SMART GARBAGE MONITORING AND CONTROLLING USING INTERNET OF THINGS

PROJECT REPORT

Submitted by

Abhishek Kumar [Reg No: RA1611008010411]
Aakash Shoraan [Reg No: RA1611008010419]
Dhruv Saini [Reg No: RA1611008010479]

Under the Guidance of

Ms. Sai Santhiya
(Assistant Professor, Department of Information Technology)

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KATTANKULATHUR-603203

BONAFIDE CERTIFICATE

Certified that this project report titled "**SMART GARBAGE MONITORING AND CONTROLLING USING INTERNET OF THINGS"** is the bonafide work of **"SHREYASI CHANDA BARMAN [Reg No: RA1611008010307], ABHISHEK KUMAR [Reg No: RA1611008010411], AAKASH SHORAAN[Reg No: RA1611008010419], DHRUV SAINI [Reg No: RA1611008010479],** who carried out the project work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion for this or any other candidate.

Ms. SAI SANTHIYA
GUIDE
Assistant Professor
Dept. of Information Technology

Dr. G. VADIVU
HEAD OF THE DEPARTMENT
Dept. of Information Technology

`ABSTRACT

Waste Management refers to the processes needed to manage and take care of waste from its gathering to its closing disposal phase. This comprises of many stages like collection, hauling, treatment and dumping of waste alongside intensive supervising of it and regulation. There are different waste discarding systems and techniques used in distinct republics and places. Curbside assortment is the commonest method of clearance in most places, during which waste is taken at various periods of time by dedicated waste collection vehicles. The collected waster is then moved to an apposite dumping place.

The main issue within the waste supervision is that the rubbish box at community places gets brim over fine-beforehand before the onset of the subsequent cleaning method. It successively results in countless dangers like bad odour & ugliness thereto place which can be the basis cause for spread of varied diseases. To avoid these different toxic scenarios and preserve public hygiene and health this work is taken place on a smart waste administration system.

The main premise of the work is to cultivate a prudent smart garbage alert system for correct garbage administration. This is a IOT based smart garbage clean administration system which tests the waste amount and level across the dustbins by using sensors. Once it is spotted instantly this system is improved and informed to concern officials through IOT. This has ensured the eco-friendly environment and support for Swatch Bharat for cleanliness.

The purpose of this system is to solve the garbage administration problem faced by different organizations in different countries. The Proposed System is a much more advanced method

of collecting and segregating garbage into different dustbins as the system continuously monitors the dustbins and type of waste and update the status of the dustbin and sort the waste.

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SHREYASI CHANDA BARMAN [RA1611008010307]

ABHISHEK KUMAR [RA1611008010411]

AAKASH SHORAAN[RA1611008010419]

DHRUV SAINI [RA1611008010479]

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Waste Management refers to the processes needed to manage and take care of waste from its gathering to its final disposal phase. This comprises of many stages like collection, hauling, treatment and dumping of waste alongside intensive supervising of it and regulation. There are different waste discarding systems and techniques used in distinct republics and places.. Curbside assortment is the commonest method of clearance in most places, during which waste is taken at various periods of time by dedicated waste collection vehicles. The collected waster is then moved to an opposite dumping place.

The main issue within the waste supervision is that the rubbish bin at community spaces gets brim over fine-beforehand before the onset of the subsequent washing procedure. It successively results in countless dangers like bad odour & ugliness thereto place which can be the basis cause for spread of varied sicknesses. To avoid these different toxic scenarios and preserve public hygiene and fitness this work is taken place on a smart waste administration system.

The main premise of the work is to cultivate a prudent clever garbage alert system for correct garbage administration. This is a IOT based smart garbage clean administration system which tests the waste amount and level across the litterbins by means of sensors. The minute it is spotted instantly this system is improved and informed to concern officials through IOT. For this we will used Microcontroller amongst the sensor structures and the IOT structure. This has ensured the eco-friendly atmosphere and backing for Swatch Bharat for cleanliness.

The purpose of this system is to solve the garbage administration problem faced by different organizations in different countries. The Proposed System is a much more advanced method of collecting and segregating garbage into different dustbins as the system continuously monitors the dustbins and type of waste and update the status of the dustbin and sort the waste.

1.2 PURPOSE

Table 1.1: Proposed vs Exiting

EXISTING SYSTEM	**PROPOSED SYSTEM**
➢ In the existing method, the dustbin is not monitored continuously due to the fact that, there is no Wi-Fi technology available for such checking. **Drawbacks of existing system** ➢ Tricky to find whether the dustbin is packed or not remotely. ➢ There is no facility to know the type of waste that comes in it.	➢ In our proposed system we are going to monitor the dustbin in real-time and update the condition of the dustbin. Furthermore, we will sort the type of waste comes in it **Advantages of proposed system** ➢ Fast response ➢ Automatic detection of waste. ➢ One time installation. ➢ Notification is enabled when the dustbin gets filled.

The purpose of this system is to solve the garbage administration problems that are faced by the different organizations of the different countries. The Proposed System is a much more advanced method of collecting and segregating the garbage into different dustbins as the system continuously monitors the dustbins and the type of waste and updates the status of the dustbin and sorts the waste.

1.3 SCOPE

The procedure provides us with the actual time evidence, data and status of the junk litterbins stationed in the distinct areas. By means of this actual time info, we can examine the bins effectively and when the bins are packed, the workers can collect the waste garbage and empty them yet again. This approach is cost-effective and can be retrieved anywhere. With the help

of this smart monitoring garbage system, it becomes efficient and simple to segregate the multipletypes of garbage (metal/biodegradable/non-biodegradable etc.) since the sensors work in such a way by providing the type of waste.

1.4 PROBLEM STATEMENT

There are millions of public dustbins out there that the people use and are emptied within a few days by the public authorities. However, the problem is not that all the garbage cans get filled at the same rate for the dump vehicle, but that they don't waste time checking each and every garbage can. This leads to more fuel usage, labour as well as cost. So, there is a need to find an effective way of segregating the different types of garbage so that the dustbin doesn't get overfilled every time.

1.5 TIMELINE

Table 1.2: Week wise distribution of Project Modules

S. NO	PROJECT MODULES	WEEK NO.
1	Problem Definition and Literature Review (Existing System Analysis)	Week 1
2	Requirement Analysis and Flow Chart	
3	Pin Declaration/Setup for Arduino	Week 2
4	setup() function for basic Input/Output Declaration on LCD Display	Week 3
5	loop() function for Ultrasonic Sensor	Week 4
6	loop() function for Soil Moisture Sensor	Week 5
7	Image Recognition, Authentication and Processing using MATLAB	Week 6-7
8	Finishing of the working model integrating all the above parts	Week 8-9
9	Debugging	Week 10

1.6 REQUIREMENT ANALYSIS

1.6.1 HARDWARE REQUIREMENTS:

- ARDUINO MEGA
- SERVO MOTOR (2)
- ULTRASONIC SENSOR (1)
- CAMERA
- MOISTURE SENSOR
- LCD 1
- IOT MODULE
- BUZZER

1.6.2 SOFTWARE REQUIREMENTS:

- EMBEDDED C
- ARDUINO IDE
- MATLAB

1.6.3 FUNCTIONAL REQUIREMENTS:

There are some main requirements for the system:

- The system should provide the alert as soon as the garbage bin reaches its full capacity.
- The system should be able to differentiate between metal, wet and all the other types of waste.
- The system should be able to separate the waste automatically in accordance with the stated categories.
- The system should be able to provide with the data collection.

1.6.4 NON-FUNCTIONAL REQUIREMENTS:

- Easy development and deployment
- Reduction of human efforts
- Scalability in terms of large area
- Low cost and efficient
- Provide real time status

CHAPTER 2

LITERATURE STUDY

1. **IoT Based Solid Waste Administration System**, Abhay Shankar Bharadwaj, Rainer Rego, IEEE, 2016.

The IOT system is constantly developing evolving. It is providing us with unique solutions to the everyday difficulties and challenges that are confronted by man. “Intelligent and Smart City” is such an execution targeted at enhancing the existence and everyday life of the common people. The major obstacle in maximum metropolises is its waste administration, and the active management of the surplus generated turn out to be avital part of a intelligent city. This research intends at presenting an IOT constructed solution to confront the issues confronted by the present waste administration structure. By offering a whole IoT built system, the practice of pursuing, accumulating, and handling the solid waste can be easily automatic and examined efficiently. Using the instance of the solid waste administration disaster of Bengaluru city, India, we have introduced by means of the complete system structural design and set of rules heap to give an IoT centered result to boost the dependability and competence of the structure. By using sensors, we plan to accumulate files as of the waste bins and show them to a entryway by means of the LoRa expertise. The information from numerous rubbish bins are composed by the entry and directed to the cloud over the net by means of the MQTT (message queue telemetry transport) protocol. The main benefit of the planned structure is the LoRa for data interaction which allows long-distance data broadcast end to end with small power utilization as associated to Wi-Fi or Bluetooth.

2. **A Waste City Administration System for Smart Cities Applications**, Dung D. Vu, Georges Kaddoum, IEEE, 2017.

This research represents an inventive approach of smart waste administration which makes the ecosystem of the city fresh and clean in a cost-effective manner. In this approach, the sensors test, discover, assess, and communicate garbage capacity information via the net.

The accumulated statistics including the waste bins' geo-site along with their sequential number is administered by using linear regression, linear classification and graph theory. Subsequently, a new approach is proposed to animatedly and effectively manage the waste compilation by forecasting waste status, cataloging the trash bin site, and examining the amount of rubbish. Then, this urges the optimization of the path to control the waste truck effectively. Finally, the replication results are produced and projected.

