Development of IoT Based Smart Dustbin Monitoring System

B. Sridhar, G. Manasa, A. Mohini, B. Naveen

Abstract: The objective of this proposed system is to stay clean and to cover all urban areas of Indian cities. In existing waste collection systems, there is no proper planning for waste collection due to certain problems that make the city unsanitary. The work which consists in cleaning the trash cans is not responsible and which aggravates the system in the event of emergency, an appropriate monitoring is compulsory to keep the city clean and green. Only the manual waste collection system is available. There are no automatic or technological systems. This proposed system is designed for efficient waste collection using the Internet of Things. The system uses a cloud-based monitoring system for monitoring waste. With the use of a cloud-based system, there is no need to regularly check the bins. The proposed model has dustbins contain Arduino based sensing and monitoring system which gives the information about the levels of filling of dustbins and locations. Whenever any dustbin is filled up, a message is sent to the concerned central station where regularly monitoring the levels and positions of dustbins is to be done. This station monitors all the dustbin levels and gives the directions of collecting the garbage by sending message to the garbage collectors and authority. This will avoid overflow of waste in the bin. A prototype of proposed system to be designed as per the consideration of all problems in garbage collection process and by this the proposal makes the city towards a smart city. That fulfils the goals of Swachhbharat.

Keywords: Internet of Things, Arduino Board, Cloud computing, Dustbins, Sensor Node Technology.

I. INTRODUCTION

Urbanization has increased significantly in recent decades. At the same stage, waste production increases. Waste management was an important issue to consider. This article is a means to an end. In this paper, the smart container is based on Arduino, GSM Module, ultrasonic sensors. An ultrasound sensor is placed on top of the container to measure the height of the container. The critical height is constant at 10cm. When the bucket is full, the proposed system is scheduled to show the remaining height at the critical height.

When the bucket reaches the threshold level, the ultrasound sensor activates the GSM modem to continuously inform the requested organization until the bucket is cut. Garbage disposal allows people to reuse it. You can cut garbage regularly. When these smart containers are developed on a large scale, they can replace existing containers to effectively manage waste so that unnecessary waste does not accumulate on the road[1-5,12,13]. The unpleasant smell of this rotten waste that has not been treated for a long time due to the negligence of the authorities and the negligence of the public can cause long-term problems. Breeding insects and mosquitoes can create an unclean environment, causing annoyance. It can even cause terrible diseases[6]. The main objective of this work is to make the cities clean and hygienic in our country. The garbage collection in now-a-days are becoming so irregular and they have some particular time for garbage collection without knowing whether the dustbin is filled or not. Due to this the garbage is flowing in some places which causes irrelevant diseases. So, in order to make our cities clean our proposed system comes into existence that to monitor all the dustbins, if the bin is filled it gives a message to the driver / higher authorities to collect the dust in that particular location. This decreases the fuel consumption and man power. This is how my proposed system helps the society to maintain a good environment.

The proposed method focuses, There are millions of dustbins in the public that people can use. Whenever the bins are filled these should be cleaned by the public authorities. Now the issue is not all the bins are permeated at the same time. The vehicle which is used for checking the bins takes more time to check all the bins. This cause to more fuel consumption cost and requires lot of workers. For this problem a smart dustbin is designed. Now days, there are tons of flats and apartments which have been built in the rapid urbanization area. This is due to high housing demands which have been drastically risen as a result of migration from villages to cities to find work. In order to accommodate the growing population in the urban area, the Government has also constructed more apartment complexes. There are several issues faced by the residents of the flats. One of them is disposal of solid waste. Unlike private houses, the residents of all the apartments use a common dustbin, which tends to fill up very quickly. This overflowing of garbage is a sanitary issue which might cause diseases like cholera and dengue. Moreover, it is a waste of fuel to travel around a complex or an area to find that some of the garbage is filled and some are not. Also, on rare days, problems might arise that there is so much garbage that the truck doesn't have enough capacity.

