VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangam” Belagavi-590014, Karnataka

A MINI PROJECT REPORT

ON

“TRAFFIC CONTROL SYSTEM USING IOT FOR ADAPTIVE AMBULANCE”

Submitted in partial fulfilment of the requirements for the award of the degree

BACHELOR OF ENGINEERING IN ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the mini project work entitled "TRAFFIC CONTROL SYSTEM USING IOT FOR ADAPTIVE AMBULANCE" is a bonafide work carried out by our students Ms. APOORVA M, USN: 1DB20EC007, Ms. JAYASHREE A R, USN: 1DB20EC038 of Sixth semester, in partial fulfilment for the award of degree of Bachelor of Engineering in Electronics and Communication Engineering of Visvesvaraya Technological University, Belagavi in the academic year 2022-2023. It is certified that all corrections/suggestions indicated during mini project work have been incorporated in the report deposited in the department library. The mini project has been approved as it satisfies the academic requirement in respect of the project work described for the partial fulfilment of said degree.

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ABSTRACT

With the increase in the number of automobiles in urban cities, the number of accidents has increased manifold. Hence, the need for ambulances is increasing at an alarming rate. In order to increase the survival rates of the patients, an efficient communication of ambulances with the hospital and routing of the ambulances at the signal posts is very essential. Hence, the proposed architecture is distributed in nature. The system not only provides effective communication between the ambulance and the hospital but also helps the ambulance send the signal to nearby traffic signal posts to open up so that the ambulance can easily pass through saving ample amounts of time. The signal posts use a camera to detect the incoming ambulance and open up that lane so that the ambulance need not spend much time waiting for the traffic to get cleared.

Keyword: Adaptive Ambulance, intelligent traffic monitoring system, Internet of Things, smart city.

ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible and under whose constant guidance and encouragement the task was completed.

We would like to express our immense gratitude to **Dr.Nagabhushana B S,** Principal, Don Bosco Institute of Technology, Bengaluru, for his timely help and inspiration during the tenure of the course.

We would like to express our deep gratitude to the **Dr.A N Maheshwarappa**, Professor and HOD, Department of Electronics and Communication Engineering, for his timely cooperation while carrying the mini project. It is his friendliness that made us learn more.

We would like to express our sincere thanks to the Project Coordinators **Mrs.Tejaswini M L,** Assistant Professor, **Mrs. Swetha B V**, Assistant Professor, Department of Electronics and Communication Engineering, DBIT, Bengaluru, for their encouragement and suggestions which helped us a lot in the completion of the mini project.

Sincerely we acknowledge our deep sense of gratitude to **………………………..** , Associate Professor, Department of Electronics and Communication Engineering, DBIT, for his constant encouragement, help and valuable suggestions.

We also extend our sincere thanks to all the **Faculty members** of Department of Electronics & Communication Engineering, DBIT, Bangalore, who have encouraged us throughout the course.

Last but not the least, we express our heartfelt gratitude to Almighty, our Parents for their love and blessings that helped us completing the mini project Work successfully.

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CHAPTER 1

INTRODUCTION

Two of the most significant aspects of modern civilization are urbanization and industrialization. The severe traffic congestion on the streets is the most detrimental result of growing urbanization and accelerating growth in traffic. Due to the circumstances, there is a confined traffic demand in both time and space. Congestion causes delays and waste of time, especially in road traffic where the peaking phenomena is very noticeable. The impediment and delay caused by one vehicle on another is known as congestion. The likelihood that one car will delay another on a given road increases with traffic volume, increasing congestion. By regulating traffic, setting regulations, and enforcing management practices to make the best possible use of the streets, the resulting problems can be somewhat alleviated. Traffic signals are one type of traffic management measure that has already been thought of.

However, a considerable portion of all investments are made in the transportation industry. Widening highways, constructing elevated flyovers, constructing bypasses, and constructing urban expressways are all costly medium and long term solutions. Simple and affordable alternatives can buy some time till the situation is resolved. Making the most efficient use of already available transportation infrastructure requires a number of short-term measures, known as transportation system management.

Additionally, traffic-related environmental degradation has been a major problem. The amount of noise in the streets and nearby places has increased to unacceptable levels. The atmosphere is polluted by the fumes and odour coming from the automobiles' exhaust. A network of physical objects or "things" that are integrated with sensors, software, and other technologies for the purpose of linking is referred to as the "Internet of Things" (IoT), and exchanging data with other devices and systems over the internet, is used to describe the concept that addresses the aforementioned issues. These devices range from basic household goods to cutting-edge industrial equipment. The employment of gadgets and sensors for traffic management systems is best made possible by their low cost and ease of connectivity. The basic idea used for traffic management here is to detect and control congestion by using a decision-making algorithm which determines how the traffic light operates based on the information collected from RFID devices. RFID and IR module are wireless technology that uses radio frequency and infrared rays, electromagnetic energy to carry information between the transmitter and receiver. RFID tag and reader are used to detect the emergency vehicle on the lane and to clear it at a faster rate.

The design proposes a smart and fully automatic system that can detect congestion in real time, and subsequently manage it efficiently to ensure smooth traffic flow with the use of RFID and IR devices. The idea is based on the principle of RFID tracking of vehicles. An RFID i.e. Radio Frequency Identification system consists of two main components, the small transponder, more commonly known as a tag, which is attached to the vehicle needing identification and the interrogator, or reader, which in some cases is used to both power the tag and read its data without contact. The RFID tag consists of all the information regarding the item to which it is attached and this can be wirelessly transmitted to the reader. The IR devices are used to detect traffic congestion on each lane using transmitter and receiver which uses infrared radiations and traffic signals are prioritized based on densely congested lane.

Principle of Sensing

IoT leveraging traffic infrastructure for sensing purposes revolves around harnessing the existing infrastructure within the transportation domain to gather data and facilitate intelligent applications. By deploying sensors in traffic-related elements such as traffic lights, road signs, street lamps, and surveillance cameras, a comprehensive sensing network can be established. These sensors are designed to capture various types of data, including traffic flow, vehicle speed, occupancy, environmental conditions, and other relevant parameters.

The collected data is then transmitted via wired or wireless connections, such as cellular networks, Wi-Fi, or dedicated communication protocols, to a central system or cloud platform. This data can be processed in real-time on the edge devices or sent to a centralized server for more advanced analysis. The principle of sensing in IoT using traffic infrastructure also involves ensuring interoperability and standardization. Adhering to industry standards and protocols enables seamless integration and communication between different sensors, devices, and systems.

This interoperability allows for the aggregation of data from multiple sources and enables a holistic view of the traffic infrastructure. Once the data is collected and processed, it can be used to develop intelligent applications and services. The sensed data can also be combined with other data sources, such as weather information or vehicle data, to provide more accurate and actionable insights. In conclusion, IoT utilizing traffic infrastructure for sensing purposes harnesses the existing elements of the transportation ecosystem to collect and analyze data, enabling the development of intelligent applications that improve traffic management, safety, and overall urban mobility.

1.1 LITERATURE SURVEY

- **Automatic traffic density control system with wireless speed limit notification, in: IEEE 11th Annual Computing and Communication Workshop and Conference, CCWC), 2021.**

The proposed system is designed and implemented to control traffic signal timer automatically according to input traffic volume in a particular lane, which is detected by the sensor unit. As per the level of traffic congestion, the timer value is increased/decreased automatically and at necessary emergency situation like high volume traffic for long time, the system will automatically trigger predefined alert SMS to the authority. The system also notifies the previous lane by sending alert message on LCD to avoid lanes ahead which has high traffic density. A conventional method of controlling signals manually is also provided for emergency situation. The smart pole is installed with LCD to display the alert message and it contains emergency alert buttons which are used to alert police, traffic, ambulance, fire authorities if any problem occurred in a particular lane. Wireless speed limit notifier is installed in desired lanes which notifies the driver about the speed limit of a zone via wireless technology.