3. **IoT based solid waste administration system for smart city,** Uttam M.Chaskar, Krishna Nirde, Prashant S. Mulay, ICICCS, 2017.

In today's age waste administration from its collection stage to its discarding stage is one of the most vital tasks for the municipalities across the world. Garbage bins are located across towns, such open spaces are swamping because of the rise in the trash produced every day. It then results in germ-infested disorder for the inhabitants and to sustain a premeditated detachment from such a situation, we have planned a smart solid waste supervision system for cities that allows municipalities and authorities to regulate the dustbins remotely by monitoring them and clean very capably by optimizing time and cost essential for it. The aim of the project is to boost work ability of IoT centered solid waste assortment and administration system for intelligent city.

4. **Cloud Computing Based Smart Garbage Monitoring System**, Joshitha Reddy, Praneeth Reddy, Jetendra Joshi, ICED, IEEE, 2016.

A clean and eco-friendly ecosystem is vital to a wholesome and pleased neighborhood. With the scheme involving of employing people to frequently test and empty the over flowing garbage can, the procedure has come to be susceptible to human miscalculation and negligence. Moreover, due to the extensively fluctuating occurrence of practice of garbage can in diverse zones, routine drafts which are based on time splits is incompetent due to the reason that a wastebasket may fill up earlier in some zones and may need instant consideration or there may be insufficient amount of checks on other zones. Hence, this is why the current approach is costly and inefficient, as brimming, stinking garbage cans become more trouble than a resolution. In this piece we represent a resolution about the Smart Garbage Bin using a web of rubbish bin which incorporates the concept of IoT with Sensor Systems.

CHAPTER 3

PROPOSED METHODOLOGY

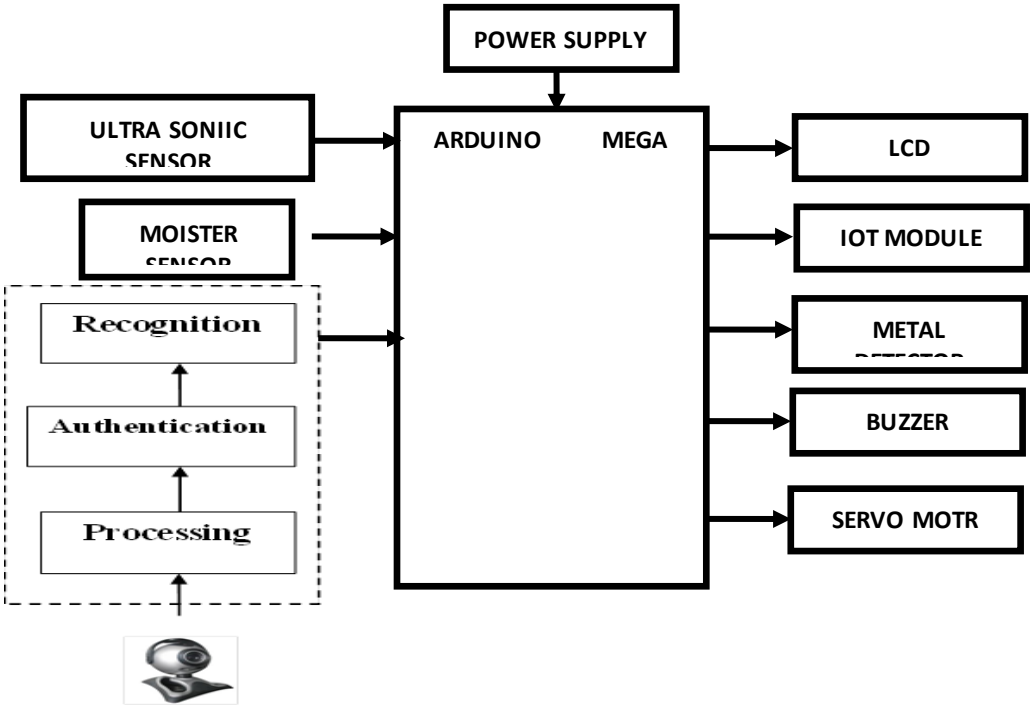


Figure 3.1: Diagram for Methodology

- In our project, we will use an **ARDUINO MEGA** (ATmega2560) Microcontroller which functions as the intellect of the structure, because the complete system instruction are stored in it.
- **Ultrasonic sensor** is utilized to **monitor** the garbage.
- In the first stage, the **metal sensor is required to isolate the metal wastes** and the other items are separated to the other section.
- **Moisture sensor** is required to **isolate the wet items** from the garbage.
- In the second section the **image processing** is done to **detect the plastics and bio-degradable objects** and they are split. Here, all the **movement is done by using servo motor.**

- The dustbin **stats are exported to the cloud using IOT**. So that all the operation is either controlled or monitored by IOT.

3.1 HARDWARE DESCRIPTION:

1. ARDUINO:

- Open-source integrated circuit technology program that supports simple hardware and the software.
- Get or receive inputs - illumination on a sensor, a touch on a button, or a other media communication - and consequently, get an output such as getting a light on LED, etc.
- Software is fairly simple and easy for novices, but adaptable for sophisticated users.
- The Mega2560 Board features several capabilities for collaborating with a workstation, another panel, or other microcontrollers

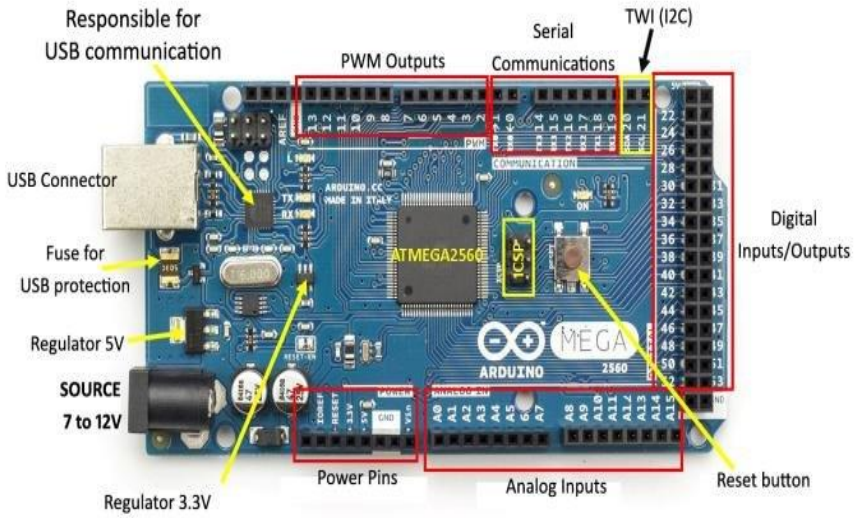


Figure 3.2: Arduino Board (MEGA)

PROGRAMMING:

The Mega2560 board are usually coded in conjunction of the Arduino (IDE).

The ATmega2560 on the Mega2560 comes pre-coded with a module that permits you to export a new program into it devoid of the consumption of an outside hardware systems analyst. It conveys using first STK50.

2. SERVO MOTOR:

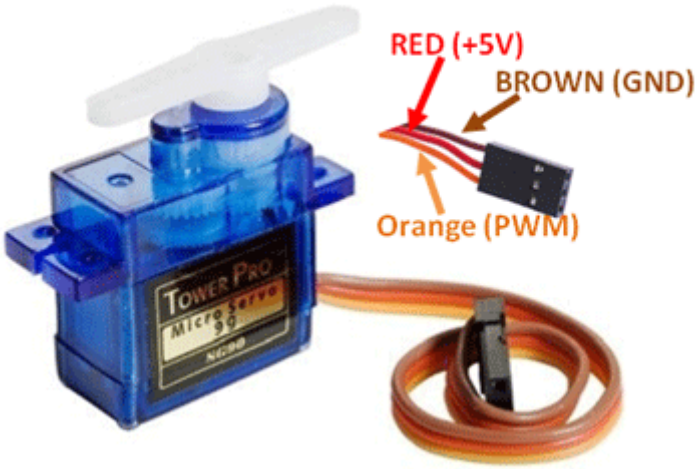


Figure 3.2: Servo Motor

A Servo Motor is a tiny machine with a production shaft. This shaft is located to certain sharp situations by sending it a oblique signal. If the implicit signal alterations, the status of the shaft will also alter. Usually, servos are applied in radio-controlled aircraft to place monitor exteriors just like the cranes and tillers. They are also employed in vehicles, marionettes andeven in computers. Servo motors take response to drive out the positioning of the shaft. The position of the shaft is controlled extremely precisely. Hence, servo motors won't monitor the positioning of items, rotate pieces, move rods, limbs of robots etc. with superior accuracy. Servo motors are tiny in magnitude, and that's why they need built-in electrical structure to synchronize their passage, they need to be linked with an Arduino. Minuscule and pawn with elevated output capacity. Servo can turn roughly 180 points (90 in each course) and works a little like the feature types but smaller.

SERVO MECHANISM:

It entails of 3components:

1. Regulated Device
2. Yield Sensor
3. Response System

It is a circuited structure where it takes a constructive response system to manage the movement and the inception stop placement of the shaft. The maneuver is monitored through a response indication produced by evaluating the yield signal and the locus input 'signal'.
Then, the input signal is contrasted to the output signal and the last signal that is delivered by a response structure. Furthermore, this last signal that acts as an response signal is used to regulate the tool. This indicator exists for the time as the response signal' is spawned or unless there is a distinction between the input signal and the output signal . Consequently, the core mission of servo process is to preserve the yield of a procedure at the preferred amount at the existence of blasts.

3. THE ULTRASONIC SENSOR:

- Sensor use sonars in a way to measure distance from an object in same way similar to the bats.