The idea struck us when we observed that the garbage truck use to go around the town to collect solid waste twice a day. Although this system was thorough it was very inefficient. For example, let's say street A is a busy street and we see that the garbage fills up fast whereas maybe street B even after two days the bin isn't even half full. Our system displays the level of waste in landfills in real time. This data can help optimize waste collection routes and ultimately reduce fuel consumption. Garbage collectors can schedule daily / weekly collection times. An ultrasound sensor is used to detect if the bucket is full. Here, the ultrasound sensor is installed at the top of the container and you can set the threshold depending on the size of the container by measuring the distance of the container from the top of the container. If the distance is less than this threshold, the message "the basket is full" will be printed on the trash can full of waste and if the distance is greater than this threshold, the rest of the trash can is full. The work is divided in 4 main sections and every section can be conceptually split into two parts: the former is related to the capacity monitoring module whereas the latter to the vision module. In the Section 2 we analyze the previous smart bins implementations and the existing papers in literature that inspired us to develop this proposed system. In Section 3 we describe the theoretical and practical technological background adopted to develop this proposed system. In Section 4 we introduce Hardware interfacing to the problem. Initially we describe the common feature, then we enter into the details showing how we have created the modules step by step. In Section 5 we introduce Hardware working to the problem Finally in Section 6 we present the obtained results and some possible use cases in real scenarios of the two smart bin modules. We have dedicated the conclusion section to describe the obtained results and some proposal for future works.

II. REVIEW CRITERIA

Today, more and more waste is created and waste management is becoming crucial for both developed and developing countries. The main idea is not to provide a solution to this widespread and complex problem, but to alleviate and improve the current resolution of incidents. To achieve this ambitious goal, I focus on an advanced intelligent container proposed system made up of two modules. [1]. The capacity monitoring module, a network of intelligent containers that communicate their status to a central server. The intention of the first module is to improve the garbage collection process. Currently, each container must be inspected to determine level ll, and then decide if there is a real need to empty it. In addition, in a relatively small environment, such as a building on a university campus, more attention is also required from the waste picker. In fact, the employee must understand if there is organic waste inside the trash that requires collection regardless of level II and, in addition, a mandatory change of the dirty trash bag. Proposed systems for this smart container are currently based on WiFi technology, which is widespread throughout the campus and provides stable, fast and low power consumption connectivity. In the near future, our goal is to replace it with 5G sensors, further increasing the performance of the proposed system and also removing the restriction of reduced WiFi coverage. We offer here an intelligent container which is: inexpensive, all the electronic components used cost only a few rupees, and easy to use, the two modules require no special skills or knowledge. As an example of this last point, to get a recommendation from the trash, just insert the object in the trash and the answer appears in a few seconds, instead of the smart trash network, notifications are automatically sent to the desired device and the card can be easily used on the screen of a smartphone. For the construction of the first module, the capacity measurement module, we added to some common bins a microcontroller: a small computer only a few centimeters long, and some sensors used to detect the state of the bin and its weight. These smart containers can also communicate with a central server which connects to a pre-existing WiFi connection. The data sent by all devices is collected by a central server which stores and calculates it, then informs the end user of the state of the container. It can not only detect the filling status of the trash, but also report if something unexpected has been thrown in a trash. Users can monitor the status of containers using a building map at any time, or they can be notified on their favorite device like a smartphone, computer or smart watch via emails or notifications . As previously mentioned, many studies have been carried out on the concept of smart container and, in particular, great interest comes in particular from the Eastern countries which have experienced great economic and demographic development over the last century. This has led to an exponential growth in the waste produced and, therefore, the need to find a more efficient method of waste disposal. In 2013, Bashir et al. from two Indian universities created a prototype using charge and infrared cells to control the level. For the communication part The system uses radio frequency (RF) tags [3]. The filling level is not very precise and only provides the status of 2 containers because the sensor is located in the center of the intelligent dumpster and the second is located near the top of the intelligent dumpster. Communication is not continuous, but a message is only sent when the smart trash is filled at the specified load and level. A similar approach at the level sensing using infrared sensors (TSOP 1738) was presented also by Navghane et al. from Lonavala (India) in 2016 [7] which used 3 IR sensors and weight sensors to communicate the filling level and the weight status via a WiFi module. In 2014, Mamum et al. from Kebangsaan University Malaysia presents a new framework which allows remote monitoring of the bin in real time, via ZigBee-PRO and GPRS [1]. The frame receives various data from an intelligent container thanks to the large number of sensors it contains: an accelerometer, a Hall effect, an ultrasound, a temperature and humidity sensor and a load cell sensor. Sharm et al. in 2015, they published an article describing their smart container model using a PIC16F73 microcontroller, an HC-SR04 ultrasonic sensor and a SIM900A GSM module for the communication part [9]. They also designed a map that gives an idea of the filling status of the containers in the city represented with widgets. These widgets that mark the level of the complete dumpster

will be placed in the location on the map exactly as the dumpsters are placed throughout the city. In 2017, Sharm et al. published a new article [10] which now uses an Arduino UNO with a WiFi sensor. In this case, their approach was similar to the one we use:

when the trash reaches the threshold limit, the status of the container is updated in the cloud, and the competent authorities can access this status. In 2017, Wijaya et al. from Hasanuddin University in Makassar (Indonesia) has created a prototype intelligent trash can that can send measurements using a GSM modem for long-range communication and a Bluetooth module for short range [11] . In their studies, they analyzed the load cell to check the accuracy of the sensors and measurements, which concluded with an error of less than 3% and the sensor HC-SR04 discovered that the average percentage of error of the sensor level is 3 to 5.%. This means that the sensor can measure the level of waste in the container. Many other examples are present, but the prototype of Kumar et al. in 2016 from Sri Ramakrishna Engineering College in India using an RFID tag to confirm the garbage dump task. In addition, each time an RFID (cleaner identity card) tag interrupts the RFID reader, the ultrasonic sensor checks the status of the bin and sends it to the web server. [6], the microcontroller thus provides real-time information to the server.   Mohammad Aazam et al. (2016) suggests the idea of a sensor bucket capable of displaying the state of the waste levels. Use the automatic recycling bin and use the cloud computing standard to develop a more powerful and efficient smart waste management mechanism. Waste management is linked to a variety of stakeholders, including recyclers, importers and exporters, the food industry, health, research, environmental protection and related organizations, and the tourism industry.. Mohammad Aazam et al proposed Cloud SWAM, in which each container is equipped with sensors to notify its waste level at different containers for each category of waste. In 2017, Fei er al. from Tun Hussein Onn University Malaysia published an article describing another example of a smart container using a NodeMCU microcontroller equipped with ultrasonic sensors and tracking collection trucks that use a GPS module to notify the nearest collection truck to reach the container that needs to be emptied. [4] In the same year, Baby et al. from the Indian School of Electronic Engineering presented an example of a smart container that implements different notifications to alert authorities to empty the container. The user receives an email via an SMTP server and, via IFTTT, a mobile notification is also sent and an event is created in the Google calendar. The technologies used to detect the state of the container are a Raspberry Pi connected to an ultrasonic sensor. [2] Two proposed systems were implemented and tested in real cases in 2015. One was deployed by Folianto et al. in Singapore achieving an average data delivery rate of 99.25% during six months of data collection. The use of IP65 certified containers is particularly advantageous to avoid any sensor malfunction caused by dust and water splashes [5]. The other proposed system was implemented by Dynacargo in the municipality of Nafpaktia in Greece using IP67 protection and the MB1040 LV-MaxSonar-EZ4 to detect the filling status [8].

III. PROPOSED METHOD
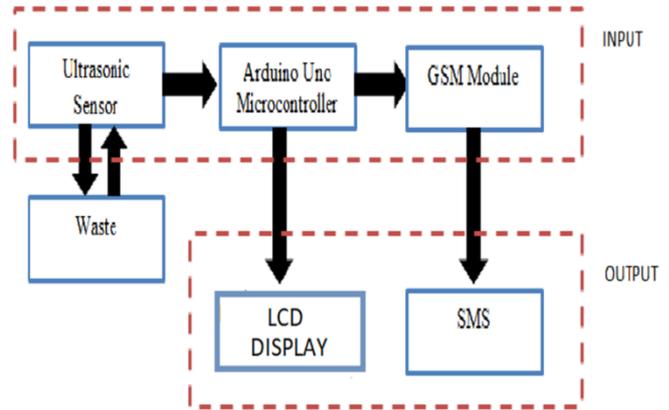
A. Hardware

Fig.1 block diagram of the proposed system

The block diagram of the proposed system is shown in Figure 1. The material elements are connected as shown. During working time, you must initialize the system and check the hardware connection. Raspberry-pi ensures that all connections are connected. In this proposed system, we connect ultrasonic sensors to measure the amount of waste that fills the container. In addition, to develop a more accurate system, historical data on waste levels used in previous periods to adapt these emissions from waste are considered.   The processed result is displayed on the module's LCD screen and similar data is sent by SMS via the GSM module. The detailed component you need is given in Figure 2. This module is placed in the trash, so two modules are prototyped and connected via wiki and monitored by thinkpeak.