- **Sonal Agrawal, Prakhar Maheshwari, Controlling of smart movable road divider and clearance ambulance path using IOT cloud", in: 2021 International Conference on Computer Communication and Informatics, ICCCI, 2021.**

In this paper, we design a movable road divider that moves depending on the traffic conditions. Real-time data of the traffic compiled using IoT in such that it will connect a link between traffic and divider with the help of computer vision. This proposed system provides the free path for an ambulance which ensures the ambulance to reach the destination on time or without any delay and the life of humans is more important. It also reduces the time of journey in peak hours and save time and fuel. Deep learning is used to acquiring the current situation of traffic and these data will store in clouds using cloud computing and big data handling over IOT. Cloud database sends the message to embedded system over IOT protocols to shift the divider left or right. Smart moveable road divider system help to clearing the traffic on road during peak hours of the day and whenever any ambulance stuck in traffic it will automatically recognize the ambulance and clearing the path using this device.

- **Qingfang Liu, Baosheng Kang1 Keping Yu, (Member, Ieee), Xin Qi, Jing Li, Shoujin Wangv, Hong-an Li, Contour - Maintaining - Based Image Adaption for an Efficient Ambulance Service in Intelligent Transportation Systems" School of Information Science and Technology, Northwest University IEEE, 2020.**

The main aim of this project is to contour-maintaining-based image adaptation method, called SC OE, for an efficient ambulance ITS service. Firstly, the method combines weighted gradient, saliency, and edge maps into an importance map. Secondly, according to the slope and curvature of the edge in unimportant areas, serrated channels are set in the gentle edge area that can guide the optimal seams to evenly pass through edge areas. This method protects the integrity and display proportion of prominent object,
improves the continuity and smoothness of edges and contours, and maintains their shape in non-salient areas. To improve the visual effect of adapted images, a contour-maintaining based image adaption method for an efficient ambulance service in ITS is proposed here. Finally, applying the sub-procedure of a forward seam carving method, the optimal seams can more evenly pass through the contour areas. The experimental results demonstrate that the proposed method is more effective than other similar methods.

- **Willy Carlos Tchoutchoua, Christophe Bobda, Md Jubaer Hossain Pantho, Internet of smart cameras for traffic lights optimization in smart cities, Sci Direct 11 (2020), 100207**

In this paper, we propose a new and versatile method that uses distributed smart cameras along with advance image understanding to supply the waiting queue in realtime with traffic data (vehicles count, types, density, etc...). This information can then be used by a central authority to control the whole traffic infrastructure. In a survey has been made on adaptive algorithms for traffic control. However, these approaches haven't considered the priority for emergency vehicles, and in case of changing traffic rules or maintenance at the intersection, the algorithm fails to adapt. We have used open-source OpenCV [27] version 4.0.0 in C++ language. The main challenges associated with traffic congestion and emergency vehicles were discussed and an adaptive algorithm was presented. Our future works will attempt to first extend the simulation to multiple intersections data-set while introducing new elements like pedestrian crossing, and secondly port this work on edge devices to perform computation on the edge.

- **Chakkaphong Suthaputchakun, Yue Cao, Ambulance-to-Traffic light controller communications for rescue mission enhancement, in: A Thailand Use Case" IEEE Communications Magazine December, 2019.**

The main objectives of this paper are to improve road safety and traffic flow. However, the paper focuses on network performance in terms of network throughput and end-to-end delay rather than the rescue mission performance, such as travel time and speed of the ambulances. Without a comprehensive performance evaluation, this approach becomes unconvincing. The proposed A2T aims to promote information sharing between ambulances and traffic light controllers along rescue routes in advance, through V2I communications. As a result, the traffic light controllers can switch to a green traffic light to allow the approaching ambulances to pass any intersections immediately and safely.

1.2 PROBLEM STATEMENT

Due to the ever increasing population of motor vehicles in modern developed industrialized and urban areas, traffic congestion is recognized as one of the major problems. Travelling to different places within the city is becoming more difficult, there is a loss in productivity from workers, trade opportunities are lost, delivery gets delayed and thereby the cost goes on increasing which ultimately leads to frustration and imbalanced life.

Urban traffic control is one of the most challenging problems of the day. Roads and highways are unlikely to, expand much due to cost and dwindling land supply, so intelligent systems such as advanced traffic signal control is critical for operating current roadway systems at maximum capacity. The case is evident from commuting experiences and the statistical surveys revealing the face that there are at least 34.77

lakh vehicles, 71% are two wheelers, 16% cars and 3% autos in a city like Bangalore alone . Road traffic control strategies like pre-timed, progression schemes, actuated, semi actuated control, traffic response, adaptive control strategies have inherent limitations even today.

The traditional public policy measures to relieve congestion is widening of the roads which carry heavy traffic and building of new roads. These measures are not only costly but also inefficient because of the acute shortage of space available for road construction in the over-crowded metropolitan cities.

1.3 MOTIVATION

The motivation behind implementing IoT using traffic infrastructure stems from the pressing challenges faced in urban areas related to traffic management, congestion, and safety. By leveraging IoT technology and integrating it with the existing traffic infrastructure, several compelling motivations can be identified. IoT can provide real-time data on traffic flow, vehicle occupancy, and road conditions, enabling more efficient traffic management. This data can be used to optimize signal timings, adjust lane configurations, and implement adaptive traffic control systems, leading to reduced congestion, improved travel times, and better overall traffic flow. IoT-enabled traffic infrastructure can contribute to sustainable transportation goals. By optimizing traffic flow, reducing congestion, and providing real-time information to drivers, IoT solutions can help minimize fuel consumption, lower carbon emissions, and promote the use of public transportation options or alternative modes of transport.

The availability of accurate and timely data through IoT sensors enables data-driven decision-making for urban planning and policy development. In summary, the motivation behind implementing IoT using traffic infrastructure lies in addressing the challenges of traffic management, safety, sustainability, and citizen convenience. By leveraging IoT technology, the existing infrastructure can be transformed into an intelligent system capable of collecting and analyzing real-time data, optimizing traffic flow, and creating a more efficient and sustainable urban transportation ecosystem.

1.4 OBJECTIVE

• To develop and implement a strategy for reducing traffic congestion.

• Use the RFID technology for easy clearance of emergency vehicle.

• To detect the traffic density using IR sensors.

• Emergency Vehicles can be tracked based on their entry and exit points.

1.5 SCOPE OF PROJECT

The future scope of the project "IoT using traffic infrastructure" is vast and holds potential for significant advancements in traffic management, urban mobility, and overall transportation systems. Further development of IoT-based traffic infrastructure can enable adaptive and predictive traffic signal control systems. These systems can dynamically adjust signal timings based on real-time traffic conditions, historical data, and predictive algorithms, optimizing traffic flow and reducing congestion.

IoT sensors and data analytics can provide real-time information on the availability, capacity, and location of different transportation options, allowing users to make informed decisions and optimize their travel routes. These future directions hold immense potential to revolutionize traffic management, improve urban mobility, and create more sustainable and livable cities.