- It provides a non-contact range detection along with highly accurate and uniform readings within easy-to-use packages.

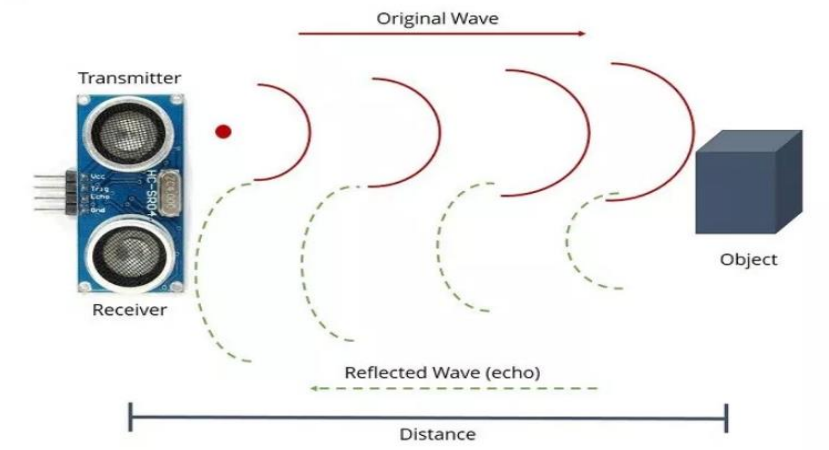
- It comes with a transmitter that is ultrasonic and modules that work as receiver. By using ultrasonic signals the sensor tip emanates ultrasonic waves and also the waves echoed back from the target, it helps to measure length / distance.

- By calculating the time period from emission to receipt, it measures the length / distance through the target.

WORKING BASICS:

Ultrasonic transmitter transmits sound waves.

These sound waves are reflected from the surface of the object. An ultrasonic sensor acquire the diverted waves. It measures the time duration elapsed during the full process i.e. from transmission to receiving which is known as "round trip time". This time duration is identical to the distance between the object and the transmitter. Following is given some visual, in order to understand its working and flow. The principle of the sensor is shown below



HC-SR04 Ultrasonic Sensor Pinout

Figure 3.4: Pin diagram

PINS :

- VCC: +5VDC
- GND: GND
- Trig : Trigger (INPUT)
- Echo: Echo (OUTPUT)

ULTRASONIC SENSOR PIN CONFIGURATION:

Table 3.1: Pin Configuration

Pin number	Pin name	Description
1.	Vcc	The Vcc point provides the power supply to the sensors nearly with +5V
2.	Triggers	Trigger is the input. The pin is set high for about 10us.
3.	Echo	Echo is the output pin. The pin goes high for the amount of time which is identical to time that is taken by the wave to return back to sensor.
4.	Ground	This pin is attached to the ground of the Ultrasonic system

TIMING DIAGRAM

To start from the range you must send a brief'10uS pulse to the start data. The module will then send out eight cycle ultrasound burst for 40 kHz and raise the echo. The Echo may be a distant object that is pulse width and therefore proportionally home. We can measure the range by the interval between sending the signal to the trigger and receiving the echo.

Formula: 'uS/58' = centimeter or 'uS/148 = inch;' or :'

range = high-level time * velocity'(340M/S)/2; to avoid the echo signal from activating.

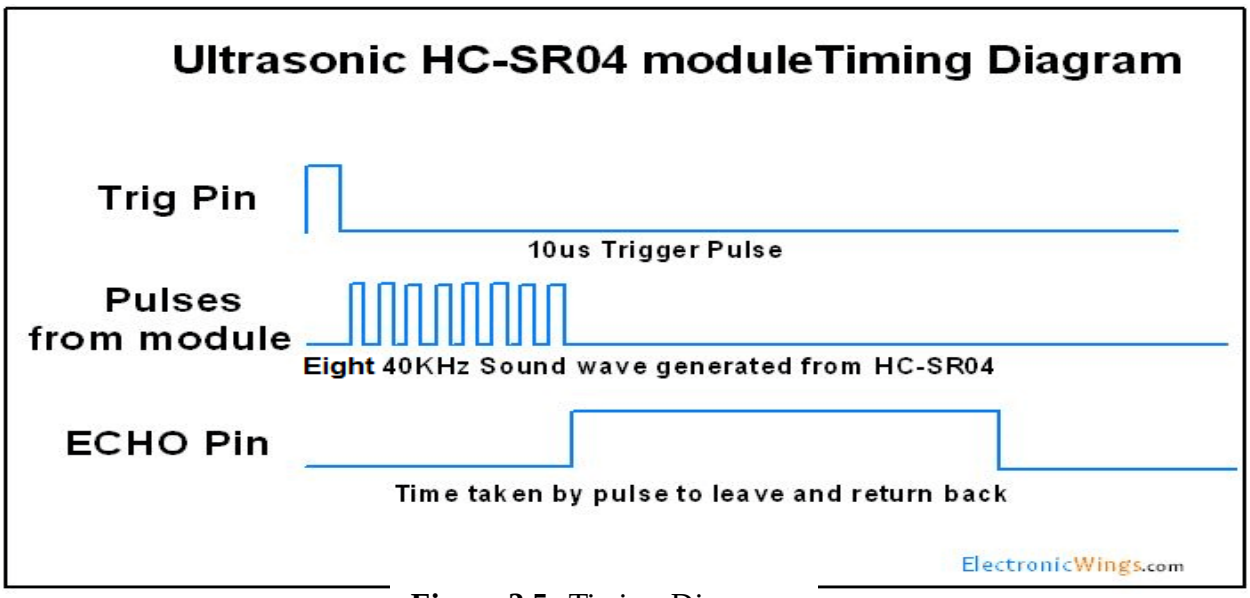


Figure 3.5: Timing Diagram

APPLICATIONS:

- To avoid and detect the barriers for robots.
- For detecting the objects that are surrounding or is near the sensor by revolving it.
- Speed and direction measurement
- Embedded structure
- Depth dimension
- Wireless charging
- Humidifiers

4. MOISTURE SENSOR FOR SOIL:

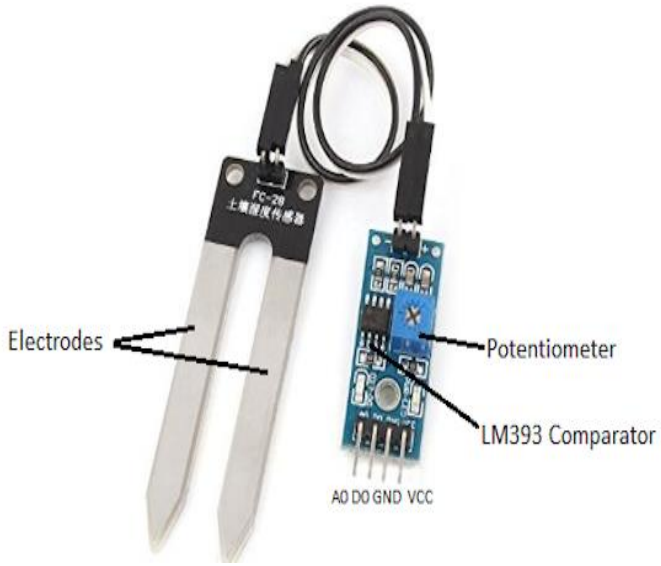


Figure 3.6 : FC-28 Soil Moisture Sensor

- This is used to investigate the humidity of soil.
- Any time the soil experiences scarcity of water, the output is at a high level, and otherwise the output level remains low.
- By using the sensor, the plants or other plants can be regularly irrigated using an automatic watering device.

DESCRIPTION:

The sensor consists of 2 parts one is the fork-shaped probe that needs to be nailed to the bottom the other is an electronic modules which will need to be connected to the probe along with the Arduino board. It is operated with a 3.3V or 5V supply VCC and GND pins. The red LED will light once we are feed it. It has both digital as well as analogical functionality, the pin AO will provide an analog signal between the value to 0V ,for higher humidity value are going to be higher. The upper the humidity is higher conductivity of the soil and thus increases the worth that we measure.

WORKING PRINCIPLE:

This digital soil moisture sensor is very simple to use. The sensor needs to be simply inserted within the soil, this will determine the amount of humidity or water content within it. It gives 5V digital output when the level of moisture is high, and 0V the level of moisture inside the soil is low.

It includes a potentiometer to line the upper limit of specified humidity. If more moisture is detected by the sensor than the set point, the cardinal productivity leaps to high, and the LED indicates production. If the soil's moisture is below the set limit the production remains low. To calculate the humidity level the cardinal outputs are regularly linked to a microcontroller. The unit also provides a comparable performance that can be linked to a microcontroller's ADC to get the same and exact amount of humidity in the strong. The sensor is suitable for the development of horticultural water projects etc.

Usage:-

- The component of soil moisture is the most cruel to the environment and wants to notice the content of soil dampness.
- When the part can not meet the edge values, the DO port output sets a very high value, the module D0 output becomes small when the soil dampness crosses a group brink value;
- The tiny digital output panel D0 is often attached to the 'MCU' so as to notice high and low soil dampness;

- Minor digital output panel DO can unswervingly drive the buzzer component or relay component in our shop, which may form an alarm gear for soil dampness;

APPLICATIONS

1. Agriculture

Measuring the moisture of the soil or ground has importance for agricultural applications that aid the farmers in order to manage the irrigation systems more efficiently as well as effectively. With the knowledge of the precise soil dampness conditions on their turfs, not solitary are agronomists ready to commonly use less amount of liquid to nurture a crop, but they are also ready to enhance the harvests and therefore eminence of the crop using the enhanced administration of soil moistness during serious plant evolution stages.

