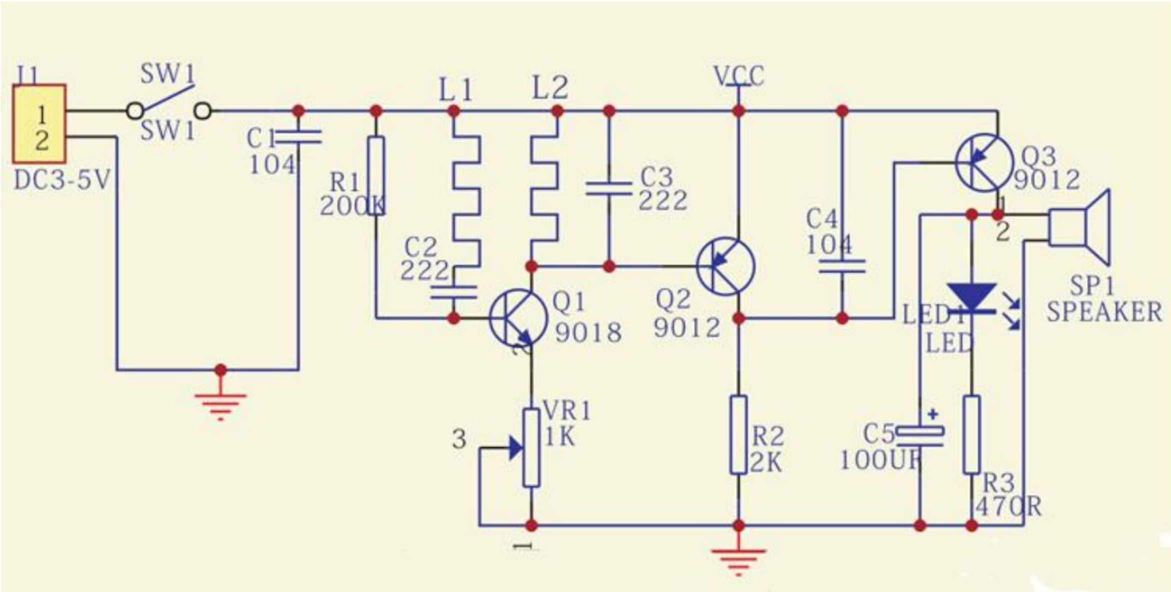
VCC Pin: This pin provides a voltage supply to the rain sensor that ranges from 3.3V to 5V. Here, the analog output will change based on the voltage provided to the sensor.

Metal detector:

The kit comes with all the necessary components and a PCB with a built-in detector coil. The PCB is made from good quality material and has all the necessary information about the component values printed on it.This product is known as Simple Metal Detector, DIY Kit Metal Detector, Electronic Kit Set Metal Detector, DIY Electronic Part Metal Detector, Metal Detector Kit, and Electronic Metal Detector Sensor, DIY Kit Simple Metal Detector Metal Locator 3V－5V Treasure Hunting.

Specifications

- Operating Voltage: 3 ~ 5VDC
- Operating Current: 40mA
- Standby Current: 5mA
- Detection Distance: 60mm
- Alarm Mode: Sound/Light
- Comes with all the components
- Good Quality PCB
- Onboard detection coil



Component listing:

NO.	Component Name	PCB Marker	Parameter	QTY
1	Metal Film Resistor	R3	470ohm	1
2	Metal Film Resistor	R2	2K	1
3	Metal Film Resistor	R1	200K	1
4	Potentiometer	VR1	100R	1
5	Ceramic Capacitor	C2, C3	0.022uf	2
6	Ceramic Capacitor	C1, C4	0.1uf	2
7	Electrolytic Capacitor	C5	100uf	1
8	Red LED	LED1	5mm	1
9	S9012	Q2, Q3	TO-92	2
10	S9018	Q1	TO-92	1
11	Power Switch	SW1	6*5mm	1
12	Buzzer	SP1	9*12mm	1
13	Power Socket	J1	KF301-2P	1
14	PCB		MDS-60	1

NOTE: Users can complete the installation by PCB silk screen and component listing

This module has a continuous running coil track on the PCB as well as several electronic devices. That mainly includes transistors, capacitors, resistors, an LED, and a buzzer. Also, this metal detector module includes a smooth circuit. That is, it emits smooth waves. When this circuit is powered on, the signal is constantly emitted. Also, Q1 (9018-transistor) provides the essential power pulse, which helps the tuned circuit to generate the signal.

The process when there is no metallic thing

As the signal passes through the coil, the s9018 transistor emits an amplified signal to create an oscillation with amplitude at the starting point (L1) of the coil. (we can control the amplitude using VR1[variable resistor]) Afterward, this signal is amplified by the 9012 transistors. Also, the 2k resistor prevents the 100uf capacitor from charging. Then the Q3 (9012-transistor) becomes inactive, so the piezo buzzer remains inactive.

The process when there is a metallic thing

In this case, the magnetic field amplitude on the coil (L2) decreases with the oscillating amplitude. Then the Q2 (9012-transistor) becomes inactive. Also, in Q3 (transistor 9012) a small voltage is produced between the base and the emitter. So, creating a small voltage between the pins of the piezo bus. Then the buzzer will ring.

Through this metal detection kit, we can identify metal parts at a distance of 30mm to 60mm. Also, we need to give a voltage of 3 to 5 volts to this module. Well, now we will connect the devices included here step by step. If you want this module you can buy it from the following links.

<u>Features:</u>

- V+ ↔ Connect to power positive
- V- ↔ connect to power negative
- Adjust the potentiometer, and let the modules work normally
- Small and easy-to-use module
- It comes with a Buzzer for metal detection indication