1.6REPORT ORGANIZATION

1. Introduction

- Overview of the project
- Background and significance of IoT in traffic infrastructure
- Problem statement and objectives

2. Literature Review

- Review of existing literature on IoT applications in traffic infrastructure
- Analysis of relevant studies, research papers, and case studies
- Identification of key technologies, challenges, and best practices

3. Methodology

- Description of the methodology adopted for implementing IoT in traffic infrastructure
- Explanation of the sensor deployment strategy and connectivity options
- Overview of the data collection, processing, and analysis techniques used

4. IoT Sensor Integration in Traffic Infrastructure

- Detailed explanation of the integration process of IoT sensors with traffic infrastructure components such as traffic lights, road signs, and surveillance cameras
- Discussion of sensor types, placement, and connectivity options
- Overview of the data collected and its relevance for traffic management

5. Data Collection and Processing

- Explanation of the data collection process from IoT sensors in traffic infrastructure
- Description of the data processing techniques used, including real-time processing and cloud-based analysis
- Discussion on data fusion and integration with other data sources for comprehensive insights

6. Intelligent Applications and Benefits

- Presentation of intelligent applications enabled by IoT in traffic infrastructure, such as real-time traffic monitoring, adaptive traffic signal control, and incident detection
- Discussion of the benefits derived from these applications, including reduced congestion, improved safety, and enhanced urban mobility

7. Case Studies and Success Stories
   - Presentation of real-world case studies and success stories of IoT implementation in traffic infrastructure
   - Examination of specific projects, their challenges, and the achieved outcomes
   - Analysis of the impact on traffic management, safety, and overall transportation systems

8. Future Scope and Challenges
   - Discussion of the future scope and potential advancements in IoT using traffic infrastructure
   - Exploration of emerging technologies, such as autonomous vehicles integration and smart city integration
   - Identification and analysis of challenges and considerations, including scalability, security, and privacy

9. Conclusion
   - Summary of the key findings and insights from the project
   - Recapitulation of the achieved objectives and their significance
   - Recommendations for further research and implementation

10. References
    - Comprehensive list of cited references, including research papers, articles, and relevant sources

11. Appendices (if applicable)
    - Additional information, technical details, or supplementary materials that support the main content of the report

CHAPTER 2

EXISTING METHODOLOGY

Existing methodologies for implementing IoT in traffic infrastructure typically involve the following steps:

- **Requirement Analysis:** Conduct a comprehensive analysis of the traffic infrastructure, including the existing infrastructure components, traffic patterns, and specific objectives of the project. Identify the key data parameters required for effective traffic management and optimization.

- **Sensor Selection and Deployment:** Select appropriate IoT sensors based on the identified data parameters and objectives. These sensors can include traffic cameras, lidar sensors, vehicle detectors, environmental sensors, and other relevant devices. Deploy the sensors at strategic locations within the traffic infrastructure, ensuring optimal coverage and data collection.

- **Connectivity and Communication:** Establish a robust and reliable connectivity infrastructure to transmit data from the deployed sensors to a central data processing system or cloud platform. This can involve leveraging wired or wireless communication technologies such as Wi-Fi, cellular networks, or dedicated communication protocols.

- **Data Collection and Processing:** Collect data from the deployed IoT sensors in real-time. Process and analyze the collected data using data analytics techniques, including filtering, aggregation, and statistical analysis, to derive meaningful insights and patterns related to traffic flow, congestion, and other relevant parameters.

- **Integration and Visualization:** Integrate the processed data with other relevant data sources, such as weather information or historical traffic data, to gain a comprehensive understanding of the traffic conditions. Visualize the data using interactive dashboards and visual representations for real-time monitoring and decision-making.

- **Intelligent Applications:** Develop and deploy intelligent applications based on the collected and processed data. These applications can include real-time traffic monitoring, adaptive signal control, predictive traffic analysis, incident detection and response, and optimized routing for emergency services.

- **Evaluation and Optimization:** Continuously monitor and evaluate the performance of the implemented IoT system. Identify areas for improvement and optimization, such as fine-tuning signal timings, adjusting sensor placements, or incorporating additional data sources. Iterate and refine the system based on feedback and evolving traffic requirements.

- **Scalability and Maintenance:** Ensure the scalability and maintainability of the IoT infrastructure. Plan for future expansions, potential sensor upgrades, and regular maintenance of the sensors and communication infrastructure.

- **Fuzzy-logic based vehicle routing algorithm:**The fuzzy-logic based algorithm basically provides a score between 0 and 1 based on which decision can be made whether to open the signal or not. If the score is less than 0.5 then the algorithm returns FALSE else it returns TRUE. The existing system makes use of fuzzy logic for vehicle routing.

- **Acoustic based emergency vehicle detection system:**The existing system uses audio recognition to detect the siren sounds of the emergency vehicle using Machine Learning concepts. The system also uses websites with laborious examination reports written/typed on-to the websites or a file containing details. The system also utilizes a doctor on-site to recognize and solve problem.

CHAPTER 3

PROPOSED METHODOLOGY

The main controlling unit of this system is ARDUINO UNO, which is connected with IR sensors to sense the signals. This system consist of RFID as per the requirement for Arduino can control it. This unit consists of Arduino UNO, RFID, IR Sensor, Power supply, 16x2 LED Display and small LED lights.

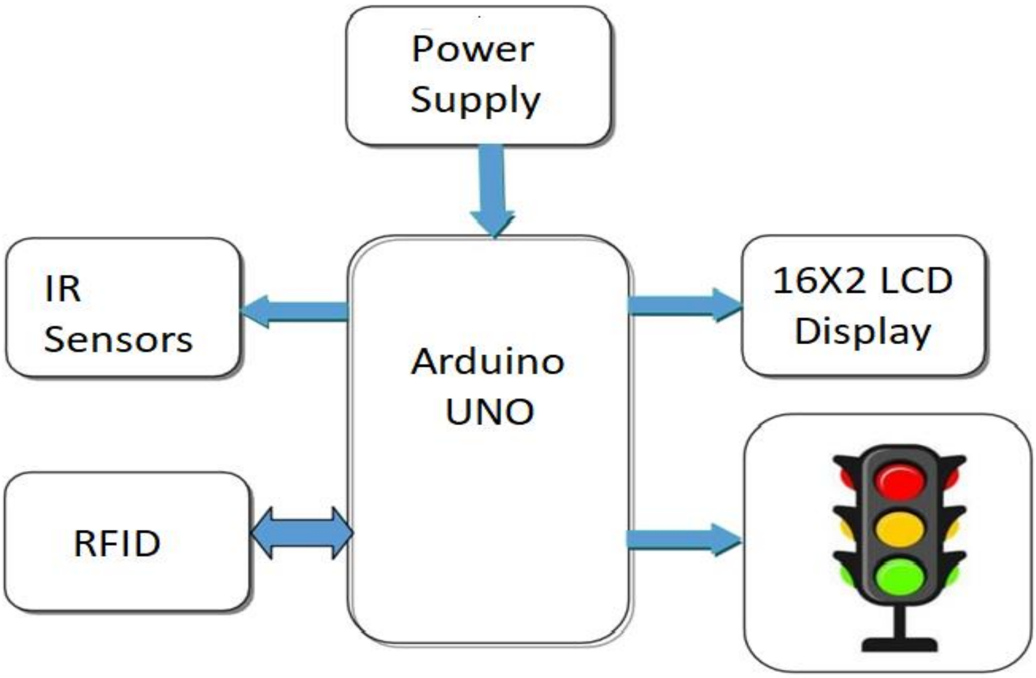

Fig 3.1 Block diagram of Traffic Control System using Arduino UNO for Adaptive Ambulance.

The Fig 3.1 represents the block diagram of traffic control system using Arduino UNO for Adaptive Ambulance. Our project density based traffic light control is an automated way of controlling signals in accordance to the density of traffic in the roads. IR sensors are placed in the entire intersecting road at fixed distances from the signal placed in the junction. The time delay in the traffic signal is set based on the density of vehicles on the roads. The IR sensors are used to sense the number of vehicles on the road. According to the IR count, microcontroller takes appropriate decisions as to which road is to be given the highest priority and the longest time delay for the corresponding traffic light.

- The system is based on microcontroller.
- The system contains IR transmitters and IR receivers which are mounted on the either sides of roads.
- This IR system gets activated when any vehicle passes on road between IR transmitter and IR receiver.
- The microcontroller controls the IR system and gets activated when vehicles are passing in between the sensors.
- Based on different densities of vehicles, the microcontroller decides the glowing time of the traffic lights.

- **ARDUINO UNO**

It is a firm that creates and produces single-board microcontrollers and microcontroller kits for creating digital devices, as well as an open-source hardware and software project. The boards have a variety of extension boards (called "shields"), breadboards (for prototyping), and other circuits that can be interfaced to the sets of digital and analogue input/output (I/O) pins on the boards. The boards have serial communications interfaces, some of which support USB (Universal Serial Bus), which are also used to load programs.