2. Landscape irrigation System

Lands and grasslands now use soil moisture detector in suburban and rural areas to create communication with an irrigation organizer. Linking a soil moisture sensor to a system clock for easy irrigation helps turn it into a 'smart' irrigation 'controller that handles irrigation cycles when the soil is already wet, e.g. after a recent 'rainfall event.

Golf courses and various other such lawn courses use soil moisture sensors to increase the efficiency as well as the efficiency of 'irrigation systems to stop over-irrigation and leaching' of composts as well as 'chemicals to the soil's bottom.

3. Research

Soil moistness detector are utilized in various examination submissions, e.g. in agricultural science and horticulture including the irrigation system and the watering planning, environmental and eco-science as well as climate research including some transport studies use ‘sensors for the soil respiration measurements.

4. Sensors for gardeners

They are moderately cheaper, easy and straightforward strategies that do not have an influence source and are accessible to check whether the plants have satisfactory moistness to live in. After approximately 60 seconds of applying a sample to the soil, a tool shows whether the soil is very dry, wet or suitably moist for plants and trees.

5. LIQUID CRYSTAL DISPLAY:

LCD screen is a display module that helps to find a good range of usability and functions. A 16x2 LCD display is an enormously straightforward unit and therefore, is particularly frequently applied in various machines and circuits. These systems are more favored over other multi section LCDs. The justifications being: LCDs are cost-efficient; easy to program; do not have restriction of exhibiting extraordinary and even custom characters computer graphics then on.

A 16x2 LCD means that 16 characters can be displayed in each line, and that there are two such lines. Each character in this LCD is displayed in the 5x7 px matrix. This LCD has a Register of Commands and a Register of Data. The former save the command commands given to the LCD and the latter is a command given to the LCD to attempt to perform a particular function, such as setting it, clearing its screen, etc. The data register will store the information which will be displayed on the LCD.

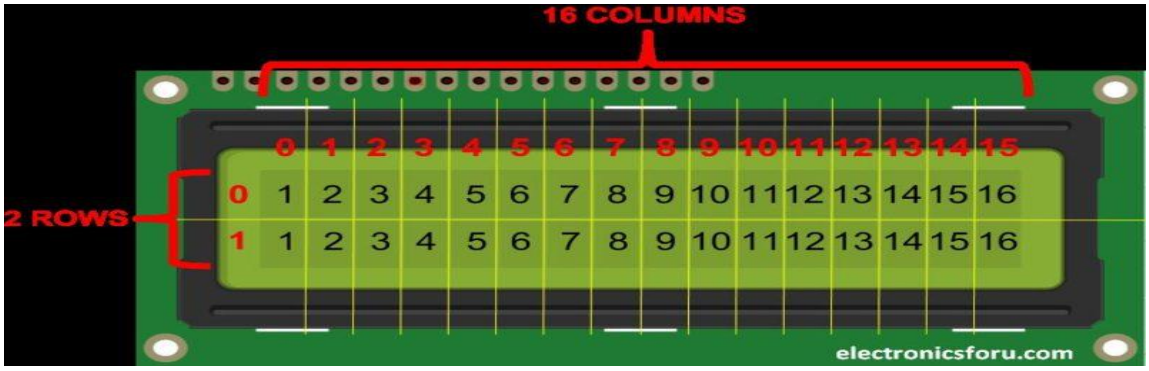
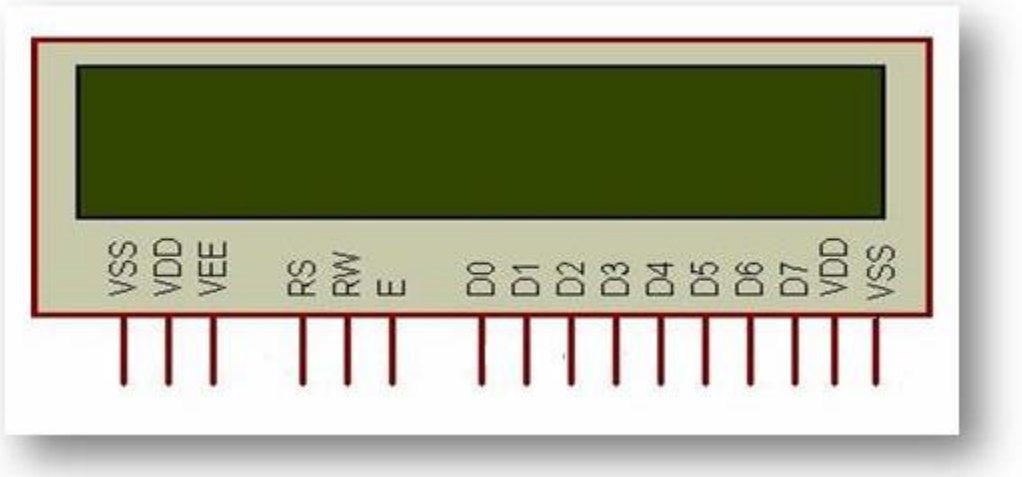


Figure 3.7: LCD Screen

16X2 LCD PINOUT DIAGRAM:



RS (REGISTER SELECT):

This LCD has a Data Register and a Command Register. For the former register plus RS=1 for the latter it is used to move from the single register to the other.'RS=0.

COMMAND REGISTER:

The command register holds all the command tasks that are delivered to the LCD. "Command" essentially means an order that is provided to the LCD with the purpose of doing a particular given job for example, initialization, clearing the screen, putting the cursor in its place, control of display etc. The commands are processed within it.

DATA REGISTER:

The data register holds the details or useful data needed for the on the LCD projection. The data consists of the ASCII value of each of the characters intended for display on the LCD. The data supplied to the LCD will be moved to the info register after which it will be processed there. When RS=1,'data'register'is picked.

VITAL COMMAND CODES FOR LCD:

Table 3.2: Command code for LCD

SR. NO.	HEX CODE	COMMAND TO LCD INSTRUCTION REGISTER
1	01	Clearing up the display screen
2	02	Returning home
3	04	Decrement of the cursor (shift cursor to left)
4	06	Increment of the cursor (shift cursor to right)
5	05	Shifting the display right
6	07	Shifting the display left
7	08	Display is off, cursor is off
8	0A	Display is off, cursor is on
9	0C	Display is on, cursor is off
10	0E	Display is on, cursor is blinking
11	0F	Display is on, cursor is blinking
12	10	Shifting the cursor position to the left
13	14	Shifting the cursor position to the right
14	18	Shifting the entire display to the left
15	1C	Shifting the entire display to the right

3.2 SOFTWARE DESCRIPTION:

ARDUINO SOFTWARE (IDE):

The Arduino IDE - or Arduino Software (IDE) - consists of a text editor for writing the codes and modules, an area for messages, a console for text, a toolbar along with buttons and other functionalities with purpose of ordinary functions as well as a succession of menus. This is connected to Arduino and Genuino for the objective of conveying information.

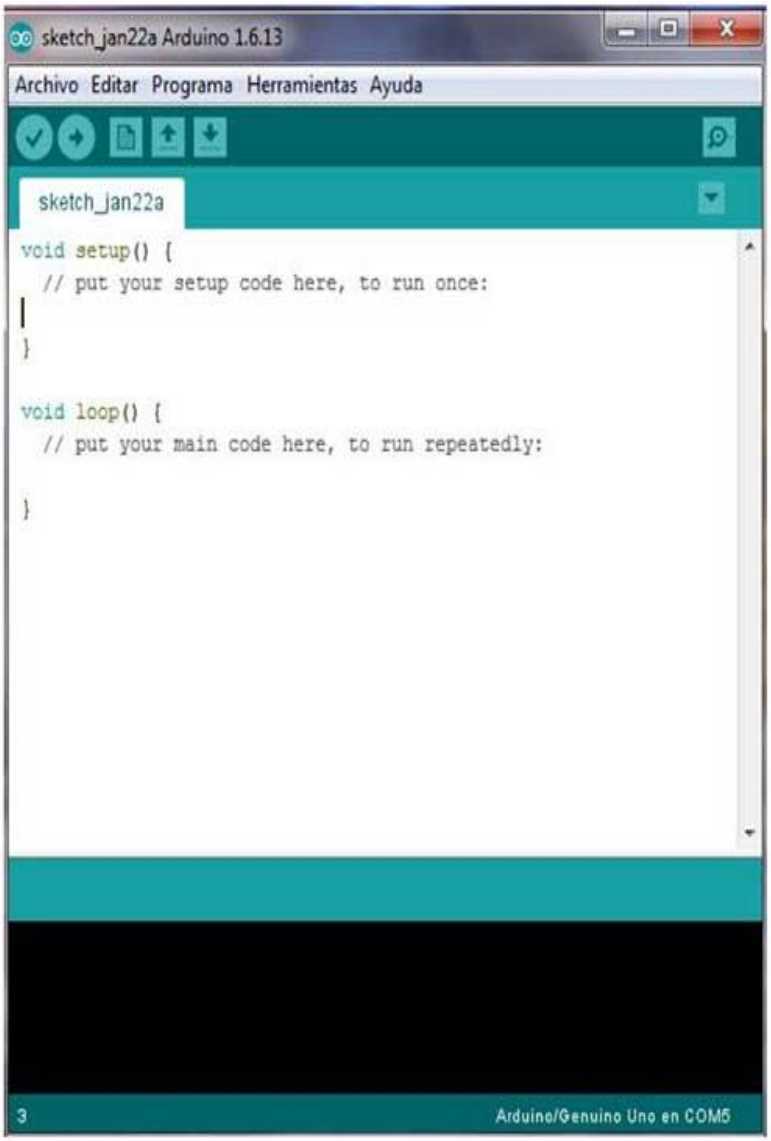


Figure 3.8: Arduino IDE

WRITING SKETCHES:

Programs, codes and modules created with the use of the Arduino IDE are referred as sketches. They are coded using the text editing software and saved using the extension, ".ino". This editor includes numerous facilities for copying, cut or paste as well as search, editing or replacement of text. The space for message provides the feedback along with saving, running and even displaying the glitches. The text output by the Arduino Software (IDE) is projected on the console and it includes the complete messages of bugs and the supplementary information. The lower right corner of the window presents the board after configuration along with the interface. The buttons at the toolbar facilitate you in verifying, uploading and also importing the programs as well as creating, opening, and saving the sketches as well as opening of the serial monitor. NB: Versions of the Arduino Software (IDE) before 1.0 used to save the sketches using the extension, ".pde". One can access the files using version 1.0. They shall then get a prompt for saving lots of their sketch using ".ino".