5. SOFTWARE DESIGN

5.1 System Architecture

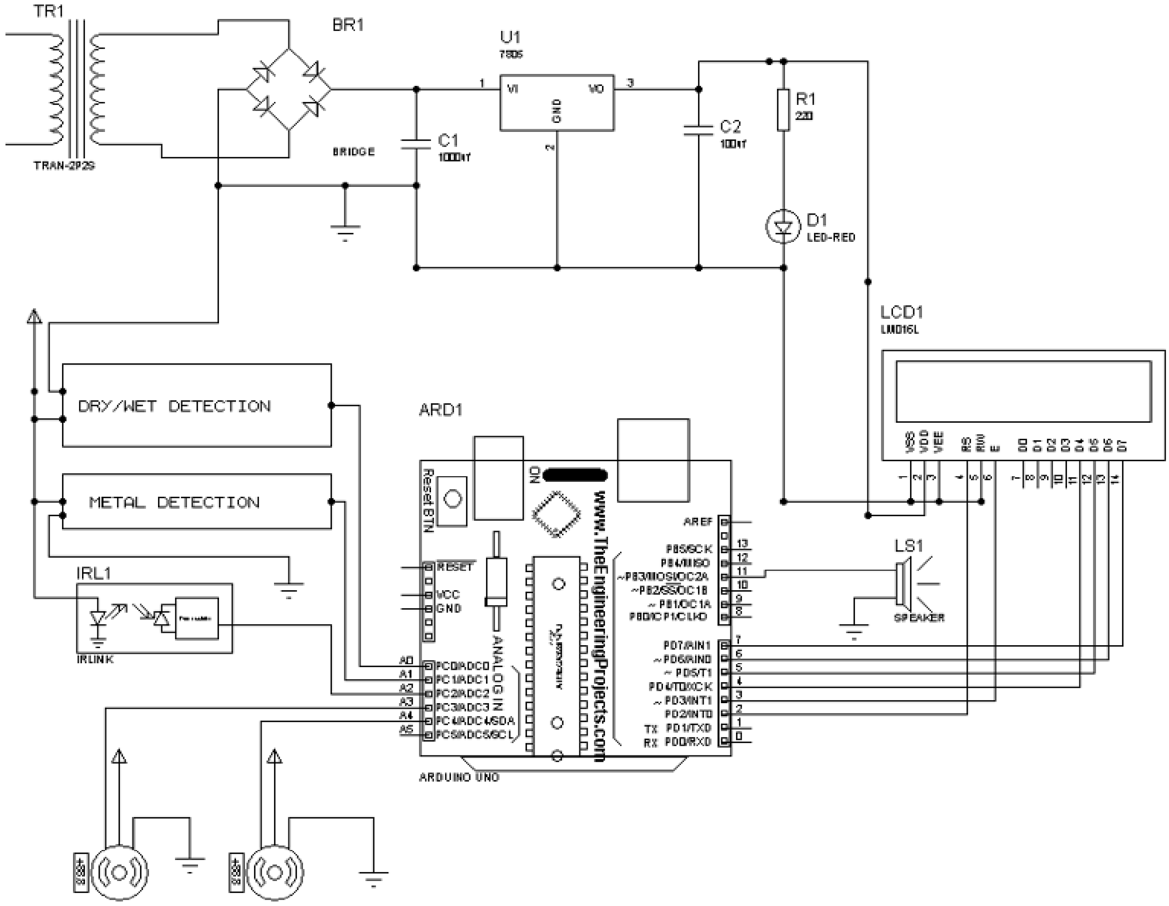


Figure:5.1 System Architecture

5.2 Dataflow Diagram

1. The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.
2. The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process, an external entity that interacts with the system and the information flows in the system.
3. DFD shows how the information moves through the system and how it is modified by a series of transformations. It is a graphical technique that depicts information flow and the transformations that are applied as data moves from input to output.
4. DFD is also known as bubble chart. A DFD may be used to represent a system at any level of abstraction. DFD may be partitioned into levels that represent increasing information flow and functional detail.

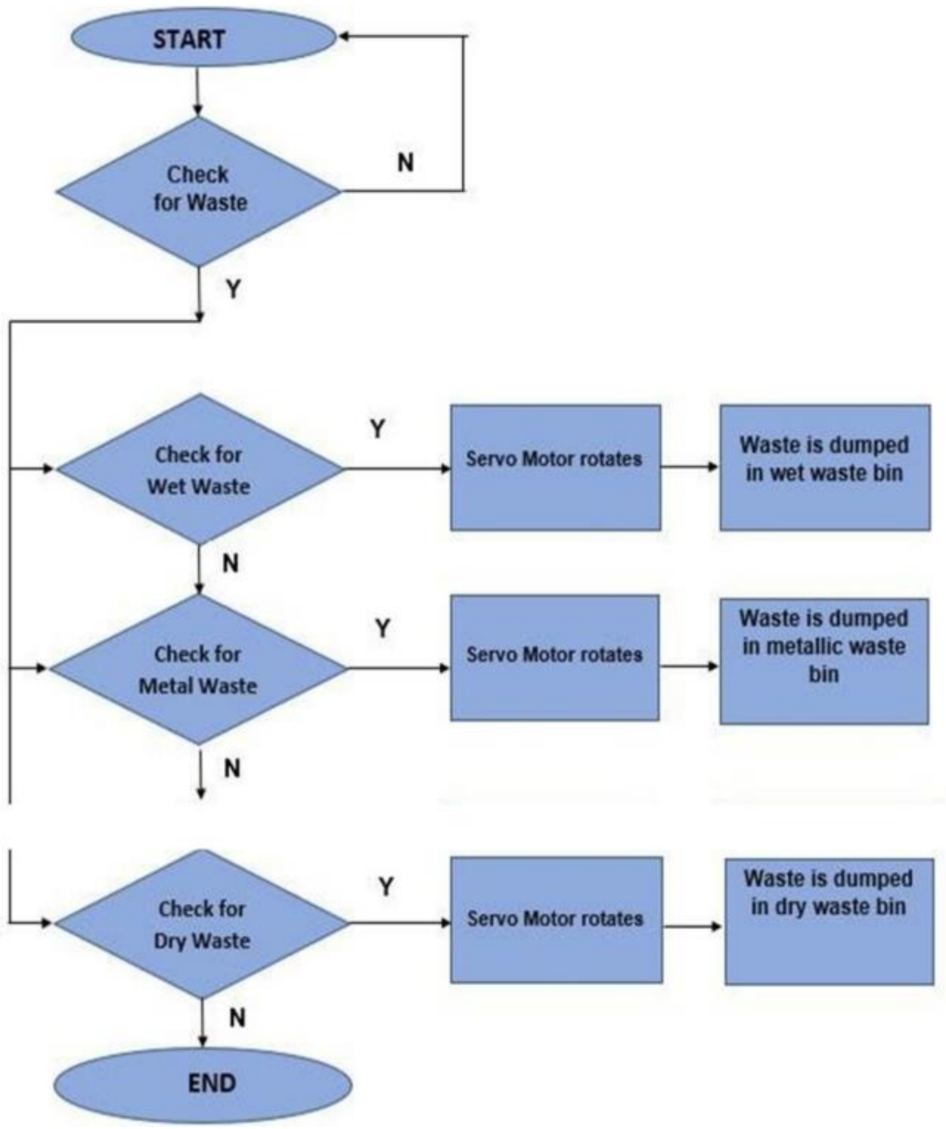


Figure:5.2 Dataflow Diagram

5.3 UML Diagrams

UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems. UML was created by the Object Management Group (OMG) and UML 1.0 specification draft was proposed to the OMG in January 1997.

There are several types of UML diagrams and each one of them serves a different purpose regardless of whether it is being designed before the implementation or after (as part of documentation). UML has a direct relation with object-oriented analysis and design. After some standardization, UML has become an OMG standard. The two broadest categories that encompass all other types are:

- Behavioral UML diagram and
- Structural UML diagram.

As the name suggests, some UML diagrams try to analyses and depict the structure of a system or process, whereas other describe the behavior of the system, its actors, and its building components.

Goals: The Primary goals in the design of the UML are as follows:

Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.

- Provide extendibility and specialization mechanisms to extend the core concepts.

- Be independent of particular programming languages and development process.
- Provide a formal basis for understanding the modeling language.
- Encourage the growth of tools market.
- Support higher level development concepts such as collaborations, frameworks, patterns andcomponents.
- Integrate best practices.

The different types are as follows:

- Sequence diagram
- Use case Diagram
- Activity diagram
- Class diagram
- Collaboration diagram

Sequence Diagram

A sequence diagram simply depicts interaction between objects in a sequential order i.e., the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function. These diagrams are widely used by businessmen and software developers to document and understand requirements for new and existing systems.

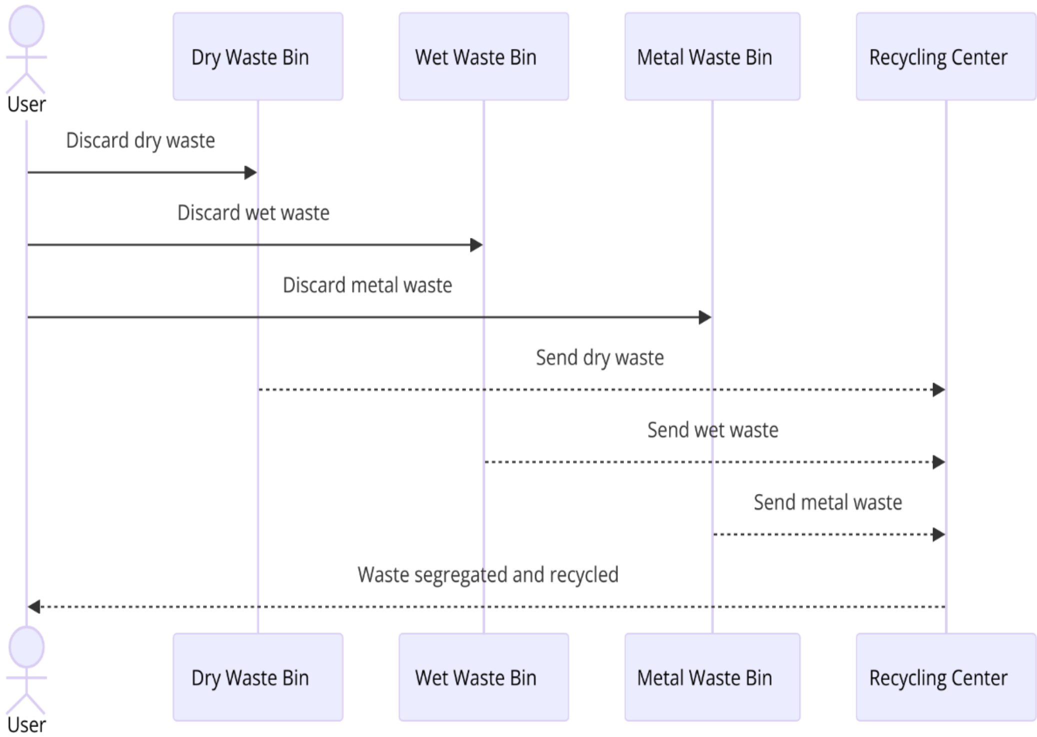


Figure 5.3.1 Sequence Diagram

List of actionsUser:

User need to press any of the given three (i.e., Prediction data, prediction Skills) then he will get theoutput accordingly.

System:

System will give the output as he enters according to the given data.

Result:

As per user enters the data it will give whether it is Fraud or not fraud

Use Case Diagram

A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use case in which the user is involved. A use case diagram is used to structure of the behavior thing in a model. The use cases are represented by either circles or ellipses.

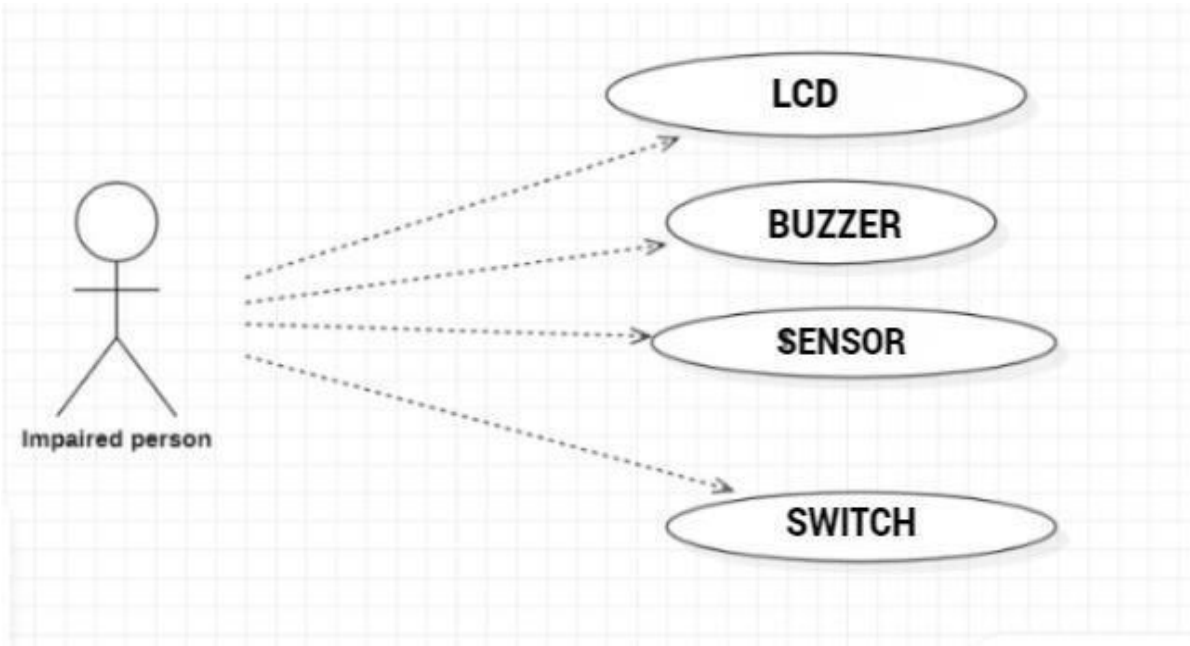


Figure 5.3.2 Use Case Diagram

Activity Diagram

Activity diagram is another important diagram in UML to describe the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity. This flow can be sequential, branched, or concurrent. Activity diagrams deal with all type of flow control by using different elements such as fork, join, etc.

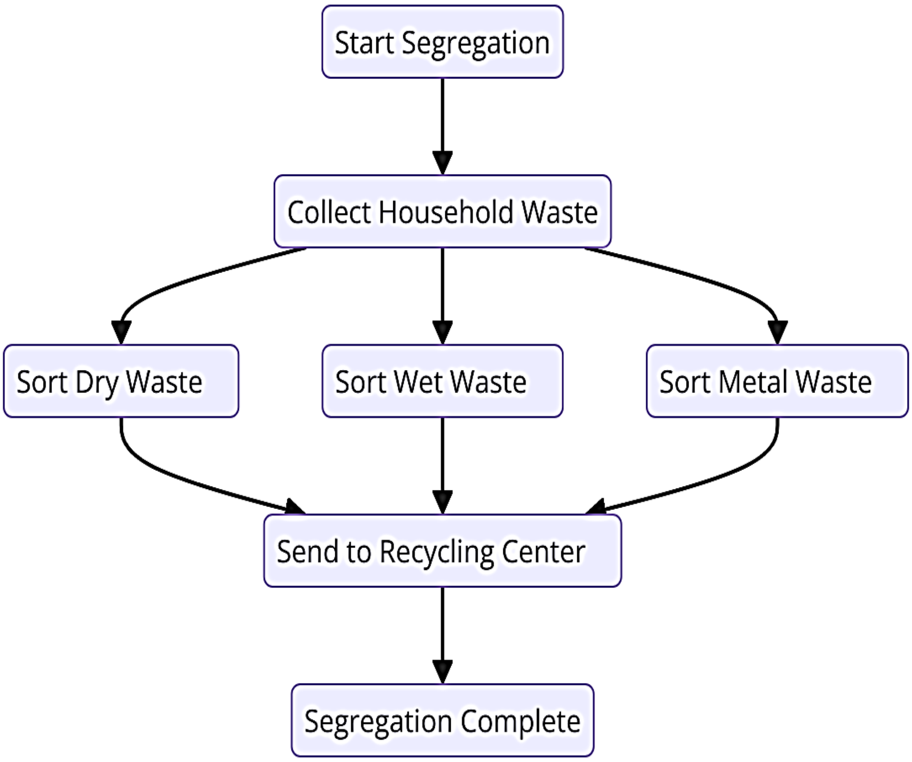


Figure 5.3.3 Activity Diagram

Class Diagram

In software engineering, a class diagram in the Unified Modelling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

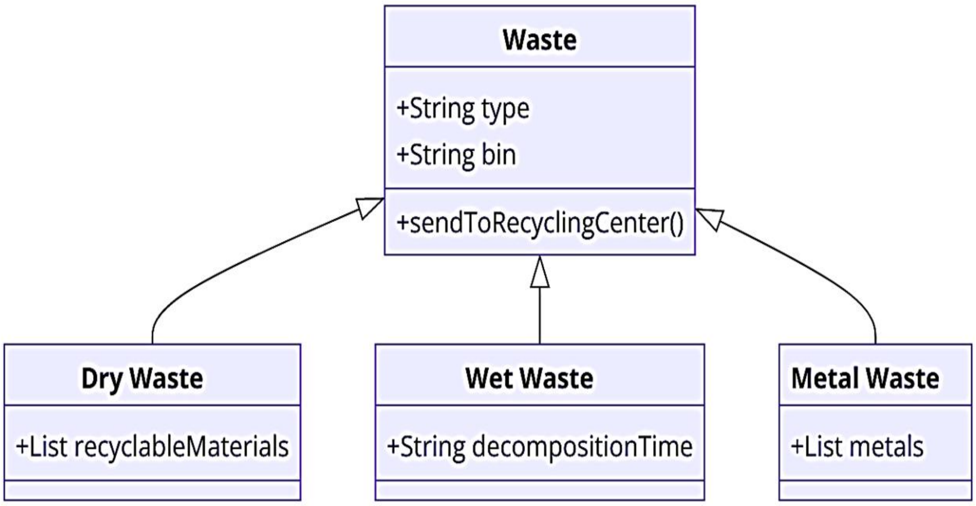


Figure 5.3.4 Class Diagram

6. CODING AND ITS IMPLEMENTATION

6.1 Source code

```
#include <SoftwareSerial.h>
#include<LiquidCrystal.h>
#include <Servo.h>
const int bz = A5;
const int ir_sensor = A0;
const int rain_sensor = A1;
const int metal_sensor = A2;
Servo myservo1;
Servo myservo2;
int pos=0;
int serv1pos = 0;
int serv2pos = 0;
LiquidCrystal lcd(2, 3, 4, 5, 6, 7);
int IR,WS,MTL,cnt=0;
void setup()
{
  Serial.begin(9600);
  Serial.println("WELCOME FIRE WATER SPRINKLER");
  pinMode(bz,OUTPUT);
  pinMode(ir_sensor,INPUT);
  pinMode(rain_sensor,INPUT);
  pinMode(metal_sensor,INPUT);
  digitalWrite(bz,HIGH);
  delay(500);
  digitalWrite(bz,LOW);
  lcd.begin(16, 2);
  welcome_note();
  myservo1.attach(9);
  myservo2.attach(10);
  myservo1.write(0);
  myservo2.write(0);
 // servo_test();
  }
void loop()
{
  IR = digitalRead(ir_sensor);
  WS = analogRead(rain_sensor);
  MTL = analogRead(metal_sensor);
  Serial.print("wet/dry = ");
  Serial.print(WS);
  Serial.print(",METAL = ");
  Serial.println(MTL);
  delay(500);
  if(IR == LOW)
  {
  lcd.setCursor(0,0);
  lcd.print("WASTE MTRL:YES ");
  lcd.setCursor(0,1);
```

```
lcd.print("MONITORING");
//digitalWrite(bz,HIGH);
delay(200);
cnt = cnt + 1;
}
else
{
lcd.setCursor(0,0);
lcd.print("WASTE MTRL:NO  ");
lcd.setCursor(0,1);
lcd.print("STATUS:          ");
digitalWrite(bz,LOW);
cnt = 0;
}
if(cnt > 5)
{
  digitalWrite(bz,LOW);
  delay(2000);
  if(MTL < 450)
  {
   lcd.setCursor(12,1);
   lcd.print("NMTL");
   if(WS < 700)
  {
   lcd.setCursor(0,1);
   lcd.print("STATUS:WET ");
   myservo2.write(90);
   delay(2000);
   myservo1.write(90);
   delay(2000);
   myservo1.write(0);
  }
   else
  {
   lcd.setCursor(0,1);
   lcd.print("STATUS:DRY");
   myservo2.write(0);
   delay(2000);
   myservo1.write(90);
   delay(2000);
   myservo1.write(0);
  }
  }
  else
  {
  lcd.setCursor(12,1);
   lcd.print(" MTL");
   digitalWrite(bz,HIGH);
   myservo2.write(180);
   delay(2000);
   digitalWrite(bz,LOW);
   myservo1.write(90);
   delay(2000);
```

```
     myservo1.write(0);
    }
    myservo2.write(0);
    }
  }
void welcome_note()
{
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("   WELCOME TO ");
  lcd.setCursor(0,1);
  lcd.print("   AUTOMATIC");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("  SEGREGATION");
  lcd.setCursor(0,1);
  lcd.print("    SYSTEM");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("WET,DRY,METAL ");
  lcd.setCursor(0,1);
  lcd.print("USING ARDUINO");
  digitalWrite(bz,LOW);
  delay(2000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("WASTE METERIAL:");
  lcd.setCursor(0,1);
  lcd.print("STATUS:");
}
void servo_test()
{
  myservo1.write(0);
  myservo2.write(0);
  delay(2000);
  myservo1.write(90);
  delay(2000);
  myservo1.write(0);
  delay(2000);
  myservo2.write(90);
  delay(2000);
  myservo2.write(180);
  delay(2000);
  myservo2.write(0);
}
```

5.1 Implementation

Arduino IDE:

Arduino IDE is the software program used to operate the Arduino board. The software program is used as a text editor to create, open, edit and examine Arduino code. The code or program in Arduino is known as a "comic strip". The Arduino incorporated development surroundings (IDE) is a software program program for writing, writing and uploading code to the Arduino board.

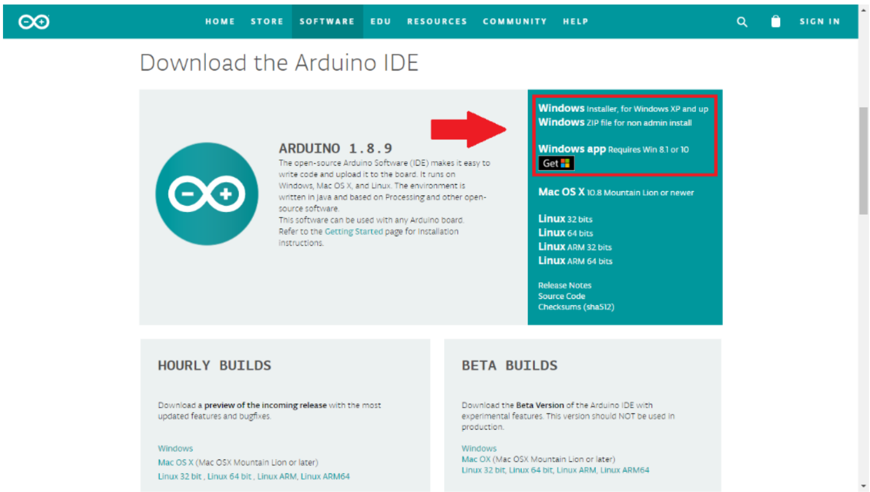
It provides an easy-to-use interface for programming Arduino boards and simplifies the code era and add process. The Arduino IDE is primarily based on a programming language and open supply, which means it's loose to apply and may be modified by way of every body. it's miles to be had for windows, Mac OS X and Linux working structures. Arduino IDE includes code editor, compiler, bootloader and serial reveal.

The code editor is used to write and edit Arduino code based on the C/C++ programming language. The compiler is used to convert the code into a format the Arduino board can understand and the bootloader is used to upload the code to the board. The serial monitor is used to communicate with and receive data from the development board.

Overall the Arduino IDE is a must-have tool for all Arduino board development users as it simplifies the process of working and passing code to the board leader. Its user- friendly interface and clear nature make it popular with hobbyists, students and professionals.

INSTALLING ARDUINO IDE:

Step 1: Download the Arduino IDE file To download the free software, click the following link in any explorer:



There are 3 download alternatives for home windows on this web page.

1. windows Installer: This software might be installed within the windows running gadget and ought to have administrator rights.

2. home windows Zip document: rau transportable installation.

3. home windows application: Rau windows 8.1 Losis 10.

Step 2: Installation Option

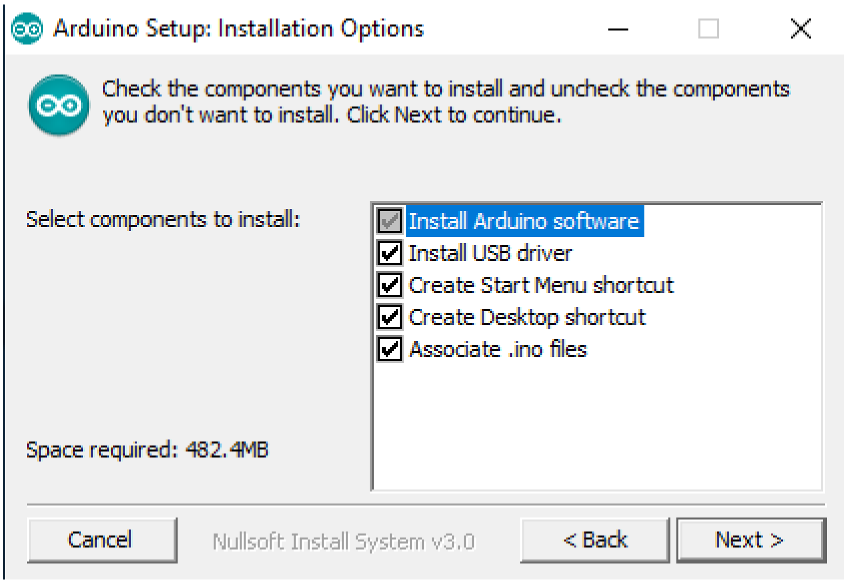
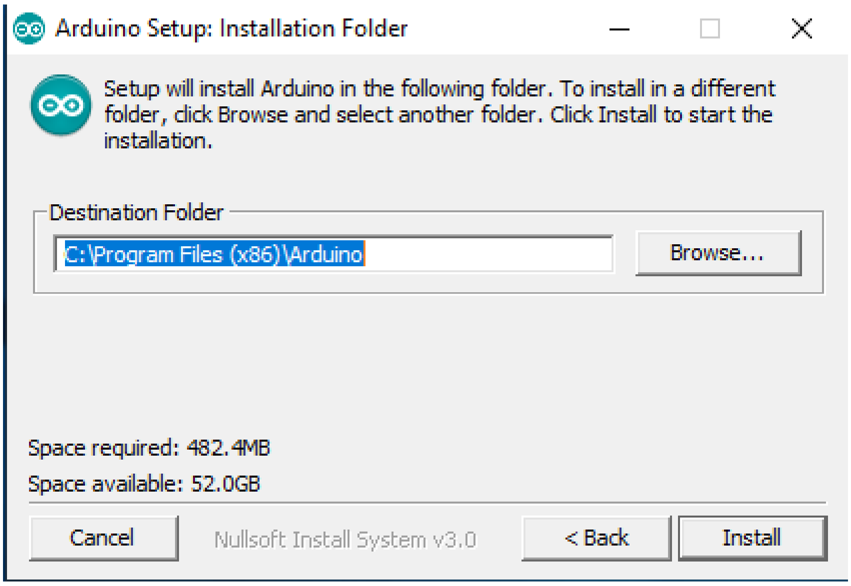


Fig 3.1 Arduino Installation

Step 3: Destination File



Arduino will automatically be established in "C:program files (x86)Arduino".
1. in case you want to alternate the folder, click on "Browse" and pick out the preferred folder.
2. click deploy to start the installation.

Step 4: Setup installation

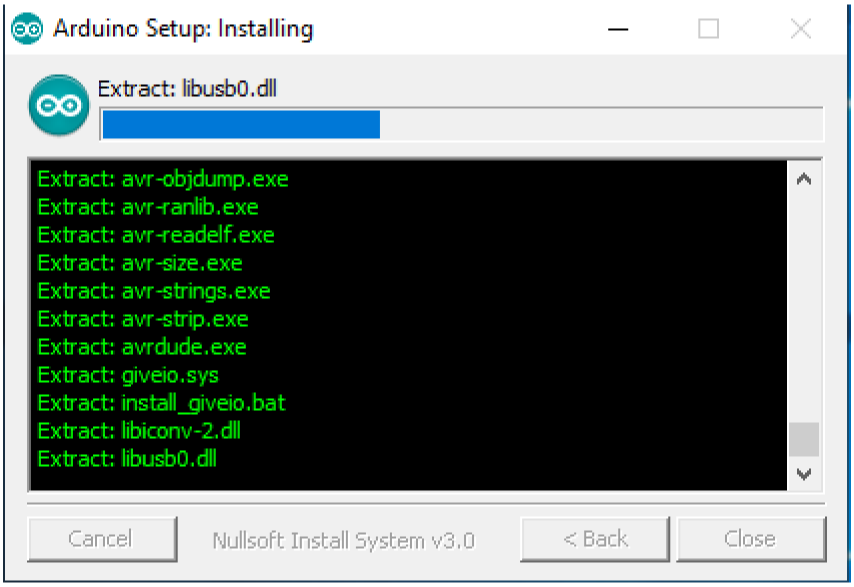


Fig 3.2 Arduino Setup

Step 5: Setup Unit Completed

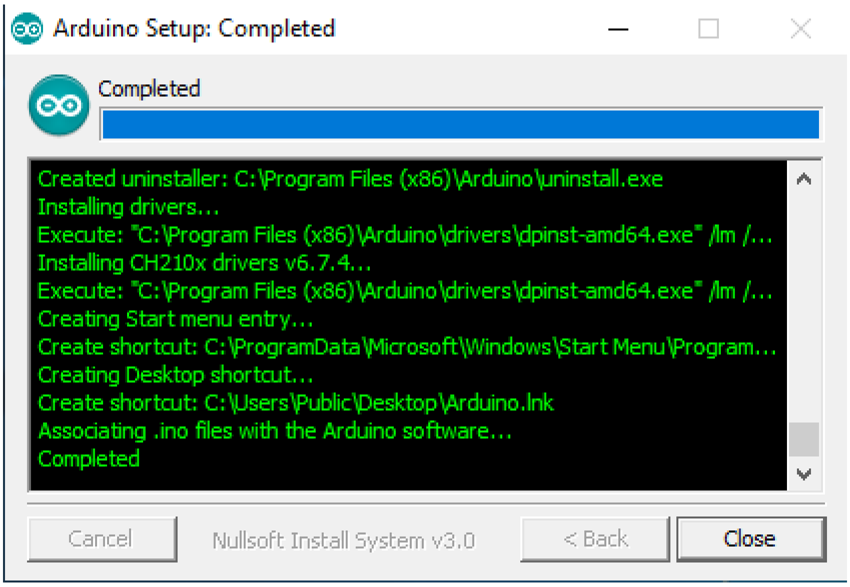
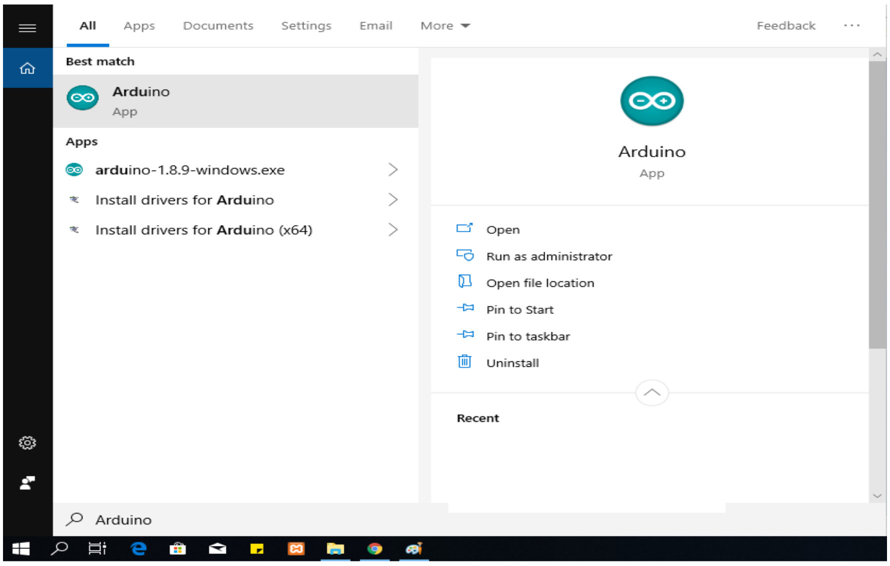


Fig 3.3 Arduino software installation

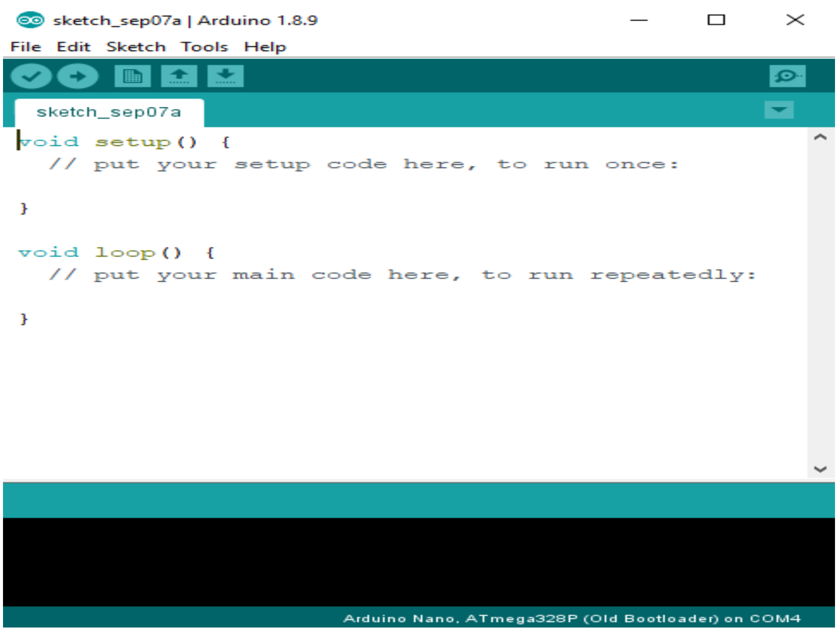
If there may be written "whole", it method that the installation manner is complete. click "near".

Step 6: View Arduino IDE



whilst the set up method is whole, the Arduino icon will seem on the laptop. Or draw the quest icon and type "arduino". in case you see the Arduino icon, run the software.

Step 7: Show Arduino IDE



That is a show of the Arduino IDE software.

7. SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of tests. Each testtype addresses a specific testing requirement.

7.1. Types Of Tests

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

Unit Testing

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach:

Field testing will be performed manually and functional tests will be written in detail.

Test objectives:

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

7.2 Test Cases:

S.no	Test Case	Excepted Result	Result	Remarks (IFFails)
1.	Sensor Initialization	All sensors(metal,moisture,IR)should intitialize successfully.	Pass	Executed successfully
2.	Data Collection	Sensors should collect data when waste is placed in the bin.	Fail	No data collected; Moisture sensor malfunction
3.	Metal Detection	System should accurately detect and classify metal waste.	Fail	Metal not detected;inductive sensor issue.
4.	Moisture Detection	System should accurately detect and classify wet waste.	Pass	Wet waste detected successfully.
5.	Dry waste Detection.	System should accurately detect and classify dry waste.	Pass	Dry waste detected successfully.
6.	Actuator Response	Actuators should direct waste to the correct bin based on classification.	Pass	Actuators responded correctly sorted successfully.

Table no 7.2 Test Cases

8. OUTPUT SCREENS

Figure 8.1: Visualization

Figure 8.2: starting with project title

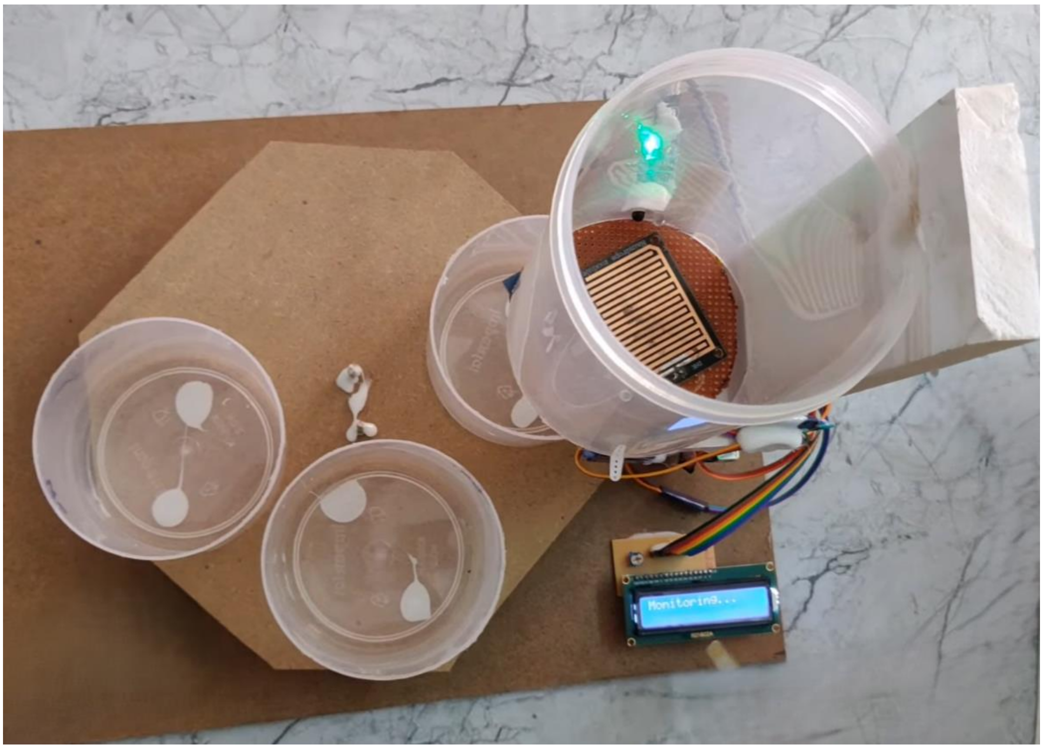


Figure 8.3: monitoring

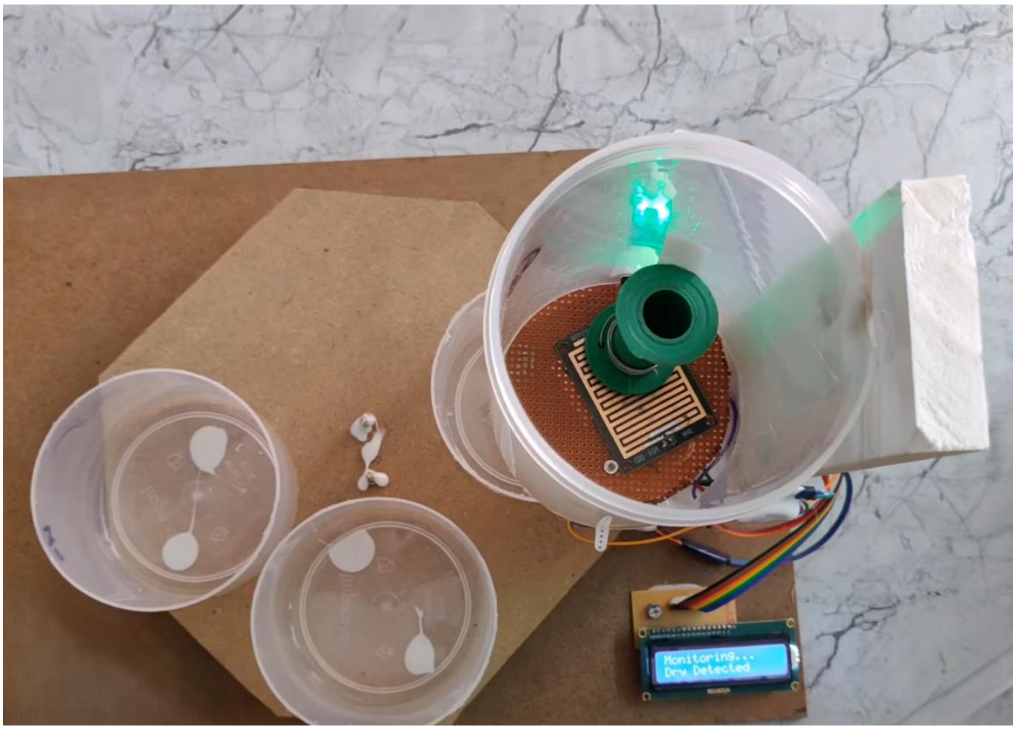


Figure 8.4: dry waste detecting.