- **IR SENSORS**

An IR transceiver, also known as an infrared transceiver, may transmit and receive infrared data. An IR transceiver, then, is a transmitter and a receiver that are contained in the same unit and share circuitry. For portable or mobile use, IR transceivers are frequently utilized. While some transceivers can perform both tasks simultaneously, others can only perform one at a time.

- **RFID**

Radio-frequency identification (RFID) uses electromagnetic fields in order to automatically recognize and track tags attached to things. A tiny radio transponder, a radio receiver, and a radio transmitter make up an RFID system. Typically, the RFID range is from a few centimeters to over hundred meters. RFID reader uses frequency 125 KHz to few MHz.

- **LED**

When semiconductors and electron holes join again, photons are produced. The energy needed for electrons to pass through the semiconductor's band gap determines the hue of the light, which corresponds to the energy of the photons. A layer of light-emitting phosphor or numerous semiconductor devices can be used to create white light.

3.2 FLOW CHART

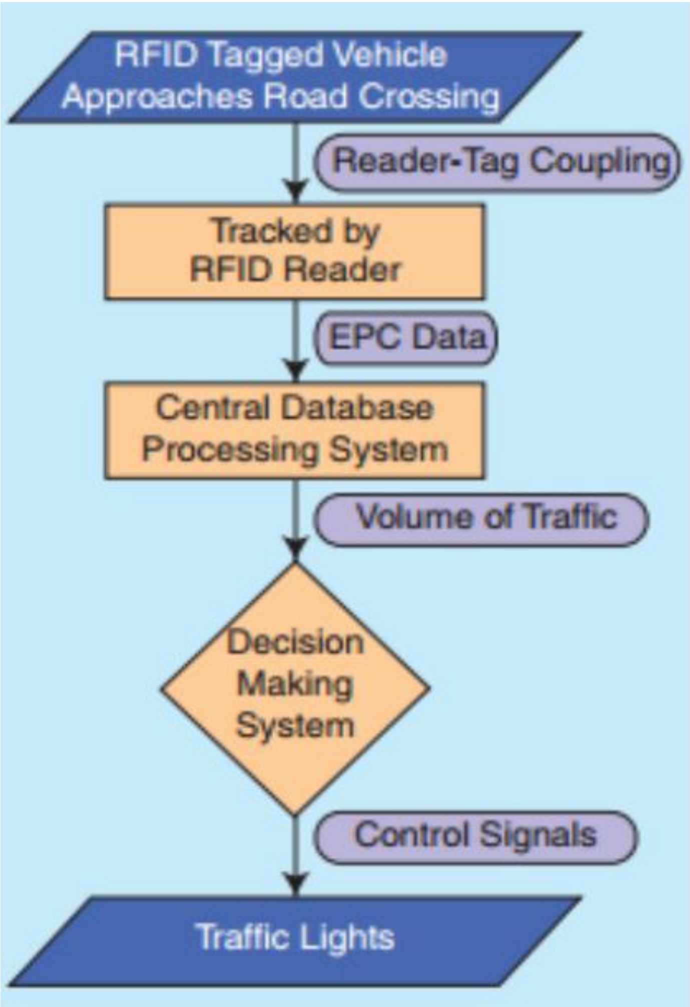

Fig 3.2 Flowchart of RFID Tagged Vehicle Approach

The Fig 3.2 shows the flowchart of RFID Tagged Vehicle approach road crossing is tracked by RFID Reader and central database processing system will detect the volume of traffic by decision making system of control signals to show traffic lights accordingly to it.

TRAFFIC VOLUME

One of the fundamental measures of traffic on a road system is volume of traffic using the road in a given interval of time. It is also termed as flow and it is expressed in vehicles per hour or vehicles per day. Knowing the flow characteristics one can easily determine whether a particular section of the road is handling traffic much above or below its capacity. If the traffic is heavy, the road suffers from congestion with consequent loss of speed, hence lower speed increases longer time of commuting.

If the traffic flow data are available over the past number of years, the rate at which traffic flow has increased in past can be easily determined by mathematically extrapolating the past trend into the future.

The following are volume characteristics to be considered:

- Variation in volume during different hours of the day.
- Average volume per day.
- Variation of traffic volume on different lanes
- Annual average daily traffic
- Average volume during different days.

There is various method to take up count of vehicles to measure volume.

Short term count

- To determine the flow or traffic in the peak hour.
- Used in measuring the saturation flow at signalized intersections.
- Used in intersections counts during the morning and evening peaks.

Continuous count

- To determine the fluctuation of flow daily, weekly, seasonally and yearly.
- To determine the annual rate of growth of traffic.
- Used for continuous monitoring of traffic flow in urban areas.

The various steps involved in the project are as follows:

- Analyzing the density of traffic based on IR SENSORS.
- Understanding the concept of RFID technology.
- Measuring traffic density and using the routing algorithm based on counter value.

Existing technologies are insufficient to handle the problems of congestion control, emergency vehicle clearance, stolen vehicle detection, etc. To solve these problems, we propose to implement our Intelligent Traffic Control System.

Traffic volume measurement

- To monitor the density of the traffic, we will be setting few IR Sensors beside roads i.e. near to traffic signal and depending upon the signals from the sensors the timing of the traffic signals will be changed. The sensors output is given to a comparator to digitize the output.
- The IR sensors sends the infrared radiations through its transmitter and receives back through receiver by reflecting back after hitting an object.
- The heavy dense lane gets cleared-off first as the green-time duration will be higher for that particular lane.
- The proximity of the sensor can be set to the required width of road throughout.

Detecting emergency vehicles and prioritizing for clearance on traffic lane.

- The ambulance carries an RFID tag, and RFID receiver will be there at few meters at the signal. The receiver will receive the signal and the module will send the command to turn on green through the RFID receiver at every traffic post.
- The RFID (Radio frequency identification) sends the radio waves to counteract the signal by RFID module.
- Whenever the ambulance comes near the traffic, the ambulance will transmit a code say “emergency” the receiver will receive this signal. Then it immediately switches off the other signals i.e. it make all the signals red and later make way for ambulance by signaling green on that lane. So by doing this the ambulance can go without any problem.
- The entry and exit points of the ambulance are stored in RFID database, later after certain delay other lanes are triggered with higher density and are prioritized to clear on that lane.

- The priority is given to the RFID based emergency vehicles and then higher traffic lane is cleared based on IR sensor detection and the traffic is delayed till the density in IR sensors becomes low.

PLACEMENT OF DEVICES

- It is expected that each vehicle is equipped with its own active RFID tag.
- It is assumed that all the four roads leading to the junction are 2-way and traffic can flow along three different directions from a crossing.
- The coordinators Ca, Cb, Cc, and Cd, as well as the routers Ra to Rd, are all able to read active RFID tags. At predetermined intervals, coordinators are positioned on each section of road going to a crossing.
- It is assumed ensure that all the four coordinators (RFID readers) are placed near a particular junction are not in each other's range of communication through RF.
- Traffic lights at the junction are controlled by the coordinators (RFID readers) nearest to them.
- IR Sensors are placed alongside the lane to trigger the density, and the traffic is cleared based on higher density priority.

CONGESTION DETECTION PHASE

- Each time a vehicle passes the router, its active RFID tag emits radiation that is sent to the closest RFID reader.
- As soon as the coordinator (RFID reader) receives the message, it saves it right away and waits to receive another message from the same tag as the coordinator passes by.
- The coordinator receives another beacon when that tag passes by it (RFID reader).
- The coordinator (RFID receiver), after receiving the beacon, saves the message's time interval using the timestamp on the beacon.
- It is proposed that all the stretches leading to the junction get the green signal in a cycle, fora time duration that is proportional to the population of vehicles in each stretch. It is assumed that Ca (RFID reader 1) only reads those tags that are in the same lane under its RF frequency range.