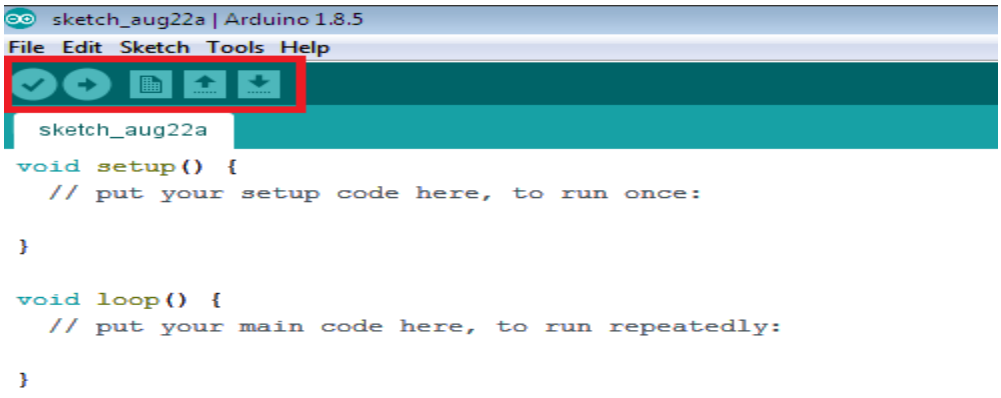


Figure 3.9: Step to write sketch

Table 3.3: Options accessible when making a new Sketch

	**Verify** Tests the code for bugs while compiling it.
	**Upload** Compiles the program and even uploads the same to the configured board. Refer to the uploading given ahead for further information. Note: In case one is making use of an external programmer together with their board, they will keep holding down the "shift" key on their computer while making use of the specific icon. Text shall transform to "Upload using Programmer"
	**New** Creates a fresh sketch.
	**Open** Displays a list of every sketch in the sketchbook. When any one is clicked, it shall be opened in the present window along with its data being overwritten. Note: On account of a glitch in Java, the menu does not scroll. In case one would like to open a sketch late within the list, the File | Sketchbook Menu must be used as an alternative.
	**Save** Saves the sketch.
	**SerialMonitor** Opens up the serial monitor.

Additional scripts are available in the 5 options: Paper, Edit, Sketch, Resources, and Support. These menus are context-sensitive, which ensures that only the items applicable to the task currently being performed will be made available.

SKETCHBOOK:

The Arduino Software (IDE) implements an idea that sketchbook is a typical location to store the programs or even sketches. The sketches in the sketchbook are often opened by using the menu File > Sketchbook or by using the Open button at the toolbar. During the primary run of Arduino software, a directory with the purpose of your sketchbook shall be created by design. The sketchbook position situation can be presented or altered using the Preferences dialog.

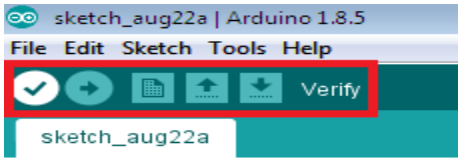


Figure 3.10: Process of compiling the Sketch

UPLOADING:

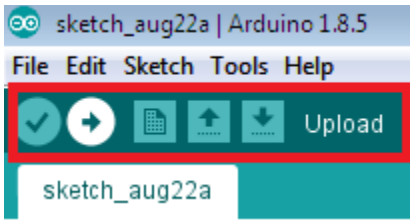


Figure 3.11: Process of Uploading

Arduino boot loader uses the uploaded sketch. It is a little program loaded onto the microcontroller on the board. It facilitates uploading of the program devoid of any sort of further machinery. Boot loader has been activated only for couple of seconds for the time of rebooting of the board after which it begins any sketch that has been last uploaded in microcontroller. Boot loader shall then flash a few times the on-board, pin 13, LED at the time that it starts (which is whilst the board shall reset).

LIBRARIES:

Libraries offer with superfluous facilities that are to be used in sketches, for example – operating using hardware device or altering the information. For using a library during a sketch, it needs to be selected using Sketch > Import Library menu. This shall put in single or multiple #include statements on highest part of sketch and amass library together with sketch. Since libraries are transferred onto board together with the sketch, they augment the quantity of the amount of storage it uses. In case sketch does not need library, one can plainly remove its library code present at the top of the code.

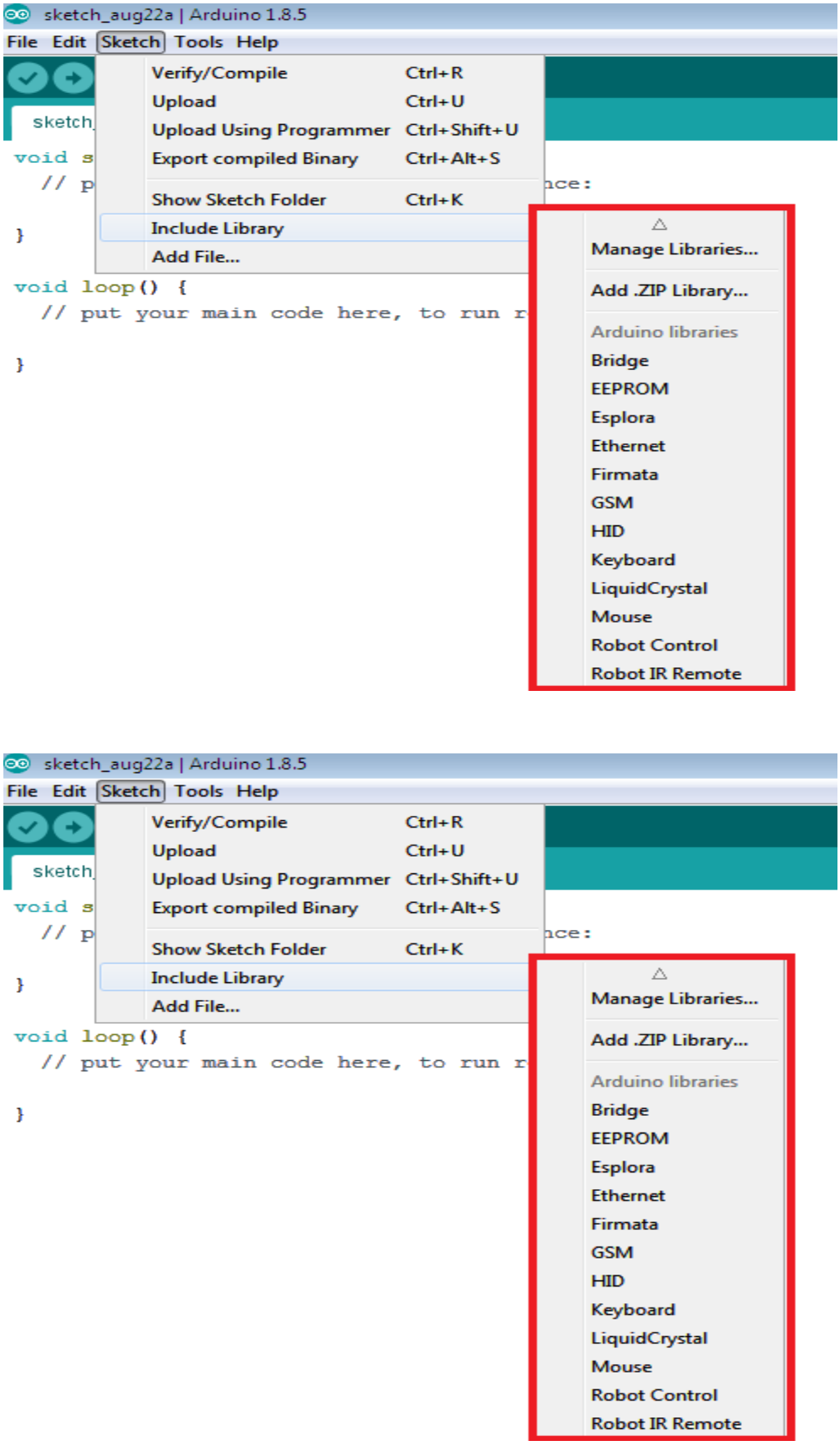


Figure 3.12: Libraries

THIRD-PARTY HARDWARE:

Sustain in favor of third-party hardware might be inserted to the hardware database of the sketchbook directory. Display places put in shall contain already predefined board explanations (that emerge within the board menu), main libraries, boot loaders, and programmer's classifications. For installation, one has to make hardware database and after that, open third-party display place in particular sub-directory. (Do not utilize "Arduino" in favor of the sub-directory title as it shall override the fixed Arduino platform.). For uninstalling, merely obliterate its database.

SERIAL MONITOR:

It projects the serial that has been delivered through the Arduino board above USB port or serial connector. For sending information to the board, one must put in input and tick "send" key or push enter key. Opt for the bandwidth among the menu which aligns with speed sent to Serial. Start the sketch. However, on Windows, Mac and Linux board shall reset once it is connected to serial monitor. Serial Monitor shall not work on the control characters, in case the sketch requires an entire administration and review for sequential statements using control characters, there is need to exercise a peripheral terminal program while connecting it to COM port allotted for the Arduino board.

3.3 EMBEDDED C:

Embedded C is not just an incredibly effective but also the most popular programming language in the software field and the IT sector for the development of electronic devices. Each processor that is applied for the electric arrangement is consequently linked to the rooted software.

Embedded C program has key position for the performance of a definite utility via processor. During the everyday life, there is application of numerous electric tools like mobile phones, washing machines, digital cameras, etc. The working of each of these devices is derived from a microcontroller which is coded by embedded C.

Below is the diagram illustration of an embedded system programming:

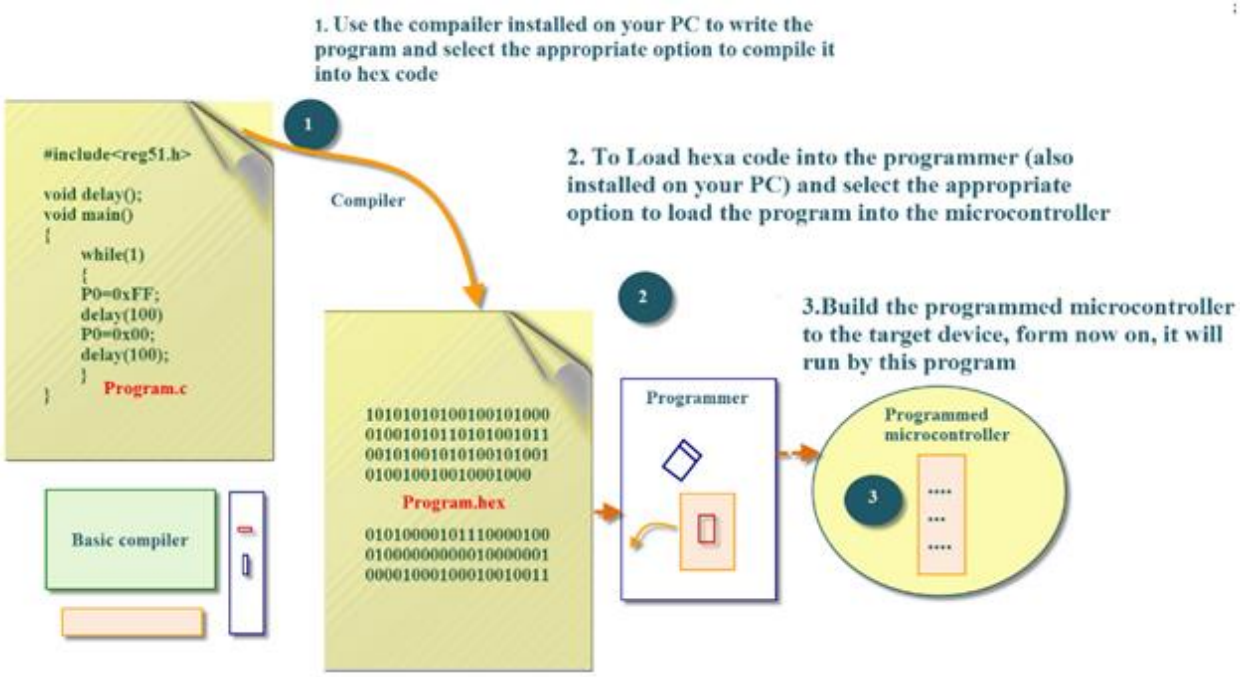


Figure 3.13: Block Diagram of an embedded system

The C code mentioned in the given block diagram is to blink the microcontroller's LED connected to Port0.

Programming in C language is favored over other languages because of following reasons:

- Easy to comprehend
- High Consistency
- Portability
- Scalability

SYSTEM PROGRAMMING:

Basic Declaration

Below is a block diagram for development of Embedded C programming:

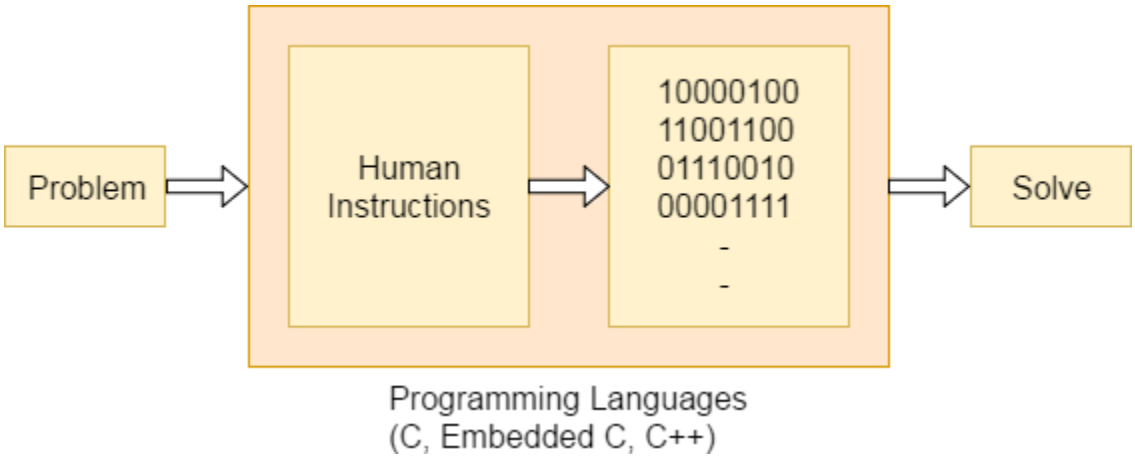


Figure 3.13: Embedded C Programming Diagram

Function is a group of the declarations that are used for executing a desired task. A group of one or more such functions or declarations is termed a programming language. Every language is consisted of essential and structural rules. The C programming is meant for functions with variables, list, datatypes, keywords, expression that are used for coding the program.

In C language the extension is understood as embedded C programming language.

EMBEDDED SYSTEMS:

Embedded System is a machine consisting of hardware, software programs and real-time operating systems. Most often, it's small, independent system or a large combination system. Our Embedded System tutorial covers all the Embedded System topics such as characteristics, architecture, processors, microcontrollers, tools, programming language, interrupts, flickering led, serial communication, LCD programming, implementation of project etc.

SYSTEM:

System is simply a way to work, arrange or execute one or more activities that are compatible with a hard and fast set of rules, schedules or plans.
It is an arrangement under which all units cooperate to carry out a desired work together by following a certain set of rules in real-time calculation. It also can be defined as 'how' of working, organizing or doing one or more tasks that are consistent with a hard and fast plan.

An Embedded System is basically a device that has computer hardware mounted software that makes a device dedicated to a range of applications, or different parts of an application or product, or part of a larger system.

The system can either be a small independent system or a large combinational system. It is a microcontroller-based control device that is used to complete a specific job of operation.

The system consists of three major components:

- **Hardware:** Hardware is the physically used component that is physically combined with an embedded system. It comprises of microcontroller-based integrated circuit, power supply, LCD display etc.
- **Application software:** Application software empowers the user to perform varieties of application that are to be run on an established system by changing the code installed within an embedded system.
- **Real Time Operating system (RTOS):** RTOS manages the workings of an embedded system. It acts as an interface between the hardware and the application software which oversees the application software and provides a mechanism to enable the processor to run on a schedule to control the effect of latencies.

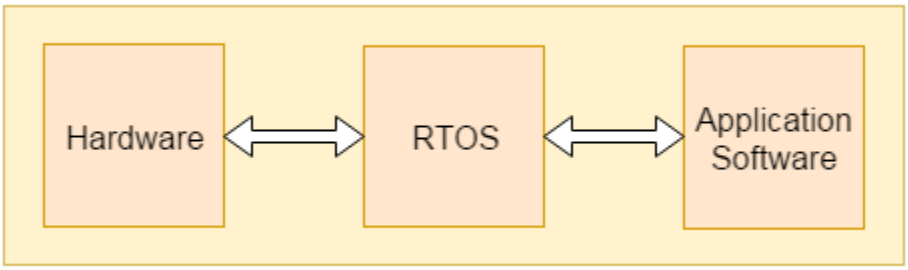


Figure 3.14: Components of Embedded System

CHARACTERISTICS OF THE SYSTEM:

- An embedded system is a software that has been implanted into hardware of the computer in order to make a device keen to be used for a variety of applications.

- Usually, embedded system is used to perform a specific function that offers a real-time product based on different features of an embedded device.

- Embedded device can also include a smaller component within a larger equipment that is used to support the more complex application to perform task quality using configuration for hardware-software intermixing.
- It supplies high security and real-time computation ability.

Advantages:

- Same hardware can be used in variety of application
- Lesser power is required
- Lower operational cost of the system
- Provides high performance and efficiency

Disadvantages:

- Developing a system requires large amount of time due to the functional complexity.
- Experienced engineers are required because even one minute error may result in destroying the complete project.

Designing of an embedded system

BASIC STRUCTURE OF AN EMBEDDED SYSTEM:

Let's see the block diagram describing an embedded system's basic structure.

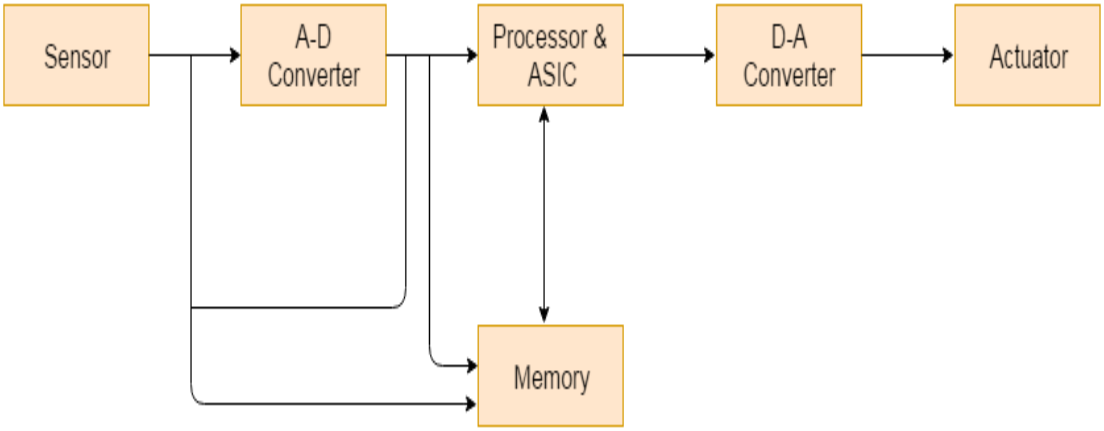


Figure 3.15: Basic Structure of Embedded System

- **Sensor**: It is used for sensing of the change in environmental conditions and it generates the electric signals on the basis of this change in the environmental condition. Therefore, it is also referred to as a transducer for providing electric input signal on the basis of the change in environmental condition.

- **A-D Converter**: A device that converts analog electric input signal to its equivalent digital signal for further processing in an embedded system.
- **Processor & ASICs**: Processor is used for processing the signal and the data to execute desired set of instructions with high-speed of operation. Application specific integrated circuit (ASIC) is designed with the purpose of performing task specific operations inside an embedded system.
- **D-A Converter**: A device that converts digital electric input signal too its equivalent analog signal aiming for further processing in an embedded system.
- **Actuators**: Actuators is a comparator used for comparing the analog input signal level to desired output signal level for providing the error free output from the system.

DESIGN MEASURES NEEDED FOR THE EMBEDDED SYSTEM:

Designing steps required for embedded system are different from the design process of any another electronic system.

A flow chart is given below which represents the design steps needed to create an embedded system:

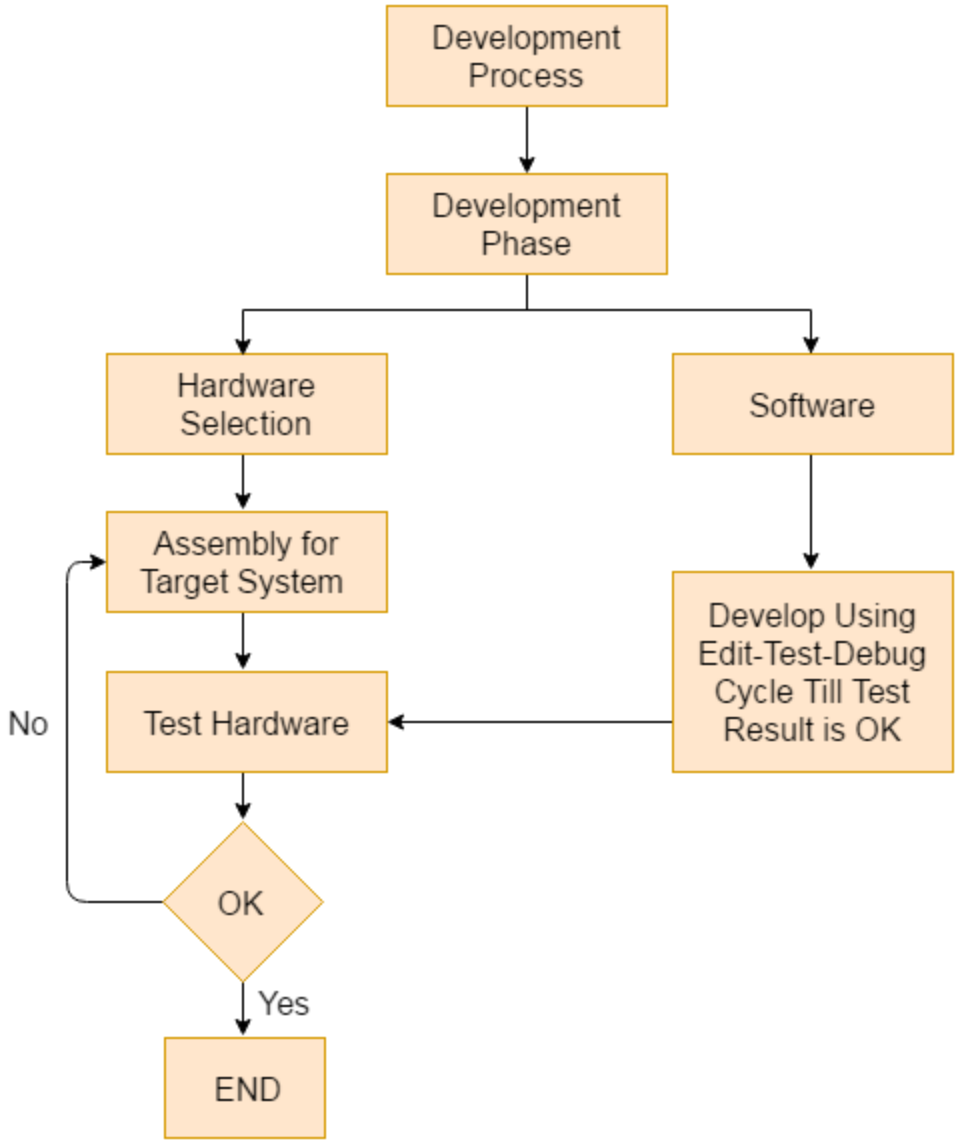


Figure 3.16: Flow Chart needed in Embedded System development

MICROCONTROLLER STARTER KIT:

In order to develop an embedded system based project, a complete microcontroller starter kit is obligatory. The major advantage of this kit over a simulator is that the former works in real-time operating condition while the latter does not. Hence, it allows the easy input/output functional verification. Consider a microcontroller starter kit consists of:-

- Hardware Printed Circuit Board (PCB)
- In-System Programmer (ISP)
- Some embedded system tools like compiler, assembler, linker, etc
- Sometimes, there is a requirement of an Integrated Development Environment (IDE)

The above component that is available in a microcontroller starter kit is completely enough and the most economical option available for developing simple microcontroller projects.

PERIPHERAL DEVICES IN EMBEDDED SYSTEMS:

Communication of an embedded system with an outside environment is done by using various peripheral devices as a combination with microcontroller.

Depicted below are the different peripheral devices in embedded system:

- Universal Serial Bus (USB)
- Networks like Local Area Network (LAN) etc.
- Multi Media Cards

- Serial Communication Interface like RS-232, RS-485, RS-422, etc.

- Fixing in System Programming (ISP), In Circuit Serial Programming (ICSP), BDM Port, etc.

3.4 IMAGE PROCESSING:

Digital image processing is the application of computer algorithms that is used to create, process, communicate, and also display digital images. Digital image processing algorithms can be used to transform signals from an image onto digital images, improve accuracy, and remove noise as well as other artifacts.

There are two types of arrangements that are being used for the image processing namely, analogue and digital image processing. Analogue image processing can be applied for the hard copies such as printouts and photographs. Digital image processing techniques assist in the manipulation of the digital images by using computers.

Image Processing Toolbox makes the image processing workflow extremely simple. You can interactively segment image data, compare images, batch large data sets.

Many toolbox functions support C/C++ code formation for desktop prototyping and embedded vision system deployment.

kNN Algorithm:

The k-Nearest Neighbor classifier is by far the most simplistic machine learning or image classification algorithm. In fact, it is so simple that it does not even really "learn" anything per se.

Inside, this algorithm solely and purely relies on the interval between feature vectors, we have the labels correlated with each image so that we can foretell and return an actual category for the image.

Simply put, the k-NN algorithm analyses the unknown data points by finding the most common class among the k-losest examples.

We will apply the k-nearest Neighbor classification which includes Euclidean distance using a distance metric.

$$d(\boldsymbol{p}, \boldsymbol{q}) = \sqrt{\sum_{i-1}^{N} (q_i - p_i)^2}$$

SURF Algorithm:

- It's trademarked local feature detector and descriptor. It is used for the purpose of projects like object detection, image registering, classifying, or 3D reorganization. Partly motivated by the 'scale-invariant-feature-transform' ('SIFT') descriptor.

- SURF descriptors were used with the intention of finding and identifying items, individuals or images, restoring 3D scenes, tracking items and extracting points of interest.

- This algorithm reconstructs the image into the coordinates to replicate the original image with the form of Pyramidal Gaussian or Laplacian Pyramid, using the technique of multi-resolution pyramid, in order to obtain a picture of the same size but with a regulated bandwidth. This gives a special blurring effect to the primary image, called Scale-Space, and ensures that the points of interest are invariant in scale there.

MATLAB:

- Math Works provides a mathematical computing environment and programming language of fourth generation, MATLAB. MATLAB facilitates matrix management, feature and data drawing, user interface development and interface along with program written in languages like C, C++, Java and Fortran.

  'MATLAB' is intended primarily for mathematical calculation which allows access to symbolic computing capabilities and a package called 'Simulink' which is a graphical programming environment used to simulate and analyze dynamic multidomain systems.

CHAPTER 4

CONCLUSION

This system assists local municipal government in the waste management system. Domestic waste disposal monitoring at the correct and reasonable time to prevent risk to public health and sanitation.

The system will also help in collection of waste in a uniform manner according to different types of waste which becomes easy to sort out waste using metal detectors, servo motors, ultrasonic sensors etc.

The proposed system is an effort to develop the current waste acquisition system. The key aim is to improve the cleanliness standard of the city and to create an atmosphere that is ideal for working and learning. By using this method, we can test the garbage level in the dustbin on a regular basis, and whether the dustbin is full or about to be full in different parts of the city. If a dustbin has exceeded its maximum capacity level then the staff must be told immediately so that they can take urgent action to clear the particular dustbin as soon as possible. Employees should monitor dustbin status on their cell phones on a regular basis, as each dustbin has its own cloud data. Moreover, while segregating the garbage, the system automatically detects the type of garbage and updates the data in the cloud continuously at real time. In this way, both, the segregation is also done and cleanliness is also maintained. We can easily get different types of garbages. This can be very useful if used and maintained properly.

.

CHAPTER 5

FUTURE ENHANCEMENTS

The primary purpose of this is to preserve the cleanliness standard in the city and to create an atmosphere that is better for living. The system is easy to use by anyone who are willing to take an initiative forward to improve cleanliness in their valued areas as a benchmark.

Ultrasonic sensor is implemented in this system to measure the volume of the garbage in the dustbins but different types of sensors can also be added with high-level sensors for accurate output in the future.

As part of our future research, we aim to create an android application in which people can access the app from their mobile phones, primarily for two the location of the nearest landfilled areas and also the bin nearest to them is full or empty according to which they can go and dispose off their garbage. This status of bins will be updated in the cloud so that customers can easily know about the status of different dustbins near to them.

Moreover, we also plan on temporary disposal of garbage by the machine itself whenever the bin is full and the person responsible for collecting the dustbin is not available or missed the notification. The bin should have a special storage which it will only use or access under such circumstances.

These are all the future enhancements which we are thinking and planning to implement in our Smart Dustbin.

CHAPTER 6

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APPENDIX.

MATLAB CODE

```
clc;
clear;
close all;
warning off;



%%
[filename, pathname] = uigetfile('*.*');
if isequal(filename,0)
disp('User selected Cancel')
else
disp(['User selected ', fullfile(pathname, filename)])
end
% % READ THE IMAGE
im=imread([pathname,filename]);
figure,imshow(im),title('input  image ');



%%
im = imresize(im,[256  256]);
figure,imshow(im),title('resized  image');
[r, c, d] = size(im);
if d == 3
    gray = im2double(rgb2gray(im));
```

```
else
    gray = im2double(im);
end
figure,imshow(gray);
% % %



points11 = detectSURFFeatures(gray);

figure,
imshow(im);

hold on;

plot(selectStrongest(points11,100))



% Extract the features.
[f1,vpts1] = extractFeatures(gray,points11);

f2 = mean(f1);

load feature.mat;

lab = ones(1,37);
```

```
lab(13:37)=2;

mdl = fitcknn(feature,lab);

yfit = predict(mdl,f2);



% % % Decision Making

if yfit == 1

disp('decomposable waste')



elseif yfit == 2

disp('plastics');
end

 %

% %%



instrumentObjects=instrfind;  % don't pass it anything - find all of them.
   delete(instrumentObjects)
```

```
a=serial('COM4','BaudRate',9600);
fopen(a);

        if yfit==1
fwrite(a,'B');

        elseif yfit==2
fwrite(a,'A');

        end

fclose(a);
% closePreview(vid);
```

ARDUINO CODE

```
/*IOT BASED GARBAGE MONITORING SYSTEM*/

#include<LiquidCrystal.h>            //HEADER FILE FOR LCD

LiquidCrystallcd(8, 9, 10, 11, 12, 13); //LCD WITH CONTROLLER CONNECTION (RS=8, EN=9, D4=10, D5=11, D6=12, D7=13)

#define FULL 6          //ASSIGNED VALUE FOR GARBAGE FULL CONDITION

#include <Servo.h>                  //SERVO MOTOR HEADER FILE

Servo s1;                       //SERVO MOTOR 1

Servo s2;                       //SERVO MOTOR 1


const int trigPin = 5;          //5th pin of the controller is connected to the trig pin of the ultrasonic sensor

const int echoPin = 4;              //4th pin of the controller is connected to the echo pin of the ultrasonic sensor

#define metal A15               //A15 pin connected with metal sensor

#define buz 22                  //22nd pin is connected with buzzer

#define mois A0                 //A0 pin connected with moisture sensor


long duration, inches, cm; // ULTRA

int pos = 90, pos1 = 90, pos2 = 90 ; // FOR SERVO ROTATION


void iotsend(String datas);         //iot function


void setup()

{

Serial.begin(9600);//input  from matlab

  Serial2.begin(9600);//FOR  IOT
```

```
lcd.begin(16, 2);
  //////////SERVO  PINSETUP////////////////////////
  s1.attach(6);//S.MOT1  PIN1
  s2.attach(7);//S.MOT2  PIN2
  //////////PIN  SETUP//////////////////////////////
pinMode(metal, INPUT);
pinMode(mois, INPUT);
pinMode(buz, OUTPUT);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
  ///////////LCD  SETUP//////////////////////////
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("GARBAGE MONITOR");
lcd.setCursor(3, 1);
lcd.print("USING IOT");
delay(3000);
lcd.clear();
}

void loop()
{
  int wread = digitalRead(mois);
  int mread = analogRead(metal);

digitalWrite(trigPin, LOW);     //ULTRASONIC
delayMicroseconds(2);
```

```
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  cm = duration * 0.034 / 2; // / 29 / 2;// calc to convert to cm

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("GARBAGE FILLING");
lcd.setCursor(0, 1);
lcd.print("DIST:");
lcd.print(cm);
lcd.print(" cm");
delay(700);

  if (cm < FULL)
  {
lcd.clear();
lcd.setCursor(2, 0);
lcd.print("GARBAGE FULL");
lcd.setCursor(0, 1);
lcd.print("DIST:" + String(cm) + " cm");
iotsend("*GARBAGE FULL#");
delay(2000);
  }
  else if(cm>20){
lcd.clear();
```

```
lcd.setCursor(2, 0);
lcd.print("GARBAGE EMPTY");
lcd.setCursor(0, 1);
lcd.print("DIST:" + String(cm) + " cm");
delay(2000);
 }

 while (Serial.available() > 0)  //MATLAB DATA RECEIVING CHECK
 {
  char c = Serial.read();
  if (c == 'A')                  //plastic garbage
  {
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("PLASTIC GARBAGE");
digitalWrite(buz, HIGH);
delay(1000);
digitalWrite(buz, LOW);
    ////////////////GARBAGE DISPOSED////////////////////////////
    for (pos = 90; pos<= 160; pos += 1)
{ // goes from 90 degrees to 180 degrees
     s2.write(pos);                          // in steps of 1 degree
delay(12);                          // tell servo to go to position in variable 'pos'
    }
delay(500);
    ////////CLOSING//////////////////
    for (pos = 160; pos>= 90; pos -= 1)
```

```
    {
      s2.write(pos);
delay(12);
    }
iotsend("*PLASTIC GARBAGE#");
    c = 0;
   }
   else if(c == 'B'){
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("DECOMPOSABLE");
digitalWrite(buz, HIGH);
delay(1000);
digitalWrite(buz, LOW);
      ////////////////////GARBAGE DISPOSED//////////////////////////////
    for (pos = 90; pos<= 160; pos += 1)
{ // goes from 90 degrees to 180 degrees
      s2.write(pos);                              // in steps of 1 degree
delay(12);                                 // tell servo to go to position in variable 'pos'
    }
delay(500);
    /////////CLOSING////////////////////
    for (pos = 160; pos>= 90; pos -= 1)
    {
      s2.write(pos);
delay(12);
    }
```

```
iotsend("*DECOMPOSABLE#");
      c = 0;
    }
  }

  if ( wread == 0 )        //wet garbage
  {
lcd.clear();
lcd.setCursor(0, 0);
digitalWrite(buz, HIGH);
lcd.print("WET GARBAGE");
delay(1000);
digitalWrite(buz, LOW);
    ////////////////////GARBAGE DISPOSED//////////////////////////////
    for (pos = 90; pos>= 20; pos -= 1)
{ // goes from 90 degrees to 0 degrees
      s1.write(pos);                              // in steps of 1 degree
delay(12);                             // tell servo to go to position in variable 'pos'
    }
delay(500);
    /////////CLOSING////////////////////
    for (pos = 20; pos<= 90; pos += 1)
    {
      s1.write(pos);
delay(12);
    }
iotsend("*WET GARBAGE#");
```

```
  }


  if (mread == 0)     //metal garbage
  {
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("METAL GARBAGE");
digitalWrite(buz, HIGH);
delay(1000);
digitalWrite(buz, LOW);
    ////////////////////GARBAGE DISPOSED////////////////////////////
    while ((pos1 <= 180) && (pos2 >= 45)) // to down
    {
      s1.write(pos1);
      s2.write(pos2);
      pos1++;
      pos2--;
delay(12);
    }
delay(1500);
    while ((pos1 >= 90) && (pos2 <= 90)) // to up
    {
      s1.write(pos1);
      s2.write(pos2);
      pos1--;
      pos2++;
delay(12);
```

```
    }
iotsend("*METAL GARBAGE#");
  }
}

void iotsend(String datas)
{
  for (int i = 0; i<datas.length(); i++)
  {
    Serial2.write(datas[i]);
  }
delay(1000);
  Serial2.println();
}
```

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