B. Required Components:

Arduino boards(2) ,GSM, GPS, Ultrasonic Sensor,Lcd Display, Adapter,Jumpers,Wifi Module,12 V AdapteR And Personal Computer as shown in fig:2.

For implementing the design for dustbin system using gsm and WiFi, the required components are:

Fig: .2 Hardware components

C. Process:

- Now a SIM is inserted into the GSM module and lock it. Connect an adapter to the GSM module and turn on the adapter and leave it for a minute.

818

- Here the ultrasonic sensor is used in which it has four pins namely **Vcc,Gnd, trigg,echo**.
- The vcc of the sensor is connected to the **Vcc** pin of the Arduino and gnd is connected to the Gnd pin of the Arduino. Trig and echo pin are connected to any of the two digitalpins of the Arduino.
- Here, the ultrasonic sensor measures the level whenever the level extends the limit a message is send to the authority.
- It is one of the behavioral techniques and it involves the measurement of level of the dustbin by using ultrasonic sensor.
- Here, the ultrasonic sensor is used to measure the level of the bin by measuring the distance.
- we will define a particular threshold value and the measurement of each level is shown.
- when the level extends the threshold value then a message is send to the driver or higher authorities that the dustbin is filled.
- The message is sent to the authority by using GSM module in order give an alert that the bin is filled and WiFi module is connected which send the data to centralized server to Thingspeak.

  The program implemented using Aurdino platform using the flowchart given the fig :3

The GSM is used to send the SMS to the authority. Here we use AT command to receive SMS from GSM module we give the command like AT+CMGS=".." this means we just need to send this command to gsm module and apply a delay. Once you send this command, you will see the SMS you had sent displayed on your arduino serial monitor if the code was written in the form of "Serial.Print". Finally the Arduino Ide is used to monitor the level by using serial monitor. the serial monitor is used to connect or show the transmitting and receiving data. The serial monitor can show the data received which indicates the level for every drop in the dustbin. This is how we can manage the garbage collection in a smart way.
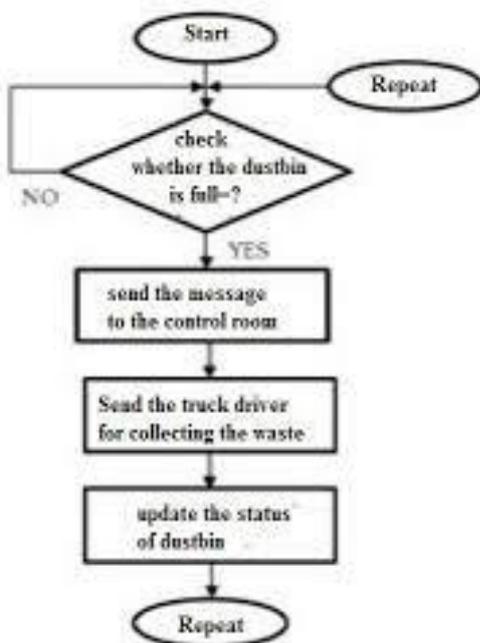
Flow chart:

Fig 3: flow chart of single dust bin module function

The operation of the module is a closed loop process system, The program that implement on the module makes entire system is automatic. So that entire garbage system maintained with less number of man power. The process of code execution is given in the coming section.

IV. STYLING EXPERIMENTAL RESULTS

A. Process Code execution process:

Programs written on Arduino software (IDE) are called sketches. This sketch is created with a word processing program and the file extension is saved as .ino. The author has text cut / paste functions and search / replace functions. The message area provides comments when storing and exporting and also displays errors.

The console displays text output from Arduino software (IDE), including complete error messages and other information.

The configured card and serial port appear in the lower right corner of the window. The toolbar buttons allow you to view and load programs, create, open and save sketches, and open the serial screen. Step-by-step execution of the program as shown in the figure: 4-5.

The setup of the proposed system is shown in fig 4. A ultrasonic sensor placed on the top of the dustbin. Initially the sensor data is observed and processed by the module. Then average threshold value is calculated.

Fig 4.dustbin filled message.

If the level of waste has reached above the threshold value then the system came to know that bin to be filled shortly , an alert information is send to driver through SMS the same will send to centralized server for continuous monitoring the maintenance of garbage monitoring system. The detailed monitoring at central server is shown in fig 5.
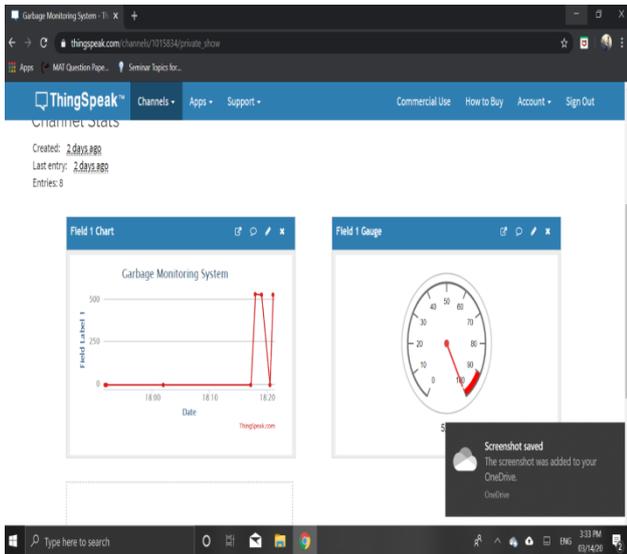
819

Fig 5: Web page monitor at central sever

The above figure shows how the bin is filling level by level. The data is stored in the webpage like this here, we have used Thingspeak website in order to monitor the garbage system. This shows the level of the bin in a graphical way and the count of the number of levels that were dropped. It is the use of Thingspeak webpage

V. CONCLUSIONS

A. Figures and Tables

Because this proposed system is designed for efficient waste collection using the Internet of Things.The proposed model includes bins containing an Arduino-based detection and monitoring system that provides information on the levels and locations of the bins. With this work, we have proposed two functional modules that can be adopted to better manage waste collection, increase recycling and, therefore, help to live in a cleaner world. The smart container capacity monitoring module is one such module and, as we have seen, we have been able to transform an ordinary bucket into a more complex object that can communicate with a central server that manages it. In addition, not only did we collect data, we were able to create a simple mechanism to actively inform the end user of the status of the containers. The user can also obtain this same information by consulting a user-friendly map which is constantly updated at all times. We also demonstrate that using a garbage container of a certain size or dimension is not essential, but almost anything can be turned into a smart container. This method facilitates the collection of waste in the city. Reduce air pollution, transportation, work, time and money. With the help of appropriate technology (GPS applications and software), the truck can be guided to choose the shortest route for waste collection. The project is smart and user friendly and can add benefits to the city.

FUTURE SCOPE:

The main goal of this proposed system is to reduce human resources and effort and improve the vision of the smart city. We often saw garbage on the street. This was an issue that required immediate attention. The proverb "Cleanliness is next to God and clean cities are next to paradise" inspired us

to design this work. Smart snatches help reduce pollution. In many cases, garbage overflows and many animals, such as dogs and mice, enter or are near the trash. Create bad scenes. Some birds try to get out of the trash. This proposed system can avoid such situations. The message can be sent directly to the cleaning vehicle and not to the contractor's office. Swatch Bharat Abhiyan (English: SBA or SBM for Clean India Mission and "Swatch Bharat Mission") is a national campaign by the Indian government to clean up roads, roads and infrastructure, including 4,041 legal cities and towns in the country.

In our system, smart dumpsters are connected to the Internet to get real-time information about smart dumpsters. In recent years, population growth has been rapid, which has resulted in further waste disposal. Therefore, an adequate waste management system is necessary to prevent the spread of certain deadly diseases. In this proposed method, the method also observed that some areas need to be improved in the future. It is a high power consumption of each smart container capacity module. This consumption is caused by the ultrasonic sensor which operates at a power of 5V which does not allow to go into deep sleep mode when the Aurdino is inactive. One possible solution requires changing the sensor used to measure the filling level, based on subsequent studies of the laser range sensor operating at 3.3 V.

This would allow a deep sleep on the Arduino and therefore the deployment of the smart container with small batteries. Another possible development should consider the possibility of using a more complex and flexible artificial intelligence algorithm to detect unexpected objects in the smart container. As for new technologies, the spread of 5G technology in the near future will increase the speed, reliability and energy consumption of Internet communications. This will give us the opportunity to improve current prototypes, reduce the size of the batteries and eliminate the dependence on a reliable WiFi connection, giving us the possibility of implementing these smart containers almost everywhere.

REFERENCES

1. Md Abdulla Al Mamun, MA Hannan, and Aini Hussain. Real time solid waste bin monitoring system framework using wireless sensor network. In Electronics, Information and Communications (ICEIC), 2014 International Conference on, pages 12. IEEE, 2014
2. Cyril Joe Baby, Harvir Singh, Archit Srivastava, Ritwik Dhawan, and P Mahalakshmi. Smart bin: An intelligent waste alert and prediction system using machine learning approach. In Wireless Communications, Signal Processing and Networking (WiSPNET), 2017 International Conference on, pages 771774. IEEE, 2017.
3. Adil Bashir, Shoaib Amin Banday, Ab Rouf Khan, and Mohammad Sha. Concept, design and implementation of automatic waste management system. International Journal on Recent and Innovation Trends in Computing and Communication ISSN, pages 23218169, 2013.

4. Teh Pan Fei, Shahreen Kasim, Rohayanti Hassan, Mohd Norasri Ismail, Mohd Zaki Mohd Salikon, Husni Ruslai, Kamaruzzaman Jahidin, and Mohammad Syafwan Arshad. Swm: Smart waste management for green environment. In Student Project Conference (ICT-ISPC), 2017 6th ICT International, pages 15. IEEE, 2017

5. Fachmin Folianto, Yong Sheng Low, and Wai Leong Yeow. Smartbin: Smart waste management system. In Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2015 IEEE Tenth International Conference on, pages 12. IEEE, 2015.

6. N Sathish Kumar, B Vuayalakshmi, R Jenifer Prarthana, and A Shankar. Iot based smart garbage alert system using arduino uno. In Region 10 Conference (TENCON), 2016 IEEE, pages 10281034. IEEE, 2016.

7. SS Navghane, MS Killedar, and Dr VM Rohokale. Iot based smart garbage and waste collection bin. Int. J. Adv. Res. Electron. Commun. Eng, 5(5):15761578, 2016.

8. Narayan Sharma, Nirman Singha, and Tanmoy Dutta. Smart bin implementation for smart cities. International Journal of Scientic & Engineering Research, 6(9):787791, 2015.

9. Sanjana Sharma, V Vaishnavi, Vandana Bedhi, et al. Smart bin - an 'internet of things' approach to clean and safe public space. In I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), 2017 International Conference on, pages 652657. IEEE, 2017.

10. Aksan Surya Wijaya, Zahir Zainuddin, and Muhammad Niswar. Design a smart waste bin for smart waste management. pages 6266. IEEE, August 2017.

11. Politecnico di Milano work"Implementation of a smart bin for waste monitoring and recognition" 2017-18

12. A. S. Bharadwaj, R. Rego and A. Chowdhury, "IoT basedsolid waste management system: A conceptual approachwith an architectural solution as a smart city application,"2016 IEEEAnnual India Conference (INDICON),Bangalore, 2016, pp. 1-6.

13. K. Tharun Kumar Reddy, P. Ajay Kumar Reddy, and P. Siva Nagendra Reddy. "An IoT Based Remote Monitoring of Landfill Sites Using Raspberry Pi2." Emerging Trends in Electrical, Communications and Information Technologies (2017): 219

AUTHORS PROFILE

Dr. B.Sridhar obtained the Ph.D degree in medical image processing from theJNT University Kakinada in the year 2015. He has joined the Electronics and communication Engineering Department at Lendi Institute of Engineering and Technology in 2011 and continues to work as Professor. His research interests are Medical Image Processing, Machine Learning and nano VLSI design. He is a life member from IEEE,IETE,IE.He has a strong basic knowledge on image processing techniques using advanced and hybrid methods in both spatial and frequency domain. He also have a very good knowledge on neural networks and deep learning methods, Good programming skills using MATLAB,PHYTON applied on medical image data sets. He has published 29 research papers in, National, International Journals so far

Gudem Manasa an under graduate student in the department of electronic and communication engineering atLendi Institute of Engineering and Technology. I am also fond of doing the projects on IOT based .Also I am the member of Institute of engineers

Adireddi Mohini an under graduate student in the department of electronic and communication engineering atLendi Institute of Engineering and Technology. I am also fond of doing the projects on IOT based .I have a very good programming skills like java Python ,tc.

Bali Naveenan under graduate student in the department of electronic and communication engineering atLendi Institute of Engineering and Technology. I am also fond of doing the projects on IOT based . Also persue the skills like coding, designing and so on.