CHAPTER 4

RESULTS AND DISCUSSION

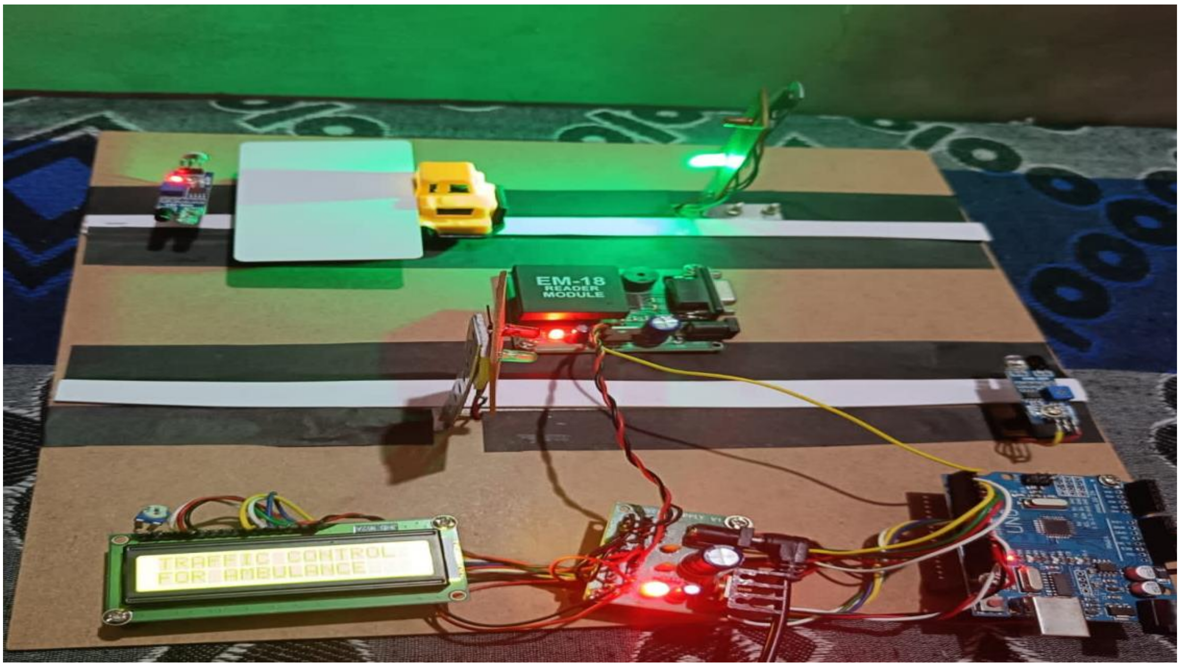

Fig 4.1 Volume Detection using IR sensors

- A strategy for reducing traffic congestion is prepared using the concept of IoT (Internet of Things).
- The traffic density is measured by using IR sensors placed on sides of the pavement for a required distance. The IR sensors transmits infrared radiations to detect the volume of vehicles on the particular lane and is allowed to clear the traffic first by prioritizing it is shown in the Fig 4.1 to sense the emergency of the vehicles.

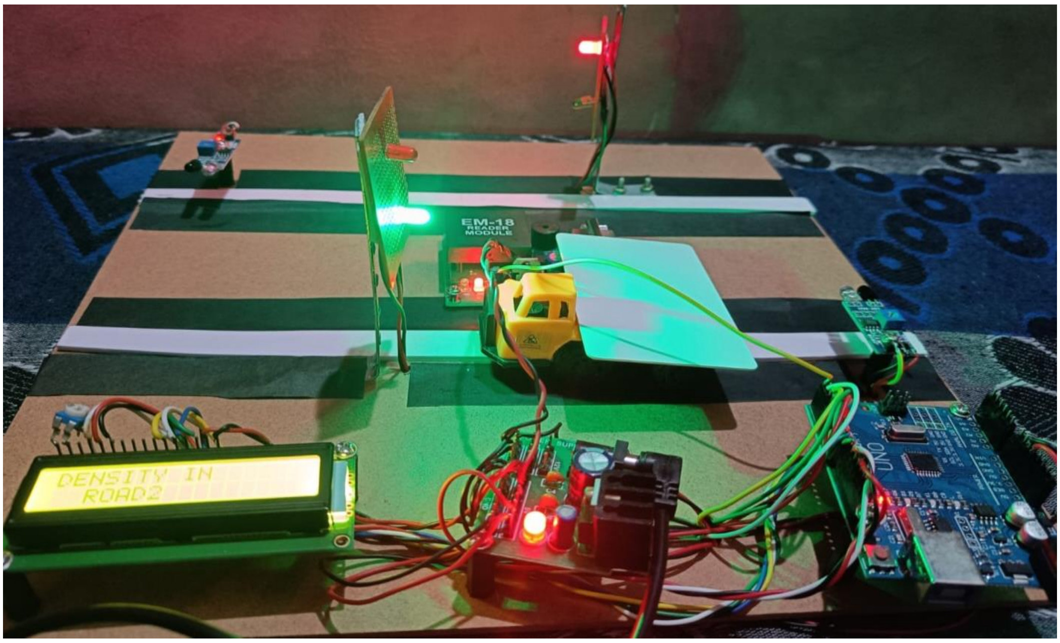

Fig 4.2 Detection of RFID

- An emergency vehicle is detected on a lane using Radio waves transmitted by RFID device and is triggered by RFID card attached to vehicle which is paired by traffic signal system, this prioritizes the traffic to get cleared at a faster rate on that lane shown above in Fig 4.2.
- The data of emergency vehicle can be stored and retrieved from the database management system which carries unique RFID tags based on their entry and exit points on the traffic lanes. The LCD displays the traffic at which road the vehicles have emergency is shown below at Fig 4.3.

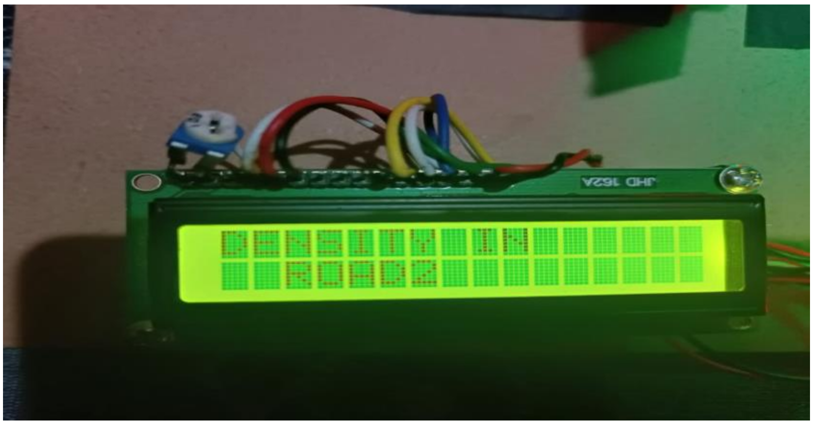

Fig 4.3 LCD displays traffic at Road

4.1 APPLICATIONS

Application of IoT (Internet of Things) in traffic infrastructure is the implementation of smart traffic management systems. These systems leverage connected devices and sensors to gather real-time data about traffic conditions and use it to optimize the flow of vehicles, improve safety, and enhance overall transportation efficiency. Here's an overview of how IoT can be applied in traffic infrastructure:

- Implementation of IoT systems in smart city projects and urban areas to reduce traffic congestion.
- Priority is given for emergency vehicle like ambulances, fire-brigades for easy movement in heavily congested area.
- Reduction of time in signal clearance on each lane in urban and densely populated areas.
- Data can be stored based on entry and exit points of the emergency vehicle.

By leveraging IoT technology in traffic infrastructure, cities can significantly enhance transportation efficiency, reduce congestion, improve road safety, and provide a better overall commuting experience for their residents.