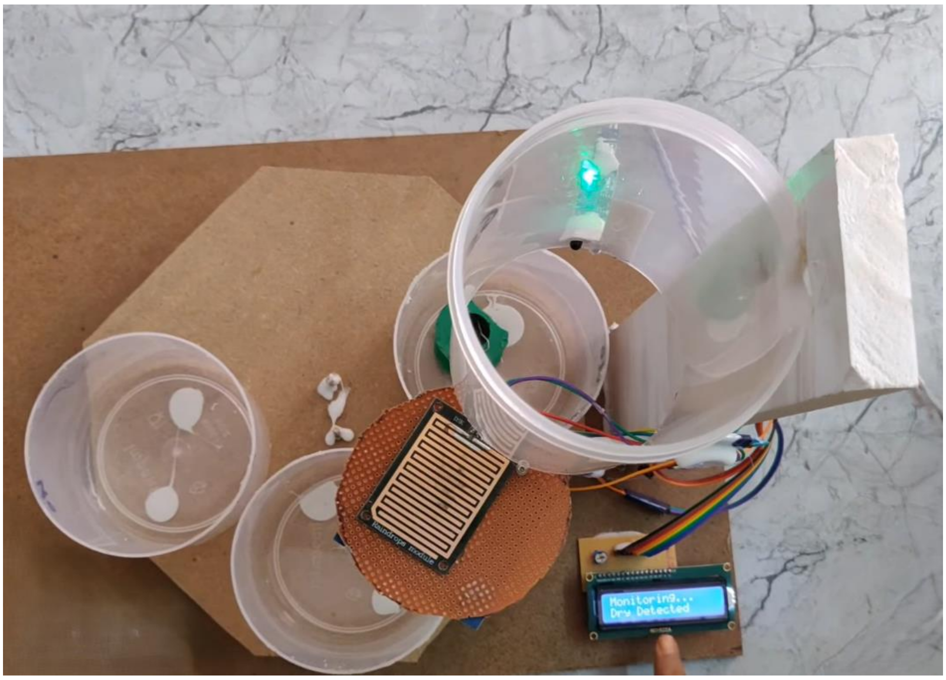


Figure 8.5: drop in dry waste bin

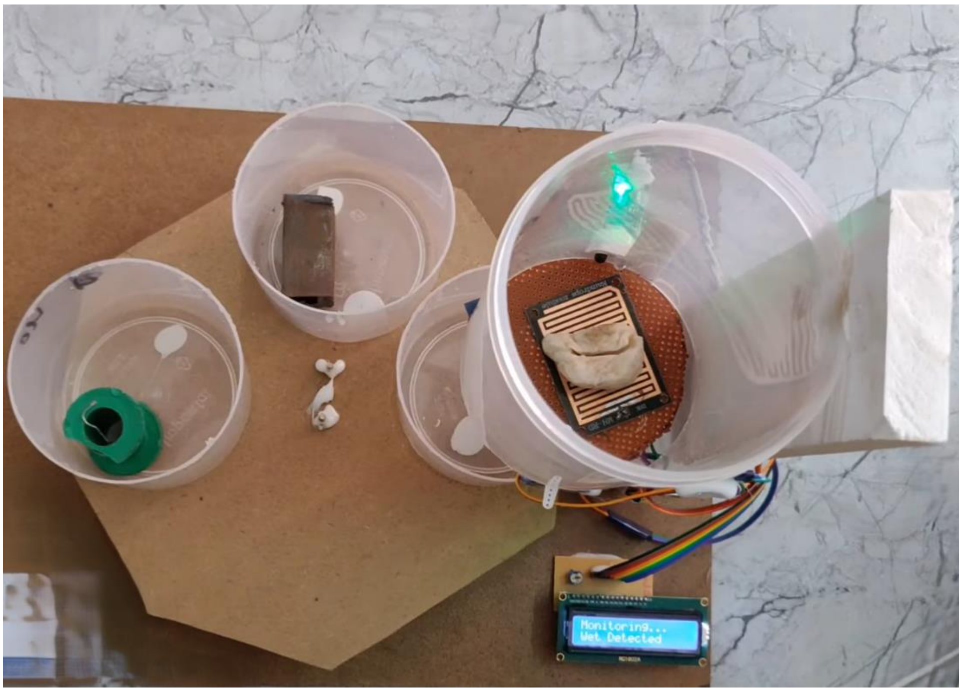


Figure 8.6: detecting wet waste

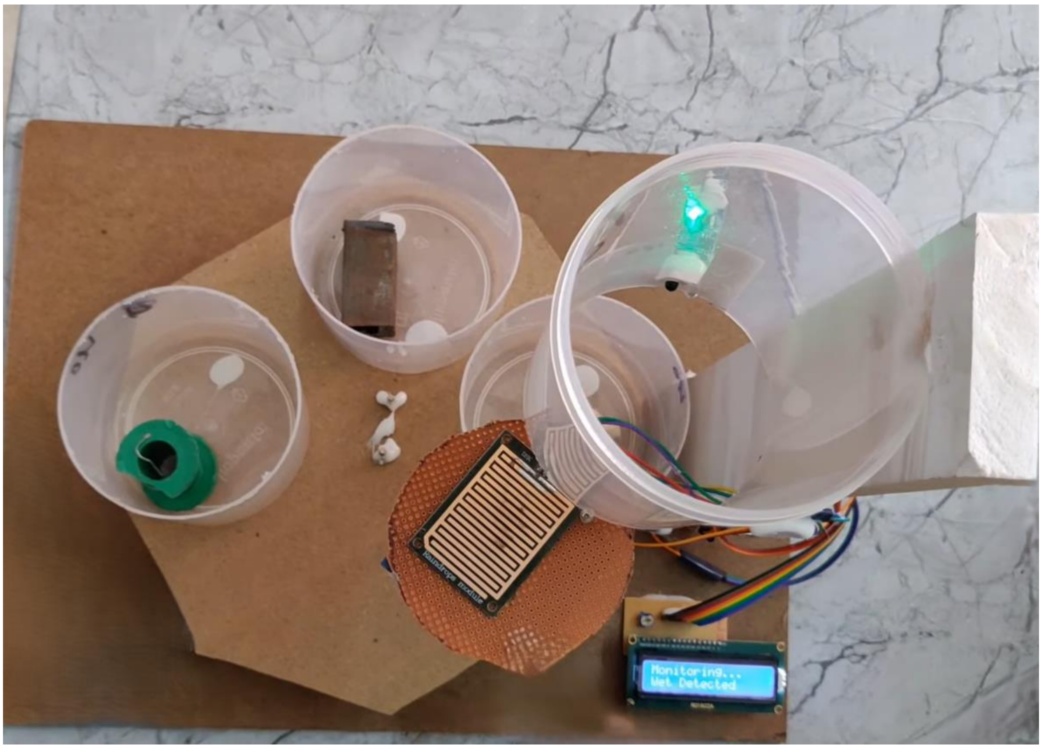


Figure 8.7: drop in wet waste bin

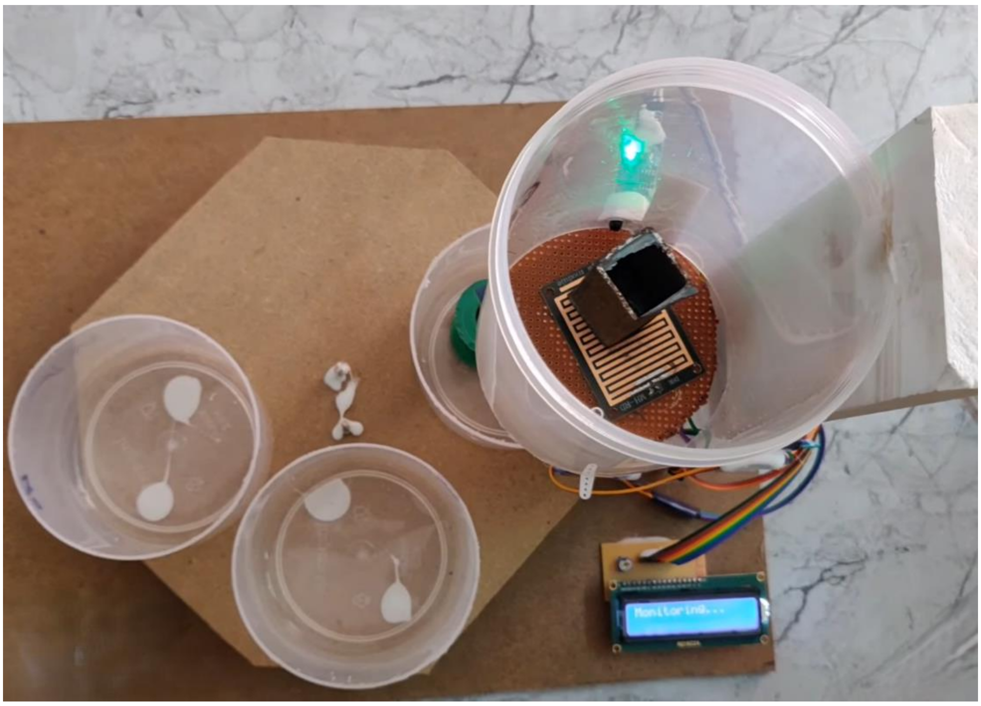


Figure 8.7: metal detecting

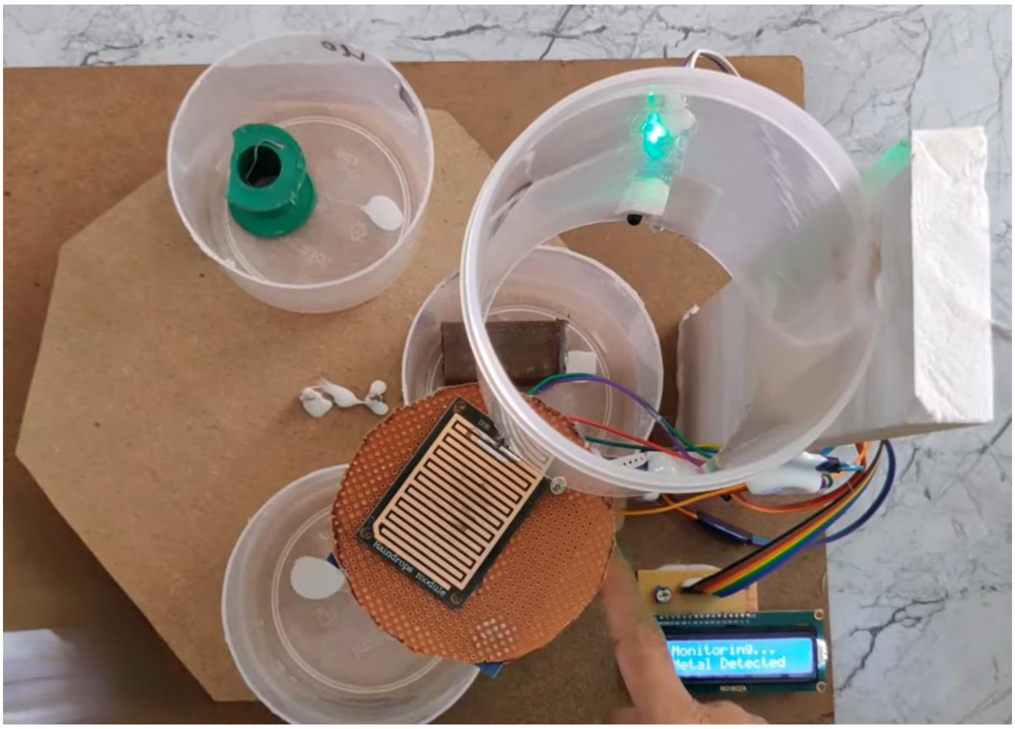


Figure 8.7: drop in metal bin

9. CONCLUSION

In conclusion, the deployment of smart waste segregation systems utilizing IoT technology to differentiate between dry, wet, and metal waste marks a transformative development in waste management. By focusing solely on the segregation of waste, this system efficiently classifies various types of waste using advanced sensors and automation. The real-time processing capabilities ensure that waste is accurately sorted into its respective categories, streamlining the waste handling process. Its primary goal of precise segregation contributes significantly to improved recycling rates and reduced landfill volumes. By effectively sorting waste at the point of disposal, the system supports more efficient recycling processes and enhances overall waste management efficiency. This innovation represents a significant step towards cleaner and more organized waste management, paving the way for more sustainable urban environments and fostering a more responsible approach to waste handling.

This approach ensures that waste is sorted effectively at the source, leading to better recycling outcomes and a significant reduction in landfill waste. Overall, such smart technologies support a more sustainable and responsible approach to waste management, contributing to cleaner cities and a healthier environment. By embracing these innovations, we move towards a future where waste is managed more intelligently and efficiently, fostering a cleaner and greener urban landscape.

10. FUTURE ENHANCEMENTS

Future enhancements in smart waste segregation through IoT are poised to revolutionize waste management by incorporating cutting-edge technologies and data-driven solutions. One significant enhancement involves the development of advanced sensor technologies that can provide more accurate detection of different waste types and contamination levels. By integrating optical sensors and AI-powered image recognition, systems could achieve a finer level of waste differentiation, improving sorting efficiency. Furthermore, the application of machine learning and AI algorithms promises to enhance waste classification by learning from extensive datasets, leading to more precise sorting and reduced errors.

Real-time data analytics will also play a crucial role in optimizing waste management processes. IoT systems equipped with real-time feedback mechanisms can monitor segregation efficiency and contamination levels, enabling dynamic adjustments to collection routes and schedules. The integration of smart bins, which can communicate with other waste management infrastructure, will streamline operations and cut costs. Additionally, automated sorting facilities utilizing IoT-enabled robotics and automation can process waste more effectively, driven by continuous data insights.

To further engage users, IoT systems could offer real-time feedback through mobile apps or smart devices, providing tips for better waste segregation and incentivizing recycling efforts through gamification. Predictive maintenance enabled by IoT sensors will ensure that waste management equipment is kept in optimal condition, reducing downtime and maintenance costs. Moreover, the integration of IoT with smart grids could enhance the energy efficiency of waste processing facilities, contributing to a lower carbon footprint.

Ensuring robust data security and privacy will be critical as IoT systems gather sensitive information. Scalable solutions that can be adapted to various urban and rural settings will make smart waste segregation more accessible. Collaboration with circular economy platforms can track material lifecycles more effectively, promoting recycling and reuse. Lastly, integrating blockchain technology could enhance transparency and accountability in waste management processes. These innovations collectively promise to make smart waste segregation more efficient, accurate, and sustainable, paving the way for improved environmental stewardship.

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