4.2 ADVANTAGES

- **Improved Traffic Management:** IoT-enabled traffic infrastructure allows for real-time monitoring of traffic conditions. This data can be analyzed to gain insights into traffic patterns, identify congestion points, and optimize traffic management strategies.
- **Enhanced Safety:** IoT devices such as cameras, sensors, and connected vehicles can provide real-time information about road conditions, accidents, and hazardous situations. This enables quick response times for emergency services and allows traffic management authorities to take immediate action to ensure safety.
- **Efficient Resource Allocation:** IoT-based traffic infrastructure allows for more efficient allocation of resources. By analyzing real-time data on traffic conditions, authorities can optimize the use of traffic signals, manage lane closures, and deploy emergency services more effectively. This leads to reduced fuel consumption, improved air quality, and overall cost savings.

- **Smart Parking Management:** IoT sensors in parking lots and street parking spaces enable efficient management of parking spaces. Drivers can quickly locate available parking spots through mobile applications or digital signage, reducing the time spent searching for parking.
- **Proactive Maintenance:** IoT sensors embedded in critical infrastructure components such as bridges, tunnels, and traffic signals enable proactive maintenance
- **Data-Driven Decision Making:** IoT-generated data provides valuable insights into traffic patterns, peak hours, and congestion hotspots. By analyzing this data, traffic management authorities can make informed decisions about infrastructure upgrades, transportation planning, and policy changes.
- **Improved User Experience:** IoT in traffic infrastructure improves the overall user experience for commuters. By providing real-time traffic information, optimized routes, and parking availability, IoT helps drivers make informed decisions, reducing frustration and stress associated with traffic congestion.

4.3 DISADVANTAGES

Here are the disadvantages of using IoT in traffic infrastructure:

- Security risks and potential cyber attacks.
- Privacy concerns regarding data collection and usage.
- Reliability and maintenance challenges.
- Scalability difficulties when managing a large network of devices.
- Significant upfront and ongoing costs.
- Technical complexity in integrating various technologies.
- Dependency on stable and reliable connectivity for real-time data transmission.

CHAPTER 5

CONCLUSIONS AND FUTURE SCOPE

5.1 CONCLUSION

In this paper we have studied the optimization of traffic light controller in a city using Arduino and IR sensors. A traffic light system has been designed and developed with proper integration of both the hardware and the software. This interface is synchronized with the whole process of the traffic system. Automatically, this project could be programmed in any way to control the traffic light model and will be useful for planning proper road system.

- IR sensors and RFID is one of the technologies that can be utilized for smart transportation system thereby reducing the human effort and avoid traffic congestions, and easy movement of emergency vehicle movements.
- RFID technology can also be used for tracking the emergency vehicles like ambulance, fire brigades, etc. like its entry and exit points and the particular vehicle using its registration number and RFID number.
- IR sensors are best used to find the density on each lane to avoid congestions, making it easier to manipulate the signal system at each junction.

IoT-based traffic infrastructure offers several advantages in terms of improved traffic management, enhanced safety, efficient resource allocation, proactive maintenance, data-driven decision making, and a better user experience. It enables real-time monitoring of traffic conditions, adaptive traffic control, smart parking management, and facilitates proactive maintenance of critical infrastructure.

However, there are also potential disadvantages to consider, including security risks, privacy concerns, reliability challenges, scalability difficulties, high costs, technical complexity, and dependency on connectivity. Addressing these challenges through robust cybersecurity measures, privacy safeguards, proper maintenance, and scalable infrastructure can help maximize the benefits of IoT in traffic infrastructure while mitigating potential drawbacks.

5.2 FUTURE SCOPE

The future scope of IoT-based traffic infrastructure projects is incredibly promising, with numerous advancements expected to transform the way we manage and optimize transportation systems. One key aspect is the continued development of Intelligent Transportation Systems (ITS) that leverage IoT technologies. These systems will utilize advanced analytics, machine learning, and artificial intelligence algorithms to analyze vast amounts of real-time data from sensors and devices embedded in the infrastructure. This data will enable more accurate and efficient traffic management, including dynamic signal control, predictive congestion detection, and proactive incident management.

The integration of IoT in vehicles will also play a crucial role in the future of traffic infrastructure. Connected vehicles, equipped with IoT capabilities, will communicate with each other and with the surrounding infrastructure through Vehicle-to-Everything (V2X) communication. This connectivity will enable cooperative collision avoidance, real-time traffic updates, and personalized routing suggestions to drivers. Moreover, autonomous vehicles will benefit from IoT-based infrastructure, as they can access real-time data to make informed decisions and navigate more efficiently.

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APPENDIX

DATA SHEET

HARDWARE REQUIREMENTS:

ARDUINO UNO- The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[Fig.1] The board has14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Fig 1. Arduino UNO

TABLE 1: Arduino Uno Technical Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

The 14 digital input/output pins can be used as input or output pins by using pin Mode (), Digital Read () and digital Write () functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 K Ohms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- External Interrupt Pins 2 and 3: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using Analog Write () function.
- SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.
- In-built LED Pin 13: This pin is connected with an built-in LED, when pin 13 is HIGH– LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference () function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library. Arduino Uno has a couple of other pins as explained below:
- AREF: Used to provide reference voltage for analog inputs with analog Reference () function.
- Reset Pin: Making this pin LOW, resets the microcontroller.

IR SENSORS- IR technology is used in a wide range of wireless applications which includes remote controls and sensing. The infrared part in the electromagnetic spectrum can be separated into three main regions: near IR, mid-IR & far IR. The wavelengths of these three regions vary based on the application. For the near IR region, the wavelength ranges from 700 nm-1400 nm, the wavelength of the mid-IR region ranges from 1400nm – 3000nm & finally for the far IR region, the wavelength ranges from 3000nm – 1mm.

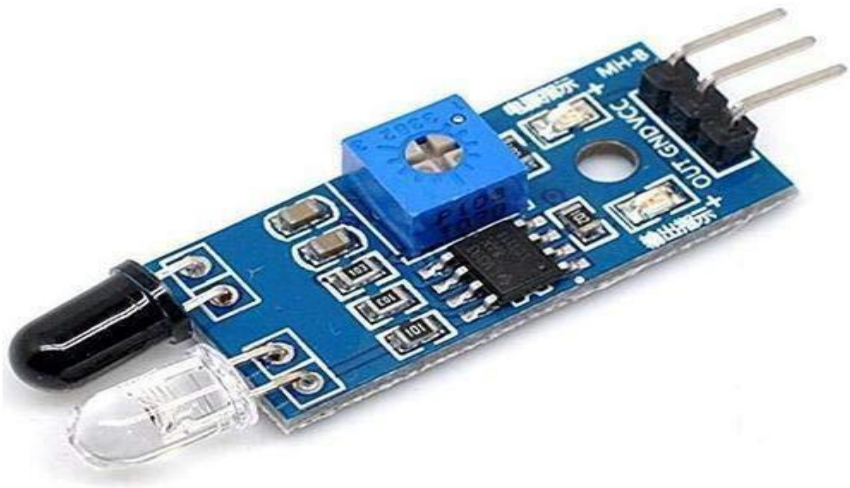

Fig 2. IR Sensor

IR Receiver LED and IR Transmitter LED

An IR receiver LED and an IR transmitter LED are both types of light-emitting diodes (LEDs)that are used in infrared (IR) communication. An IR receiver LED is a device that detects infrared signals from remote controls and other IR sources. It is typically a small, clear, or translucent device that is sensitive to IR light in a specific frequency range. When an IR signal is detected, the IR receiver LED will emit a small amount of visible light, which can be used to confirm that a signal has been received.

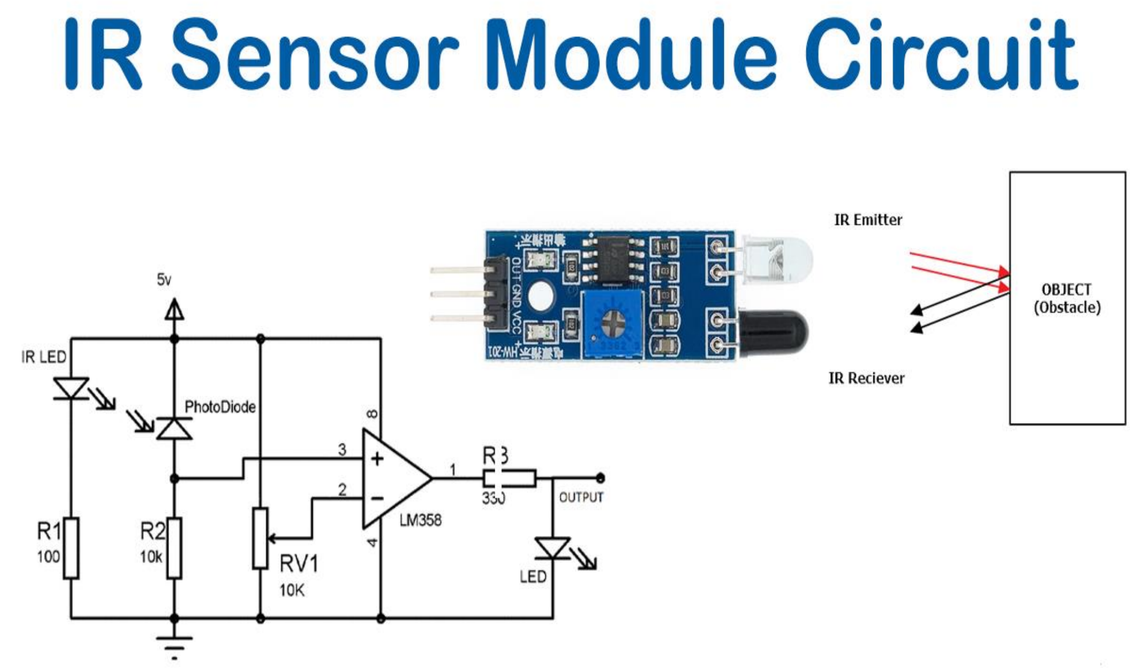

Fig 3. IR Sensor Module

Fig 3 shows IR sensor module is a device that contains an IR receiver LED and other components that are used to detect and process IR signals. It typically includes an IR receiver LED, a signal amplifier, and a demodulator circuit. The IR receiver LED is used to detect IR signals, while the signal amplifier and demodulator circuit are used to amplify and process the received signal, respectively.

- IR Based Obstacle Detector
- Adjustable Range with POT
- Operating Voltage 5v
- Sensitivity up to - 30cm-Adjustable
- Logic output -1/0 -5v

Application - Industrial safety devices.

RFID (Radio-frequency identification)- RFID uses electromagnetic fields in order to automatically recognize and track tags attached to things. A tiny radio transponder, a radio receiver, and a radio transmitter make up an RFID system. The tag transmits digital data, often an inventory number used to identify the item, back to the reader when it receives an electromagnetic interrogation pulse from a nearby RFID reader device. The inventory of products can be tracked using this number. The radio waves used for interrogation by the RFID reader provide power to passive tags. Active tags can be read at a wider distance from the RFID reader, up to hundreds of meters, because they are battery powered. RFID range depends on transmit power, receive sensitivity and efficiency, antenna, frequency, tag orientations, surroundings. Typically, the RFID range is from a few centimeters to over hundred meters. RFID reader uses frequency 125 KHz to few MHz.

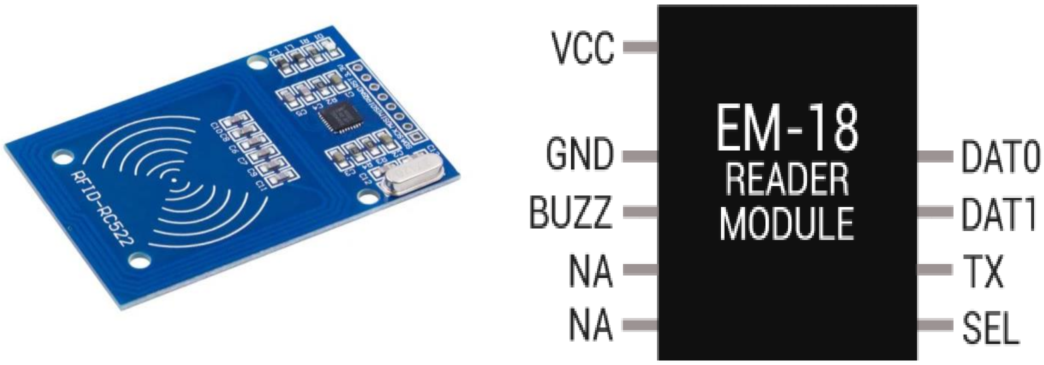

Fig 4. RFID and EM-18 Reader Module

RFID tags have similar applications to barcodes in that (barcodes) data from a tag are captured by a device that stores the data in a database. RFID, though, has more than a few advantages over barcode asset tracking software. Most importantly data of the RFID tag can be read outside the LOS (line-of-sight), whereas barcode stickers must be made straight against an optical scanner to decode/read is shown in Fig 4.

EM-18 is a nine pin device. Among nine pins, 2 pins are not connected, so we basically have to consider seven terminals.

TABLE 2: EM18 RFID PIN CONFIGURATION

Pin Number	**Description**
VCC	Connect to the positive of power source
GND	Connected to ground
BUZZ	Connect to BUZZER if used
NC	No Connection
NC	No Connection
SEL	SEL=1 then o/p= RS232 SEL=0 then o/p=WEIGAND
TX	DATA send through TX using RS232 communication
DATA1	WEIGAND interface DATA HIGH pin
DATA0	WEIGAND interface DATA LOW pin

EM18 SPECIFICATION

- Operating voltage of EM-18: +4.5 V to +5.5 V
- Current consumption: Less than 50 mA
- Can operate on LOW power
- Operating temperature: 0 ºC to +80 ºC
- Operating frequency:125 KHz
- Communication parameter: 9600 bps
- Reading distance: 10 cm, depending on TAG
- Integrated Antenna

16X2 LCD DISPLAY MODULE- The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

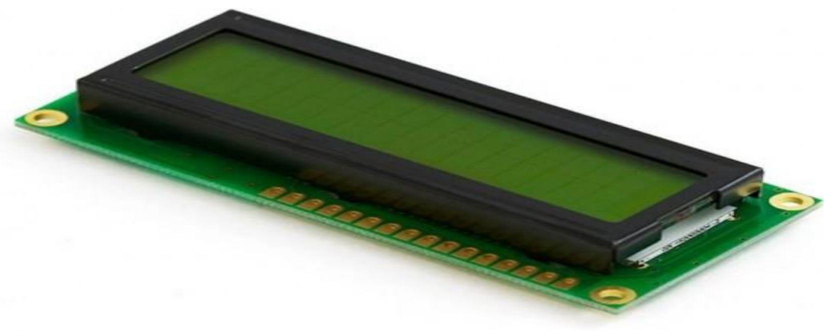

Fig 5. 16X2 LCD Display

TABLE 3: 16X2 LCD DISPLAY PIN CONFIGURATION

The 16×2 LCD pinout is shown below at Fig 6.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).

- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V.
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

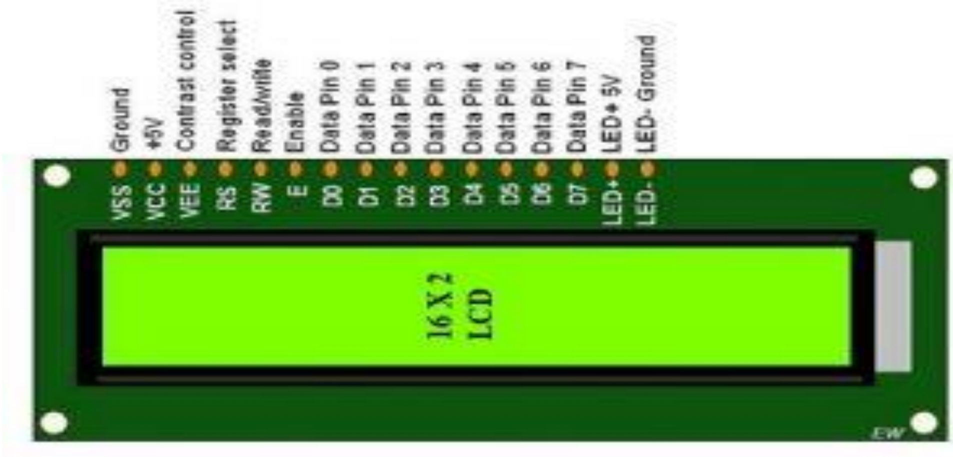

Fig 6. Pin Description of LCD Display

LED LIGHTS- When semiconductors and electron holes join again, photons are produced. The energy needed for electrons to pass through the semiconductor's band gap determines the hue of the light, which corresponds to the energy of the photons. A layer of light-emitting phosphor or numerous semiconductor devices can be used to create white light. A Light-emitting Diode is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Early LEDs emitted low- intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness.

When a light-emitting diode is forward biased switched on, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electro luminescence the colour of the light corresponding to energy of the photon is determined by the energy gap of the semiconductor. An LED is often small in area less than 1 mm * 1 mm and integrated optional components may be used to shape its radiation pattern. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching and greater durability and reliability.

Fig 7. LED lights

LEDs are used in application as diverse as replacements for aviation lighting, automotive lighting particularly brake lamps, turn signals and indicators as well as in traffic signals. Infrared LEDs are also used in the units of many commercial products including T.V, DVD player and other domestic appliances.

Features:

- Popular T-1 3/4 colorless 5mm package
- High luminous power
- Typical chromaticity coordinates x=0.30, y=0.29 according to CIE1931.
- Bulk, available taped on reel.
- ESD-withstand voltage: up to 4KV .
- The product itself will remain within RoHS compliant version.

Descriptions:

- The series is designed for application required high luminous intensity.
- The phosphor filled in the reflector converts the blue emission of InGaN chip to ideal white.

POWER SUPPLY- All Arduino boards need electric power to function. A power supply is what is used to provide electric power to the boards and typically can be a battery, USB cable, AC adapter or a regulated power source device. There are different ways to power your Arduino board. The most common way is through the USB connector available on every board, but there are a few other possibilities to power your board.

Fig 8. Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power (uninterruptible power supply).

JUMPER WIRES- A jumper wire (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire or group of the min a cable with a connector or pin at each end (or sometimes without them simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

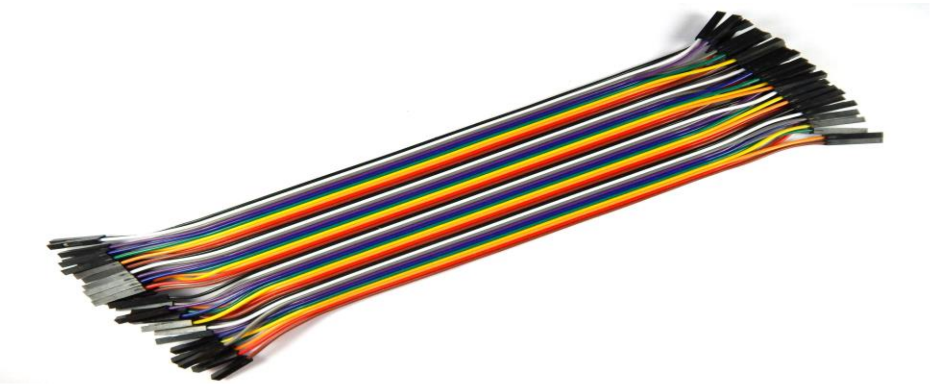

Fig 9. Jumper Wires

PORT CABLE- An Arduino serial port cable is used to burn the programming instructions in the Arduino board from computer.

Fig 10. Port cable

SOFTWARE REQUIREMENTS:

ARDUINO IDE- The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. Refer to the Getting Started page for Installation instructions. Active development of the Arduino software is hosted.

Fig 11. Arduino IDE software

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, macOS, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. The Arduino IDE site is shown below at Fig 12.

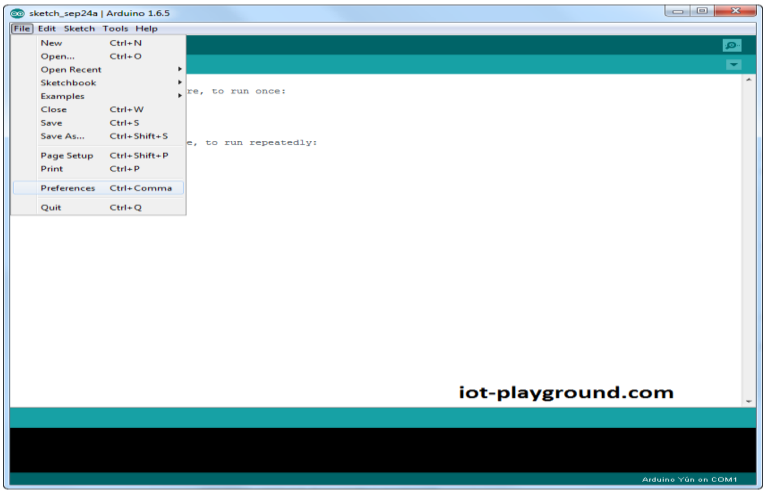

Fig 12. Arduino IDE Site

Arduino is an open-source project, enabling hobbyists to easily take advantage of the powerful Atmega chips. The Arduino IDE is the software where you can write code and upload it to the Atmega chip. The code is then executed on the chip. Most 3D-printer electronics are Arduino-compatible, they use the Atmega chip and enable the user to upload their code using Arduino. This includes Megatronics, Minitronics and RAMPS.

Before you can start using the electronics you need software 'firmware', that translates machine instructions (gcode) into actual movements. There are a few options here, including Marlin and Sprinter and Repeater. The actual firmware is not discussed in this document. You can use Arduino to upload this firmware onto your electronics. This document will guide you in the steps you need to take.

To upload a firmware, you must first open the files using File → Open. Select the file from the directory containing the firmware. Arduino will open several tabs with files. Next step is to select the correct electronics board. From the Tools menu, locate the Board item. This item should include a few sub items, including Megatronics,Minitronics, Arduino mega 2560 (RAMPS with mega 2560) and Arduino Mega 1280 (RAMPS with mega1280). Select the board that fits your electronics.

Also we need to select the serial port the electronics is connected to. In the Tools menu, locate the Serial port item. This should include at least one item if the board is connected and the drivers are installed properly. If there are multiple items here, you need to find out which is the correct one by unplugging the board and checking which port was removed. Once you have set the board and serial port, you can upload the firmware by pressing File→ Upload.

Arduino will try to compile the firmware, if any errors occur the process will stop and you will need to fix the errors before trying again. Once compilation is complete, the actual upload will start. This may take a minute for alargesketch Arduino.You can actually 'talk' to the firmware using the Serial monitor. Make sure the correct serial port is selected and locate the Serial monitor button.

2. EMBEDDED C- Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. Embedded C programming typically requires nonstandard extensions to the C language in order to support enhanced microprocessor features such as fixed point arithmetic, multiple distinct memory banks, and basic I/O operations.

The C Standards Committee produced a Technical Report, most recently revised in 2008[1] and reviewed in 2013, providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics of standard C, e.g., main () function.

The embedded C language is used for program coding. Use of C in embedded system is driven by following advantages: It is small and reasonably simpler to learn, understand, program and debug. C Compilers are available for almost all embedded devices in use today and there is a large pool of experienced C programmers.

Unlike assembly, C has advantage of processor- independence and is not specific to any particular microprocessor/microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems. As C combines functionally of assembly language or high level assembly language. It is fairly efficient. It supports access to I/O and provides ease of management. Embedded C has to use with limited resources RAM, ROM, I/Os as an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash.