Traffic Stimulator Based on IoT Technology

Aman Ulla
R.R.C.E,
Bangalore, Karnataka, India
email: winwithaman@gmail.com
Phone Number: +91-8147066971

CHAPTER 1

INTRODUCTION

Internet of Things (IoT)

The term "the Internet of Things" was coined by Kevin Ashton of Procter & Gamble, later MIT's Auto-ID Center, in 1999. The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies" and for these purposes a "thing" is "an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks". The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 260 billion objects by 2020.

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid, and expanding to areas such as smart cities. "Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring. As well as the expansion of Internet-connected automation into a plethora of new application areas, IoT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems.

Working of the SONAR Obstacle

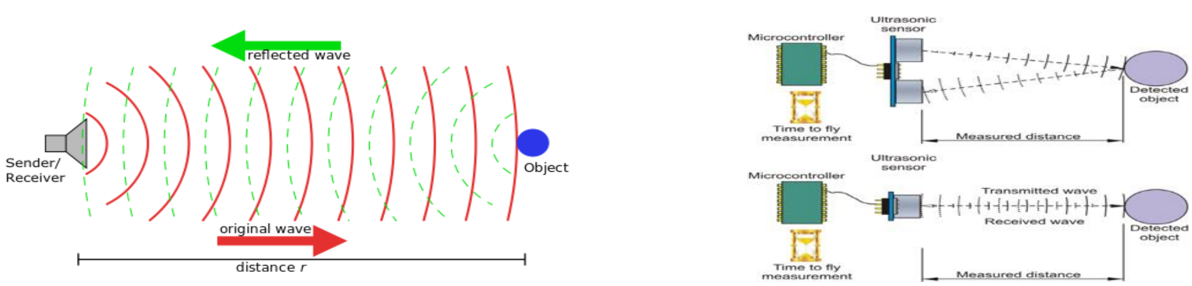


Fig 1. Working Principle of Ultrasonic Sonar

Distance measurement of an object in front or by the side of a moving entity is required in a large number of devices. These devices may be small or large and also quite simple or complicated. Such distance measurement systems are available. These use various kinds of sensors and systems. Low cost and accuracy as well as speed is important in most of the applications. In this Context, we describe such a measurement system which uses ultrasonic transmitter and receiver units mounted at a small distance between them and a Arduino microcontroller based system. This microcontroller is equivalent to the most popular 8051 microcontrollers and hence very easily available at low cost. A correlation is applied to minimize the error in the measured distance. Ultrasound sensors are very versatile in distance measurement. They are also providing the cheapest solutions. Ultrasound waves are useful for both the air and underwater. Ultrasonic sensors are also quite fast for most of the common applications. In simpler system a low-cost version of 8- bit microcontroller can also be used in the system to lower the cost. The system will compute the distance of obstacle or blockage store it and also communicate the distance or location of the obstacle or blockage to the control station above ground.

1.1 Motivation

Cities are the main poles of human and economic activity. They hold the potential to create synergies allowing great development opportunities to their inhabitants. However, they also generate a wide range of problems that can be difficult to tackle as they grow in size and complexity. Cities are also the places where inequalities are stronger and, if they are not properly managed, their negative effects can surpass the positive ones.

Urban areas need to manage their development, supporting economic competitiveness, while enhancing social cohesion, environmental sustainability and an increased quality of life of their citizens. With the development of new technological innovations -mainly ICTs- the concept of the "Smart City" emerges as a means to achieve more efficient and sustainable cities. Since its conception, the Smart City notion has evolved from the execution of specific projects to the implementation of global strategies to tackle wider city challenges. Thus, it is necessary to get a comprehensive overview of the available possibilities and relate them to the specific city challenges. Despite there is some kind of consensus that the label Smart City represents innovation in city management, its services and infrastructures, a common definition of the term has not yet been stated. There is a wide variety of definitions of what a Smart City could be. However, two trends can be clearly distinguished in relation with what are the main aspects that Smart Cities must take into consideration. On the one hand there is a set of definitions that put emphasis just on one urban aspect (technological, ecological, etc.) leaving apart the rest of the circumstances involved in a city. This group of mono-topic descriptions are misunderstanding that the final goal of a Smart

City is to provide a new approach to urban management in which all aspects are treated with the interconnection that takes place in the real life of the city. Improving just one part of an urban ecosystem does not imply that the problems of the whole are being solved. On the other hand, there are some authors that emphasize how the main difference of the Smart City concept is the interconnection of all the urban aspects. The tangled problems between urbanization are infrastructural, social and institutional at the same time and this intertwining is reflected in the Smart City concept. From the definitions, it can be noticed that infrastructures are a central piece of the Smart City and that technology is the enabler that makes it possible, but it is the combination, connection and integration of all systems what becomes fundamental for a city being truly smart. From these definitions it can be inferred that the Smart City concept implies a comprehensive approach to city management and development. These definitions show a balance of the technological, economic and social factors involved in an urban ecosystem. The definitions reflect a holistic approach to the urban problems taking advantage of the new technologies so that the urban model and the relationships among the stakeholders can be redefined.

1.2 SMART CITY PROJECT ACTION

Once the concept of Smart City and the main challenges are defined, a systematic approach to the possibilities of action of the Smart City projects has been developed. The Smart City concept has changed from the execution of specific projects to the implementation of global strategies to tackle city challenges. Thus, it is necessary to get a comprehensive overview of the possibilities and to relate them to the city challenges. As a common point to all of them, the key factor of the Smart City projects has been identified to be the use of ICT. According to these criteria, project actions have been defined as seen in Table 3. The different Project Actions have been described and put into relation with the various city challenges identified in Part 1. In a second step, Smart Projects that are being developed in cities have been grouped in the different dimensions. Smart City strategies comprehend a combination of these sub actions. Smart City Project Actions are also composed by more concrete sub actions, that are further interwoven. The aim of this second phase is to widen the panel of possibilities of action and to present an approach that is closer to implementation. Paying special attention to the environmental dimension, it stablishes the relations of the existing city with its territorial support, both natural and built. The relations of the city with its natural environment constitute the departure point for project actions that affect climate, biodiversity, resources (energy, water, etc.) and monitoring. The built environment is present in the project actions related to urban planning and building, either renewal or new construction. The challenges addressed in this dimension intertwine these two dimensions from the point of view of citizens.

1.3 GOVERNMENT SUPPORT FOR SMART CITY

Recently, many local governments have been aiming to implement an IoT-based smart city through the construction of a test bed for IoT verification and an integrated infrastructure. This movement also corresponds to the creative economy that is emphasized by the Indian government. In this chapter, Traffic stimulator implementation models based on IoT that can be implemented by local governments are described through examples. Traffic simulation or the simulation of transportation systems is the mathematical modelling of transportation systems (e.g., freeway junctions, arterial routes, roundabouts, downtown grid systems, etc.) through the application of computer software to better help plan, design and operate transportation systems. "Traffic Stimulator" is an autonomous designed traffic control, which helps a lot in reducing traffic and management of traffic signals with advanced technology. In India traffic is major problem which leads to stress, and it is caused due to over growth in population and the needs and demand of humans. To solve this problem, we introduce this "TRAFFIC STIMULATOR" which smartly judges the density of vehicle crowd and according to it control the traffic signals. The Traffic Stimulator system includes the Arduino Uno Microcontroller and all of the sensors required to navigate the robot around its environment.

1.4 ADVANTAGES OF SMART CITY

Smart Cities Mission of the Government is a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalyzing the creation of similar Smart Cities in various regions and parts of the country. The core infrastructure elements in a smart city would include: I. adequate water supply,

ii. assured electricity supply,

iii. sanitation, including solid waste management,

iv. efficient urban mobility and public transport,

v. affordable housing, especially for the poor,

vi. robust IT connectivity and digitalization,

vii. good governance, especially e-Governance and citizen participation,

viii. sustainable environment,

ix. safety and security of citizens, particularly women, children and the elderly, and

x. health and education. As far as Smart Solutions are concerned, an illustrative list is given below. This is not, however, an exhaustive list, and cities are free to add more applications.

IN FUTURE

By the year 2020, urban citizens will start demanding intelligent cities with sustainable environment and higher quality of life. New technologies will allow Smart Cities to put citizens first and help deliver the promise of social, environmental and economic sustainability. By the year 2030, all the major Cities of the world will be on the path to becoming Smart Cities and existing Smart Cities will continue to mature and adopt new technologies such as grid sensors and pneumatic waste disposal while incorporating sustainable architecture and low-carbon energy production. By the year 2050, Smart Cities could reduce greenhouse gas emissions by up to seventy-five percent through green buildings and use of renewable energy. The eco-friendly high rises in these Smart Cities will be smog eaters with suspended gardens of green algae bioreactors, vertical farms and green bridges, all of which will be efficiently managed by future technology.

1.5 DISADVANTAGES OF SMART CITY

Until now intelligent technology is in its pre-commercial level**.** Creates social risks

For example: elder individuals have a limited access to broadband due to the lack of skills. In addition, Individuals might lack information on how to use some technologies such as: smart meters.

CHAPTER 2

2 PROPOSED SYSTEM

The Traffic Stimulator is designed:

There are sonars placed at every 250m distance from the traffic light

The sonar sends/transmit and the receiver near the traffic signal receives.

When the receiver is unable to detect or receive data from the receiver that means vehicles are blocking the way, which in turn implies that the traffic is reached to that particular range

Then the traffic signal allows that particular lane to move for a longer duration.

When the signal light is red and if any vehicle breaks the signal, and moves then the camera captures that particular vehicle image and forward it to the traffic management department.

If any vehicle tends to move while humans are crossing road then the camera takes snaps of that particular vehicle.

If the camera detects any ambulance or police vehicle with the siren, then it immediately stops all lane and allow the lane to move in which the ambulance or police vehicle is resent.

All the streets light will be made automated controlling by sensors which responds to the intensity of sunlight and then according to that it switches on and switches off the street light.

All the electrical street light can be converted to solar street light thus decreasing the power consumption.

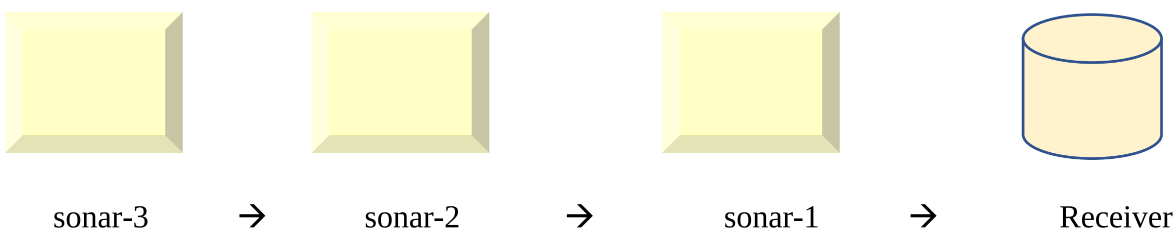


Fig. 2. Proposed methodology

2.1 OBJECTIVE

- To minimize the Human Effort
- A stepping Towards the Smarter City
- Efficient

2.2 FEATURES AND SCOPE

- It has a very promising future in front of it.
- Research claims that fueled by rapid rise in Smart city research.
- It would provide revolutionizing statistics in the upcoming years which would entirely change the underwater research world.
- It would also prove to be a viable replacement for the sonar technology that causes the brain of marine mammals to explode inside their body and die.

2.3 RELATED WORKS

1- Roadway Traffic Control Software

Author- Darcy Bullock and Chris Hendrickson

Roadway traffic control relies upon a large number of Redistributed microprocessors responsible for intersection signals, freeway ramp meters, traffic volume monitoring, communication and various other tasks. Effective traffic control can have significant impacts on urban congestion, air pollutant emissions and fuel consumption. Nevertheless, modernization and improvement of roadway traffic control is hampered by inadequate field computing hardware and software. Existing controllers are based on decades-old control strategies; and describe typical techniques. This paper presents a software model that is intended to foster significant improvements in the scope and opportunity for effective roadway traffic control. In describing the software model, the special characteristics of the roadway control problem are reviewed. An example application is described for freeway ramp metering implemented as a demonstration on Route 52 in Sacramento, CA. Most distributed control systems are comprised of several hierarchical levels of control. Ideally, roadway traffic control Manuscript received February 2, 1993. Paper recommended by Associate Editor X. Cao. D. Bullock is with the Remote Sensing and Image Processing Laboratory, Department of Civil Engineering, Louisiana State University, 322 I CEBA Building, Baton Rouge, LA 70803 USA. Chris Hendrickson is with the Camogie Institute of Technology, Engineering Design Research Center and the Department of Civil Engineering, Carnegie Mellon University, Pittsburgh, PA 152 13 USA. IEEE, Log Number 9403414. Chris Hendrickson Strategic Planning. Supervisory Field Control. Hierarchical traffic control architecture for traffic signals. systems are comprised of three distinct control layers: local, supervisory, and strategic. The local controllers are used to monitor inductive loop vehicle detectors, to sequence signal phasing’s, and to archive a limited amount of historical data. To mitigate the impact of local controller failures, an individual controller is typically used to control a single intersection or freeway entrance ramp. Coordination of adjacent controllers and synchronization of arterial routes is implemented using supervisory controllers called "on street masters" or "field masters." A single supervisory controller may be connected to a dozen or more local controllers in a particular zone or along a corridor. A third level of control provides strategic guidance to the "field masters." At the present time, most strategic planning is provided by human operators in traffic operation centers. Local and supervisory controllers are typically based on one of two different hardware platforms. One family of controllers, commonly called NEMA units, are built with connectors conforming to standard mechanical and electrical connectors. Suppliers compete based upon the internal hardware and software. Since the units have standard connectors, an agency can migrate to another controller by unplugging one unit and plugging in a new one. However, due to additional proprietary sockets added to the NEMA TSI units and nonstandard communication protocols, this interchangeability is not realized in practice. The 1988 NEMA TS1 standard has recently been updated (NEMA TS2 Type 1 and NEMA TS2 Type2) to address shortcomings of the NEMA TS1 standard and incorporate a 40-character, 16-line display for interacting with the controller. However, the software on all NEMA controllers remains proprietary and cannot be ported by the customer. Since most public agencies are required to solicit competitive bids, engineers and technicians must learn and maintain controllers based upon several different software models. Furthermore, if a particular installation requires software modifications, manufacturer participation is required. This is often unavailable, administratively very difficult, or prohibited by competitive bid regulations. A second family of controllers, referred to as the Caltrans Type 170 controllers, are built to provide both standard connectors and portable software. The philosophy of this standard is to develop a very precise specification for a traffic control microcomputer. Suppliers are selected periodically through competitive bidding. This standard has been tremendously successfully for the past twenty years and has seen several improvements over the years, including adding a serial port, adding additional memory, and changing ROM sizes. A distinguishing feature of 170 controllers is their program module. This program module is an insert able card with a ROM that stores the traffic control program. This module can be removed from one manufacturer's 170 controller, inserted in another controller, and the software will run without modification. Instead of relying on embedded user interfaces (as in the NEMA controllers), the 170's are typically configured by connecting a PC to serial port for downloading a control strategy. Alliteratively, configuration codes can be keyed in on a hexadecimal keypad. In general, larger states such as California and New York have preferred the Caltrans 170 platform because they could control the software development and competitively purchase functionally identical units. However, the Caltrans 170 standard is beginning to age. First, the software is written entirely in assembly language. The complex nature of assembly language development precludes all but the largest cities and states from maintaining a software staff for making software configuration changes other than changing parameters. Second, no operating system is employed. Routine chores such as task scheduling and communication semaphores must be reinvented. The "home-grown" executives that have evolved preclude sharing of new control strategies since the strategies are not based upon any standard operating system. Third, the 170 hardware is based on decades old designs with a relative slow processor and limited memory. It is unclear how I. A speed-density relationship. A flow-density relationship. much longer manufacturers will support the embedded 6800 microprocessors. To address these deficiencies, the state of California is in the process of developing a specification for a new controller that would address many of these issues. The initial Caltrans 170 specification detailed every component of a special purpose microcomputer. In contrast, the current development focuses on adopting an open architecture platform composed of existing industrial computing components. The new specification will likely involve a 3U VME chassis, a 68000 family of CPU boards, the OS-9TM operating system, and a collection of modular VO boards. This Open Architecture Traffic Controller (OATC) provides several important hardware advances, but has not adequately addressed the software development obstacles commonly encountered by traffic engineers. The following sections of this paper I) briefly summarize issues in roadway traffic control, ii) describe an adaptation of a synchronous data flow model to traffic engineering, iii) discuss verification issues, and iv) present an application of the model to freeway ramp metering.

2- Automatic Intelligent Traffic Control System

Authors- Linganagouda R, Pinite Raju, Anusuya Patil

Traffic light optimization is a complex problem. With multiple junctions, the problem becomes even more complex, as the state of one light influences the flow of traffic towards many other lights Changes, depending on the time of day, the day of the week, and the time of year. Roadwork and accidents further influence complexity and performance. As the number of road Users constantly increases, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future. However, some limitations to the usage of intelligent traffic control exist. Avoiding traffic jams for example is thought to be beneficial to both environment and economy, but improved traffic-flow may also lead to an increase in demand. There are several models for traffic simulation. In our project we focus on optimization of traffic light controller in a city using IR sensor and developed visual monitoring using microcontroller. Traffic light optimization is a complex problem. Even for single junctions there might be no obvious optimal solution. With multiple junctions, the problem becomes even more complex, as the state of one light influences the flow of traffic towards many other lights. In this paper, we propose three approaches, the firstly - to give authority to ambulances to pass the respective lane without delay, secondly – allow smooth passage of vehicles with maximum priority (VIP cars, POLICE cars), and thirdly – control traffic density of cross-roads by increasing the green light time. The project is a replica of a four-way lane crossing of real time scenario. In the first part, concentrated on problems faced by Ambulances, RFID concept is used to make the Ambulance's lane Green and thus providing a stoppage free way for the Ambulance. IR transmitter and receiver are used to make the vehicles' lane Green and thus preventing traffic congestion. IR transmitter and receiver are used to provide dynamic traffic control and thus increasing the duration of the Green light of the lane in which traffic density is high and hence, regulating traffic.

3- Techniques for Smart Traffic Control

Author- Roxanne Hawi, George Okeyo, Michael Kimwele

The steady increase in the number of vehicles on the road has increased traffic congestion in most urban cities of the world. One approach most countries are taking to address this issue is the expansion of roadways. However, this approach still comes with its share of challenges. Demolition of older roads can be quite costly. Most urban cities lack the free space required for such a venture. Even with the improvements in road infrastructure, it is evident that the rate at which travelers buy vehicles has surpassed that of new infrastructure development. Also, due to expansions, roads are able to serve more vehicles; consequently, utilizing the additional capacity. This is consistent with the 'fundamental law of highway congestion' suggested by Downs who avers that increasing road supply invariably increases vehicle traffic. With inadequate space and funds for the construction of new roads, and the growing imbalance between traffic demand and transportation resources; it is increasingly obvious that countries must move beyond the traditional model of just building roads to solve traffic problems. This is demonstrated in a survey done by CBT in Britain. The report supports that expansion and building of new roads will do very little to help solve the congestion issue. CBT survey found that nearby local roads suffered up to 137% more traffic after the bypasses opened, and reductions on the roads intended to be relieved were less than expected. Therefore, managing of traffic flow needs to be a combination of physical infrastructure, new ways of thinking and new technologies. Smarter transport transcends infrastructure. In light of this, smart traffic control systems have gained a lot of interest. These smart traffic control systems use advanced technologies such as image processing, computer vision, intelligent controls and artificial intelligence to make traffic routing decisions; a task typically done by traffic officers e.g. policemen or traffic marshals. Other application areas include: surveillance, management of freeway and arterial networks, intersection traffic light control, congestion and incident management.

4- Density Based Traffic Signal System

Author- K.Vidhya, A.Bazila Banu

The project is designed to develop a density based dynamic traffic signal system. The signal timing changes automatically on sensing the traffic density at the junction. Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. Junction timings allotted are fixed. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. The image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. After calculating the number of vehicles, we will come to know in which side the density is high based on which signals will be allotted for a particular side. Raspberry pi is used as a microcontroller which provides the signal timing based on the traffic density.

5- HARDWARE IMPLEMENTATION OF INTELLIGENT TRAFFIC LIGHT CONTROLLER

Author- NOORRASHIKIN BINTI JAAFAR

Traffic signal controller is playing more and more important roles in modern management and controls of urban traffic to reduce the accident and traffic jam in road. The traffic light controller is a sequential machine to be analyzed and programmed through a multi-step process. The device that involves an analysis of existing sequential machines in traffic lights controllers, timing and

Synchronization and introduction of operation and flashing light synthesis sequence. The methods that are used in this project are design the circuit, write a coding, simulation, synthesis and implement in hardware. In this project, QuartussII Software was chosen to design a schematic using schematic edit, writes a coding using Verilog HDL (Hardware Description Language) text editor and implements the circuit using gate logic.

6- Smart Control of Traffic Signal System using Image Processing

Author- V. Parthasarathi , M. Surya , B. Akshay , K. Murali Siva and Shriram K. Vasudevan

The aim of this project is to control traffic signals with the help of surveillance camera present at the junction points. The frames of the traffics obtained from the camera through continuous video processing. To calculate the density, an image from the camera is used to calculate the number of vehicles in each lane. According to the number of vehicles in each lane, the time for respective green signal is given which varies time to time. If there are same numbers of vehicles in the lane, the signal will follow the basic timer circuit. But when an emergency vehicle such as an ambulance is detected, priority is given for latter lane. The time for which each lane will be green is shown in the display of the individual down counter. In case, if an ambulance is detected, the current green lane will become red and the counter display will show an ambulance symbol, after a few seconds the lane having the ambulance will be allowed. Incase if there are two ambulances detected in the junction, the ambulance which is nearer to the signal get the priority first. Successful implementation of our research will result in faster clearance of traffic and improvement in the transportation of emergency vehicles.

7- Smart Traffic Control System Using Image Processing

Author- Vismay Pandit, Jinesh Doshi, Dhruv Mehta, Ashay Mhatre, Abhilash Janardhan

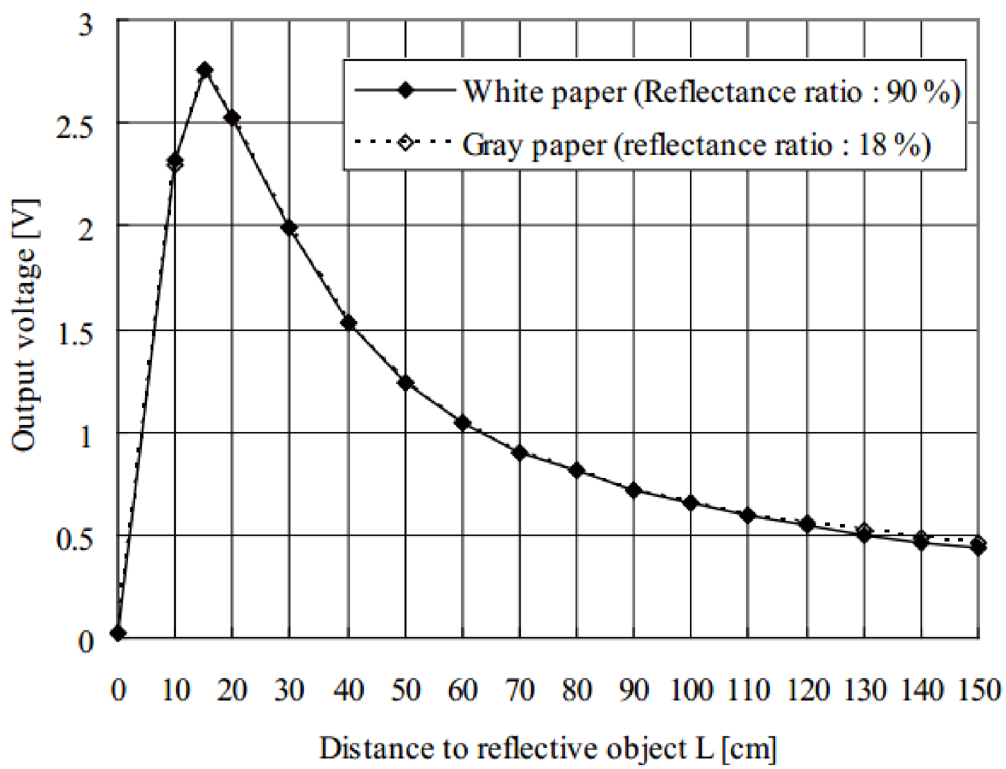
Automatic traffic monitoring and surveillance are important for road usage and management. Traffic parameter estimation has been an active research area for the development of intelligent Transportation systems (ITS). For ITS applications traffic- information needs to be collected and distributed. Various sensors have been employed to estimate traffic parameters for updating traffic information. Magnetic loop detectors have been the most used technologies, but their installation and maintenance are inconvenient and might become incompatible with future ITS infrastructure. It is well recognized that vision-based camera system is more versatile for traffic parameter estimation. In addition to qualitative description of road congestion, image measurement can provide quantitative description of traffic status including speeds, vehicle counts, etc. Moreover, quantitative traffic parameters can give us complete traffic flow information, which fulfills the requirement of traffic management theory. Image tracking of moving vehicles can give us quantitative description of traffic flow. In the present work the designed system aims to achieve the following.

• Distinguish the presence and absence of vehicles in road images; • Signal the traffic light to go red if the road is empty; • Signal the traffic light to go green in case of presence of traffic on the road and the duration of green light is adjusted according to the traffic density. Components of the current project • Hardware module • Software module • Interfacing Hardware Module Image sensors: In this project a USB based web camera has been used. Computer: A general purpose PC as a central unit for various image processing tasks has been used. Platform: consisting of a few toy vehicles and LEDs (prototype of the real-world traffic light control system). Software Module: MATLAB version 7.8 as image processing software comprising of specialized modules that perform specific tasks has been used. Interfacing: The interfacing between the hardware prototype and software module is done using parallel port of the personal computer. Parallel port driver has been installed in the PC for this purpose.

3 Technological Issues

3.1 SONAR

External sound that is both loud enough and that contains transducer-sensitive frequencies may cause the receiver circuit to be falsely triggered and lead to noisy data. We have observed this with air tracks and their air supplies due to high-pitched whistling. The presence of this noise can be confirmed by turning off the supply. To reduce it, turn down the supply or place it under the table or shield it. You can Extremely high (ultrasonic). The study of underwater sound is known as underwater acoustics or hydro acoustics. also shield the transducer from direct airflow from AirTrack holes with a small piece of cardboard. Frequently computer monitors and (rarely) fluorescent-light ballasts produce 50-kHz noise that can interfere with the ranger as well. Move away from computer monitors and test your rangers in another room if you suspect these latter problems. Currently available versions of non-Polaroid sonar systems typically contain two units, an ultrasonic receiver and a transmitter. The fixed sonar receiver is connected to a computer, and when operated by the computer an elapsed-time clock is started and an IR pulse is sent from the sonar receiver to the battery powered sonar transmitter. The IR pulse is effectively instantaneously received and causes a single sonar click to be emitted by the sonar transmitter. When the receiver stops the clock, range is determined by sound pulse travel time. The sonar transmitter is very simple and usually powered by a long-life battery. This system has no blind spot, and neither the surface nor the shape of the ranged object is important. However, attaching and aiming the transmitter can be difficult. A sophisticated IR/sonar ranger system, the Scope is unique in that it uses three spatially separated IR/sonar stations (originally located in separate towers, now in a fixed geometry) transmitting coded IR pulses to up to four conveniently small sonar transmitter buttons. The coded IR signal selects one of the buttons to send a pulse, which when received by the three receivers fixes the button location in three dimensions



(Ref Google Image)

Fig 3. Graph showing the decrease in the efficiency

CHAPTER 4

SYSTEM REQUIRMENT SPECIFICATION

Software requirement specification is a fundamental document, which forms the foundation of the software development process. It not only lists the requirements but also has a description of its major features. An SRS is basically an organization of understanding (in writing) of a customer or the potential client's system requirements and dependency at a particular point in the time (usually) prior to any actual design or development work. The SRS also functions as a blueprint for completing a project with as little cost growth as possible. The SRS is often referred to as the "parent" document because all subsequent project management documents, such as design specifications, statements of work, software architecture specifications, testing and validation plans, and documentation plans, are related to it. It is important to note that an SRS contains functional and non-functional requirements only. It doesn't offer design suggestions, possible solutions to technology or business issues, or any other information.

4.1 FEASIBILITY STUDY

A feasibility analysis involves detailed assessment of the need, value and practicality of the systems development. Feasibility analysis forms the transparent decisions at crucial points during the developmental process as we determine whether it is operationally, economically and technically realistic to proceed with a particular course of action. Feasibility analysis can be used in each of the steps to assess the financial, technical and operational capacity to proceed with particular activities.

4.1.1 Types of Feasibility

The feasibility study is carried out to test whether the proposed system is worth being implemented. The proposed system will be selected if it is best enough in meeting the performance requirements. The feasibility carried out mainly in three sections namely.

- Technical feasibility

- Operational feasibility

- Economic feasibility

Technical Feasibility

Technical feasibility is one of the first studies that must be conducted after a project has been identified. In large engineering projects consulting agencies that have large staffs of engineers and technicians conduct technical studies dealing with the projects.

A systems development project may be regarded as technically feasible or practical if the organization has the necessary expertise and infrastructure to develop, install, operate and maintain the proposed system. Organization will need to make this assessment based on the knowledge of current and emerging technological solutions, availability of technically qualified staff in-house for the duration of the project and subsequent maintenance phase.

Operational Feasibility

Operational feasibility is the measure of how well a proposed system solves the problems, and takes advantage of the opportunities identified during scope definition and how it satisfies the requirements identified in the requirements analysis phase of system development. The operational feasibility assessment focuses on the degree to which the proposed development projects fits in with the existing business environment and objectives with regard to development schedule, delivery date, corporate culture and existing business processes. To ensure success, desired operational outcomes must be imparted during design and development. These include such design-dependent parameters as reliability, maintainability, supportability, usability, producibility, disposability, sustainability, affordability and others. These parameters are required to be considered at the early stages of design if desired operational behaviors are to be realized. A system design and development requires appropriate and timely application of engineering and management efforts to meet the previously mentioned parameters. A system may serve its intended purpose most effectively when its technical and operating characteristics are engineered into the design. Therefore, operational feasibility is a critical aspect of systems engineering that needs to be an integral part of the early design phases.

Economic Feasibility

A systems development project may be regarded as economically feasible or good value to the organization if its anticipated benefits outweigh its estimated costs. Many development costs are easier to identify. These costs may include the time, budget and staff resources invested during the design and implementation phase, as well as infrastructure, support, training and maintenance costs incurred after implementation. Nonetheless, it can also be difficult to accurately quantify project costs when new technologies and complex systems are involved. In these high-risk situations it may be appropriate to use sophisticated cost-benefit analysis tools to make appropriate assessments of financial feasibility.

4.2 SOFTWARE REQUIREMENTS SPECIFICATION

Software requirements deal with defining software resource requirements and prerequisites that need to be installed on a computer to provide optimal functioning of an application. These requirements or prerequisites are generally not included in the software installation package and need to be installed separately before the software is installed.

- Arduino IDE
- Python IDE
- Windows XP or higher Operating System
- Processing IDE

4.3 HARDWARE REQUIREMENTS SPECIFICATIONS

The most common set of requirements defined by any systems is the physical computer resources also known as hardware.

- Arduino Mega and Uno
- Seven Segment Display
- Led’s
- Camera Module
- Ultrasonic Sensor
- LDR
- Resistor
- Battery

- Raspberry Pi 3

CHAPTER 5

SYSTEM DESIGN

System design is the process of defining the elements of a system such as the architecture, modules and components, the different interfaces of those components and the data that goes through that system. It is meant to satisfy specific needs and requirements of a business or organization through the engineering of a coherent and well-running system. Systems design implies a systematic approach to the design of a system. It may take a bottom-up or top-down approach, but either way the process is systematic wherein it takes into account all related variables of the system that needs to be created—from the architecture, to the required hardware and software, right down to the data and how it travels and transforms throughout its travel through the system. One could see it as the application of system theory to product development. There is some overlap with the disciplines of system analysis, system architecture and system engineering. If the broader topic of product development “blends the perspective of marketing, designing and manufacturing into a single approach to product development,” then design is the act of taking the marketing information and creating the design of the product to be manufactured. System design is therefore the process of defining and developing system to satisfy specified requirements of the user.

5.1 ARCHITECTURAL REPRESENTATION

The architectural design of a system emphasizes the design of the system architecture that describes the structure, behavior and more views of that system and analysis. A system architecture is the conceptual module that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organization in a way that supports reasoning about the structure and behavior of the system.

5.1.1 System Overview

A very simplified overview of the architecture is necessary for the better understanding of the user before entering in detail. Figure 5.1 presents the simplified system which describes the working of the traffic stimulator.

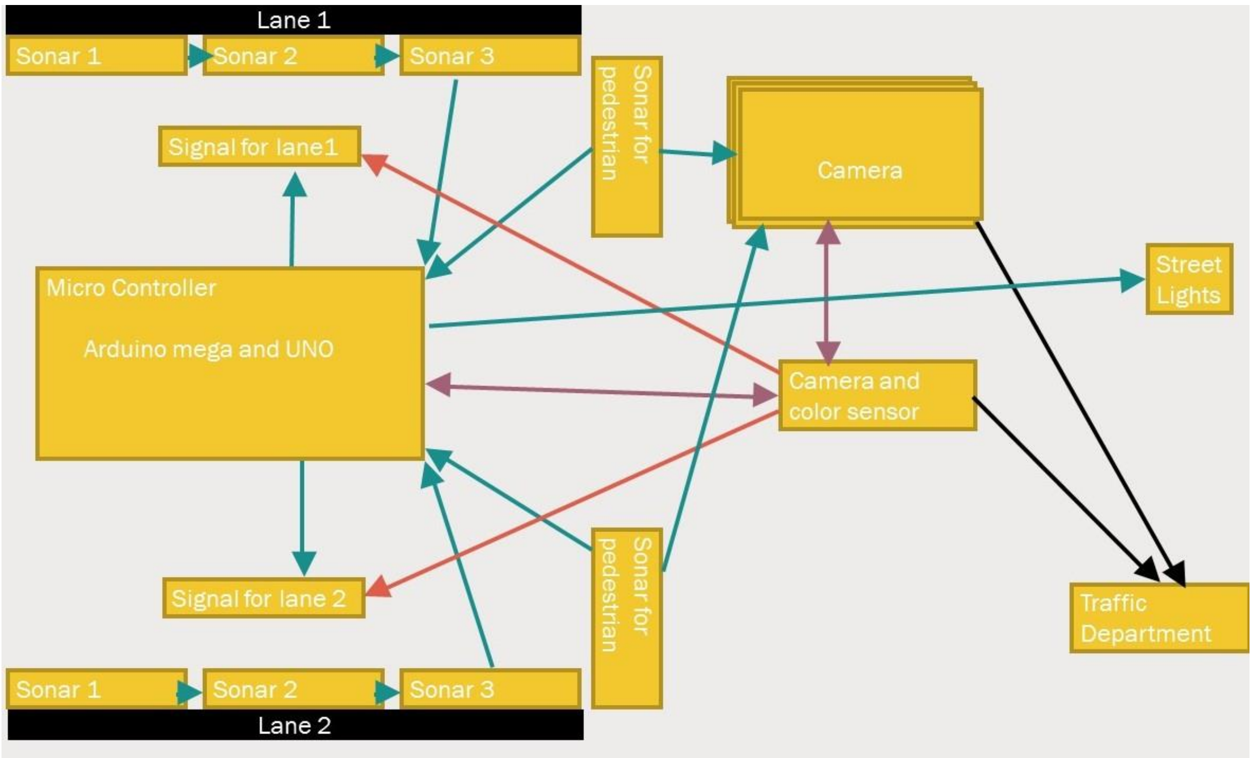


Fig 5.1 Architectural representation for traffic Stimulator

5.1.2 System Architecture

The Microcontroller takes the command from the sonar and further processes the data and figures out which road lane has the greater number of vehicles and it makes sure that particular lane is been given green signal or go sign for a longer time compared to the other roads. Now if the traffic in all the lanes are equally distributed then it allows all the road green signal for a longer duration. Now another case to be considered is when any one of road has no vehicle at all then that particular lane is not given green signal or the go signal instead provides that duration to other road to avoid the traffic.

Now there are many cases where when the signal is red for a particular road and many riders/drivers tries to jump the signal then we use image processing to capture the vehicle image from camera facing it and then process it and then send the vehicle number to the traffic department with the details of case on the vehicle. No vehicle is allowed to move while the pedestrian crossing the road not no. The vehicle must stop and stay behind the Zebra crossing or else that particular vehicle image will be taken and process and sent to the traffic department with the presiding case.

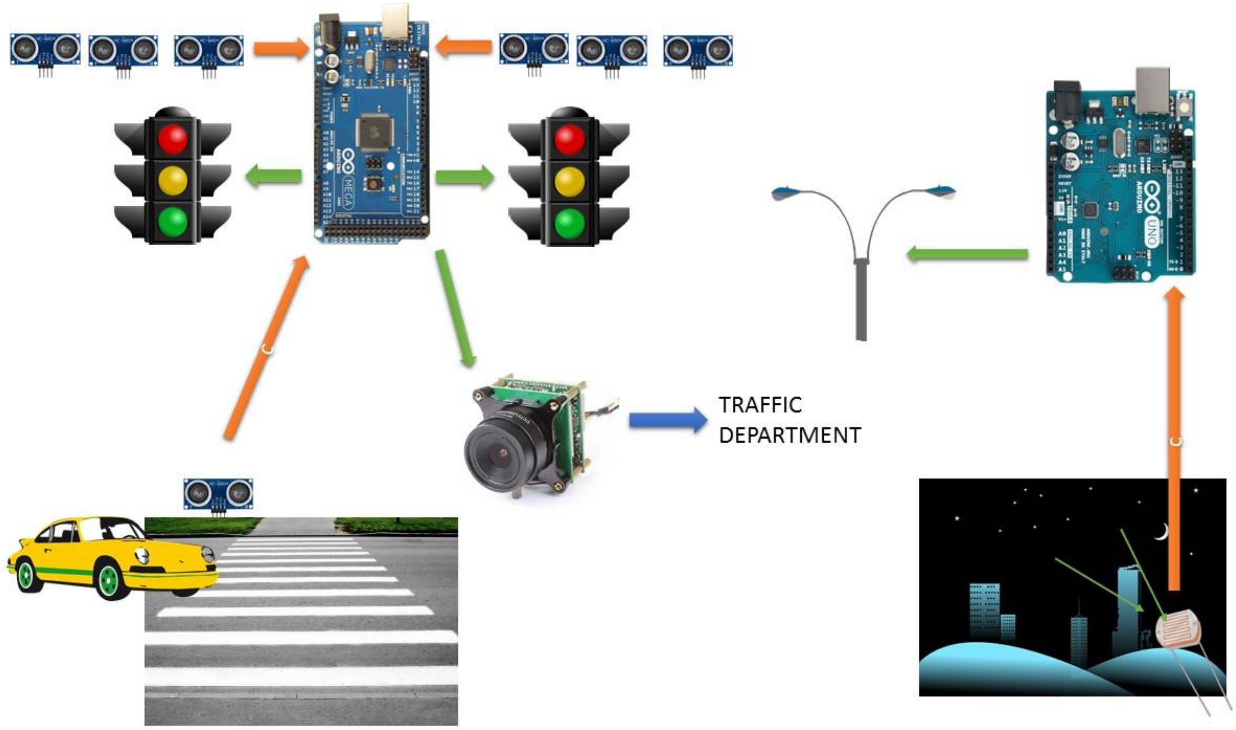


Fig 5.2 Communication between Arduino and Real-time things

5.2 FLOWCHART

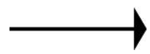
A flowchart is a graphical or symbolic representation of a process. A flowchart is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields.

A flowchart is a powerful business tool. With proper design and construction, it communicates the steps in a process very effectively and efficiently. As a visual representation of data flow, flowcharts are useful in writing a program or algorithm and explaining it to others or collaborating with them on it. You can use a flowchart to spell out the logic behind a program before ever starting to code the automated process. It can help to organize big-picture thinking and provide a guide when it comes time to code. More specifically, flowcharts can:

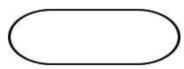
- Demonstrate the way code is organized.
- Visualize the execution of code within a program.
- Show the structure of a website or application.
- Understand how users navigate a website or program.

Common Flowchart Symbols

Flow Line: An arrow from one symbol to another represents that control passes to that symbol.

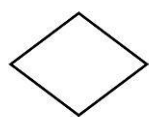


Terminator: An oval flowchart shape indicating the start or end of the process.



Process: A rectangular flowchart shape indicating a normal flow step.

Decision: A diamond flowchart shape indicating a branch in the process flow.



Data: A parallelogram that indicates data input or output (I/O) for a process.

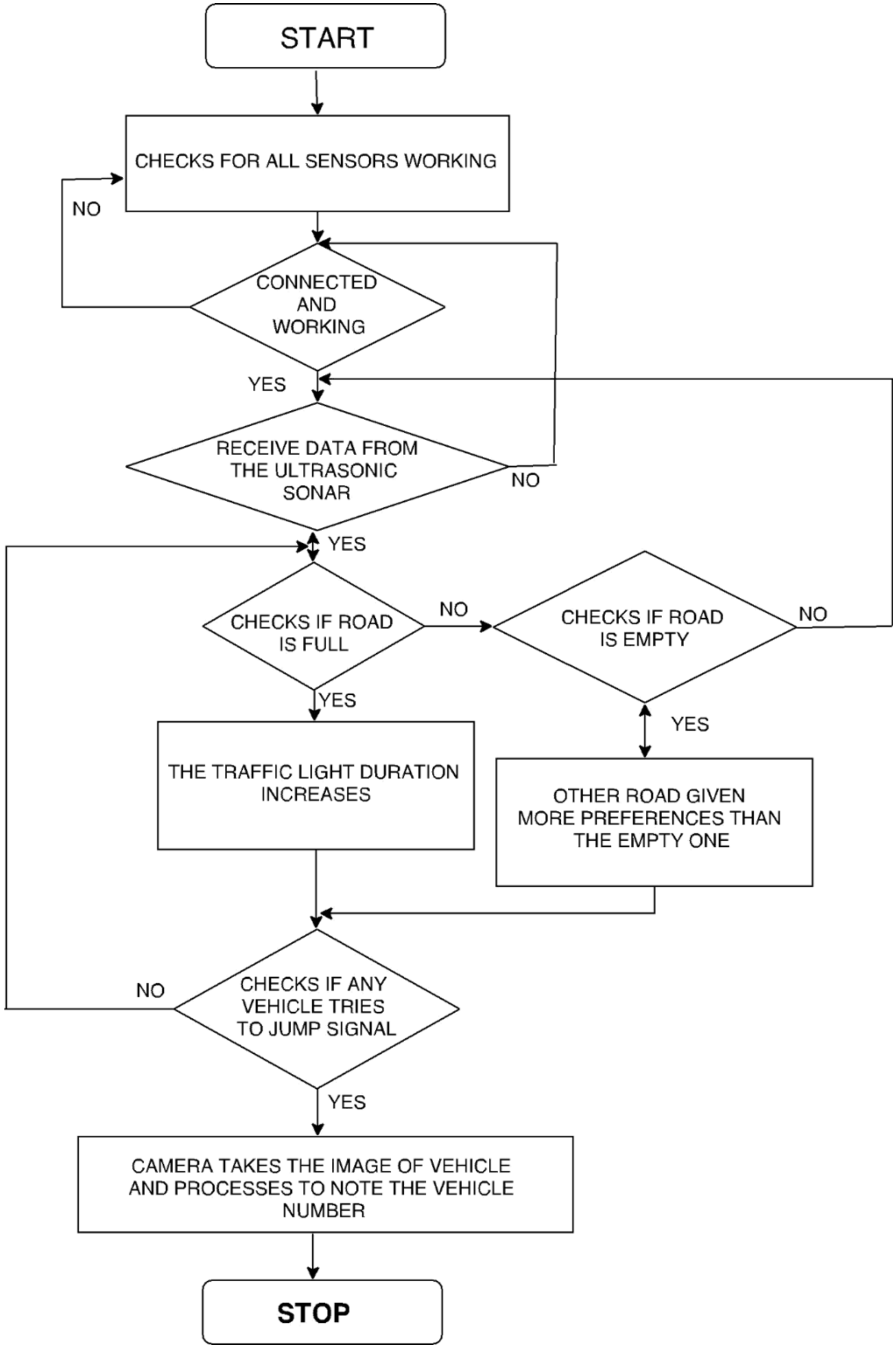


Fig 5.3 Flowchart representing the principle working of Traffic Stimulator

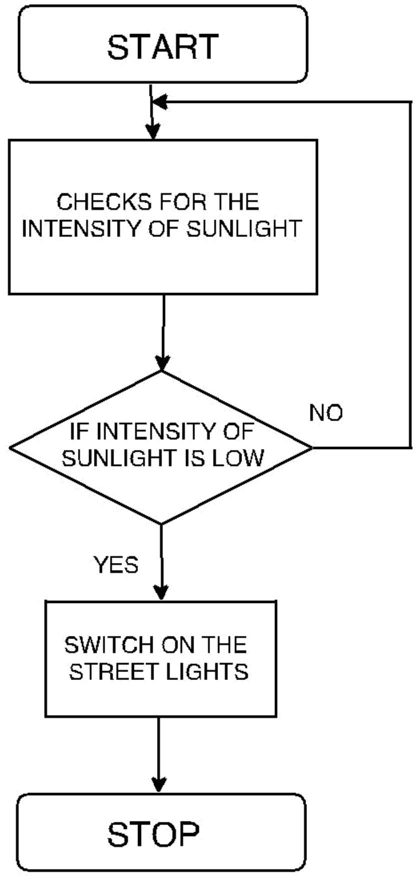


Fig 5.4 Flowchart representing the principle working of Automated Street Lights

CHAPTER 6

IMPLIMENTATION AND TESTING

Once the system has been designed, the next step is to convert the designed one into actual one, so as to satisfy the user requirements as expected. If the system is approved to be error free it can be implemented. When the initial design was done for the system, the department was consulted for the acceptance of the design so that further proceedings of the system development can be carried on. The aim of the system illustration was to identify any malfunctioning of the system. Implementation includes proper training to end-users. The implemented software should be maintained for prolonged running of the software. Initially the system was run parallel with manual system. The system has been tested with data and has proved to be error-free and user-friendly. Training was given to end-user about the software and its features.

6.1 GENERAL IMPLEMENTATION

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus, it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confident that the new system will work and be effective. Implementation is defined as a specified set of activities designed to put into practice an activity or program of known dimensions or execution of plan, idea, model, design, specification, standard, algorithm, or policy and is also realization of a technical specification or algorithm as a program, software component, or other computer system through computer programming and deployment. According to this definition, implementation process is purposeful and are described in sufficient detail such that independent observers can detect the presence and strength of the “specific set of activities” related to implementation. In addition, the activity or program being implemented is described in sufficient detail so that independent observers can detect its presence and strength. Project implementation (or project execution) is the phase where visions and plans become reality. This is the logical conclusion, after evaluating, deciding, visioning, planning, applying for funds and finding the financial resources of a project.

6.1.1 Module Description

The project deals with controlling or managing the traffic in cities and how to handle traffic in a smarter way. It can even be controlled by Human in case of any emergency or breakdown of the circuit. All the data is being transmitted by the sonar and been processed by the microcontroller.

- **Receiver**

  All the waves transmitted will be received by the sonar and then we use the speed of the wave to calculate the distance of the obstacle (in our case it is the vehicles). The formula to calculate the distance of the obstacle is given by

  $$\text{Distance travelled} = (\text{Time taken}/2) / 29.1$$

  But here we see that the time taken by the wave is twice because the waves after hitting the obstacle reflects back and follows the same path but in opposite direction.

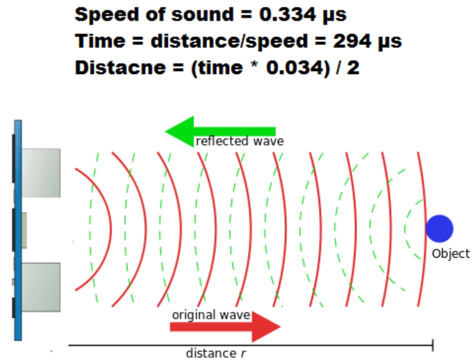


Fig 6.1 the time taken by wave to reach the receiver

- **Transmitter**

The transmitter can transmit signals from two ways, one is it can be placed at the surface of the road facing towards the sky so that when even the vehicle comes above it, it detects. Secondly it can be place perpendicular to the road i.e. attached to the end of the road so when it gets obstacle in between of the end of the road it is understood the vehicle is present.

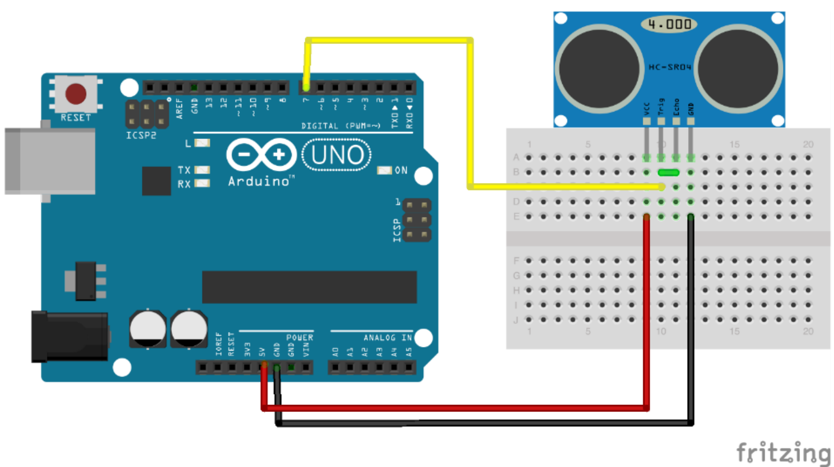


Fig 6.2 Sonars transmitting and receiving circuit diagram

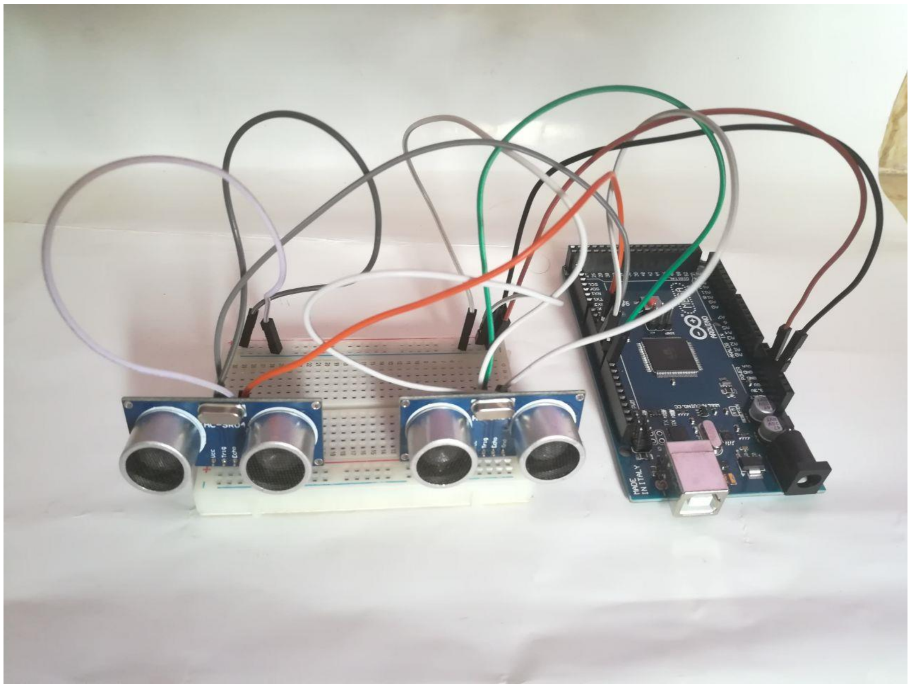


Fig 6.3 Sonars transmitting and receiving

- ## The Camera Module

The camera module plays a vital role in this, whenever there is any vehicle trying to break signal or cross the zebra crossing while the pedestrian crossing road or if any vehicle is found riding on the footpath then it capture the image and process the data and figures out the vehicle number of the vehicle and then send the data to the transport department with the cases on that vehicle.

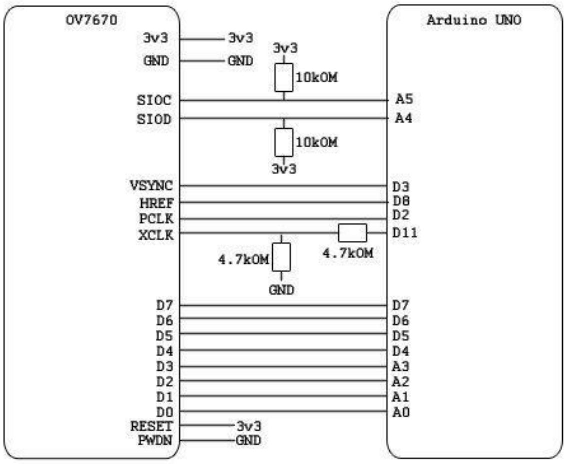


Fig 6.4 Camera module circuit diagram

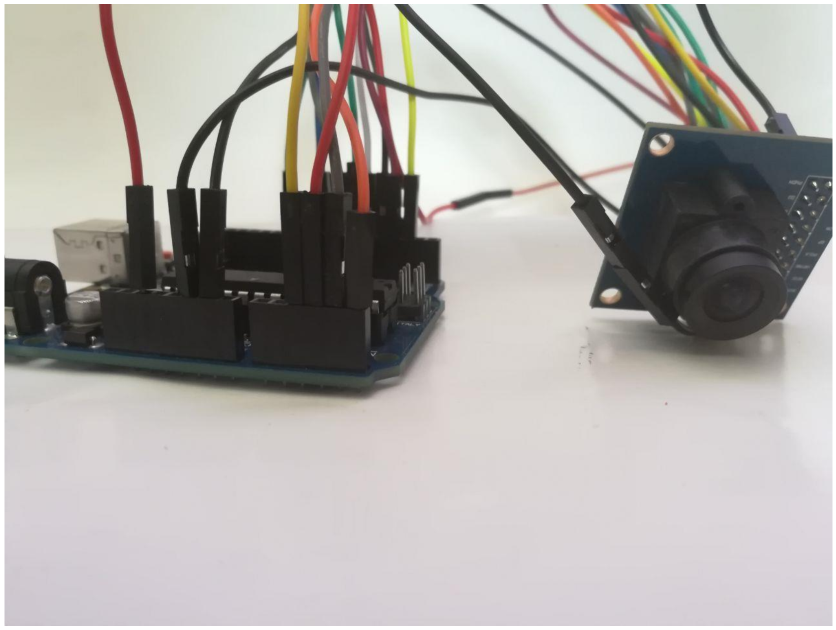


Fig 6.5 Camera module for image processing

- **Traffic Signal**

The traffic signal is used to display the duration and the color indication like red amber green for stop ready and go respectively. It is must to follow the traffic signals to avoid any accidents or harm to society.

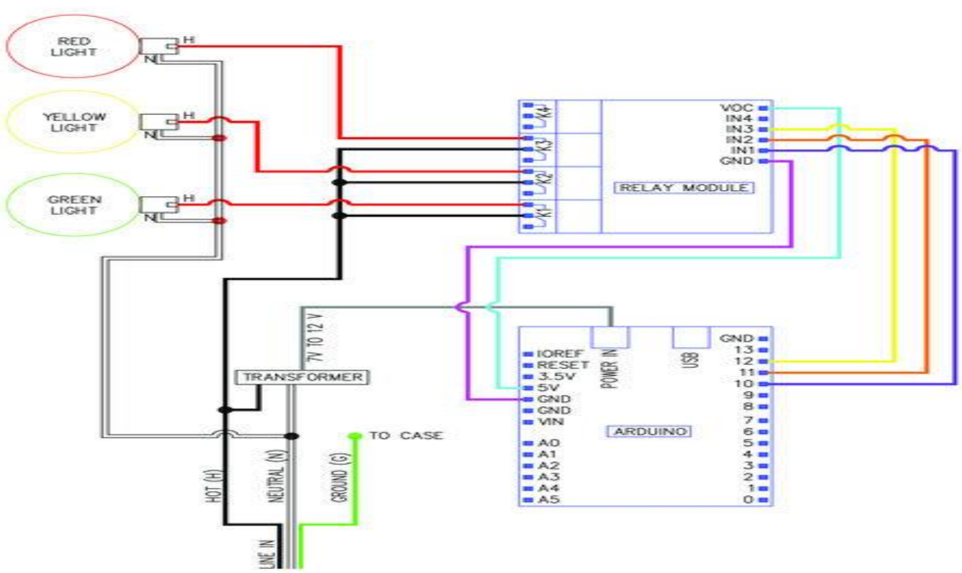


Fig 6.6 Traffic signal circuit diagram

Fig 6.5 Traffic signal

6.2 TESTING

Testing is an essential part of software development, and it is vital to begin it at the right time. It is better to make testing a part of the procedure of choosing requirements. To get the most helpful point of view on your improvement venture, it is advantageous committing some idea to the whole lifecycle including how input from clients impacts the fate of the application. After the code is produced it is tried against the necessities to verify that the item is really illuminating the needs tended to and accumulated amid the prerequisites stage. During this stage unit testing, integration testing, system testing, acceptance testing is done.

- **Unit Testing:** Unit testing is a level of software testing where individual units/ components of a software are tested. The purpose is to validate that each unit of the software performs as designed. A unit is the smallest testable part of software. It usually has one or a few inputs and usually a single output.

- **Integration Testing:** Integration testing (sometimes called integration and testing, abbreviated I&T) is the phase in software testing in which individual software modules are combined and tested as a group. It occurs after unit testing and before validation testing.

- **System Testing:** System testing is a level of the software testing where a complete and integrated software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements. The process of testing an integrated system to verify that it meets specified.
- **Acceptance Testing:** Acceptance testing is a level of the software testing where a system is tested for acceptability. The purpose of this test is to evaluate the system's compliance with the business requirements and assess whether it is acceptable for delivery.

6.2.1 Test Objectives

Testing has different goals and objectives. The major objectives of Software testing are as follows:

- Finding defects which may get created by the programmer while developing the software.
- Gaining confidence in and providing information about the level of quality.
- To prevent defects.
- To make sure that the end result meets the business and user requirements.
- To ensure that it satisfies the BRS that is Business Requirement Specification and SRS that is System Requirement Specifications.
- To gain the confidence of the customers by providing them a quality product.

It is very important to have good test coverage in order to test the software application completely and make it sure that it’s performing well and as per the specifications. While determining the test coverage the test cases should be designed well with maximum possibilities of finding the errors or bugs. The test cases should be very effective. This objective can be measured by the number of defects reported per test cases. Higher the number of the defects reported the more effective are the test cases.

6.2.2 Testing Principles

There are seven principles of testing. They are as follows:

- **Testing shows presence of defects:** Testing can show the defects are present, but cannot prove that there are no defects. Even after testing the application or product thoroughly we cannot say that the product is 100% defect free. Testing always reduces the number of undiscovered defects remaining in the software but even if no defects are found, it is not a proof of correctness.

- **Exhaustive testing is impossible:** Testing everything including all combinations of inputs and preconditions is not possible. So, instead of doing the exhaustive testing we can use risks and priorities to focus testing efforts. For example: In an application in one screen there are 15 input fields, each having 5 possible values, then to test all the valid combinations you would need 30 517 578 125 (5^{15}) tests. This is very unlikely that the project timescales would allow for this number of tests. So, accessing and managing risk is one of the most important activities and reason for testing in any project.
- **Early testing:** In the software development life cycle testing activities should start as early as possible and should be focused on defined objectives.
- **Defect clustering:** A small number of modules contains most of the defects discovered during pre-release testing or shows the most operational failures.
- **Pesticide paradox:** If the same kinds of tests are repeated again and again, eventually the same set of test cases will no longer be able to find any new bugs. To overcome this "Pesticide Paradox", it is really very important to review the test cases regularly and new and different tests need to be written to exercise different parts of the software or system to potentially find more defects.
- **Testing is context dependent:** Testing is basically context dependent. Different kinds of sites are tested differently. For example, safety – critical software is tested differently from an e-commerce site.
- **Absence of errors fallacy:** If the system built is unusable and does not fulfil the user's needs and expectations then finding and fixing defects does not help.

6.3 LOG IMAGES

A test case, is a set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement. A test case could simply be a question that you ask of the program. The point of running the test is to gain information, for example whether the program will pass or fail the test. Test case is the cornerstone of Quality Assurance whereas they are developed to verify quality and behavior of a product.

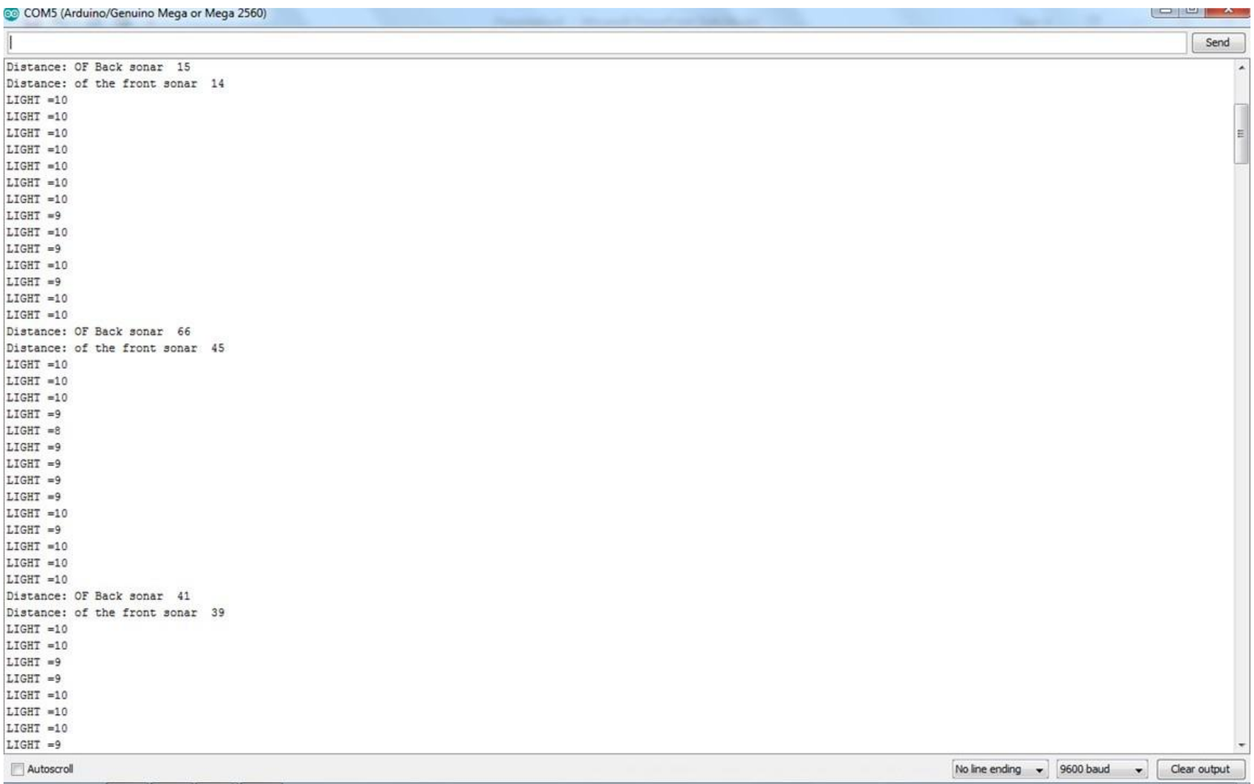


Fig 6.6 The sonar values are high which intern means there is no obstacle's

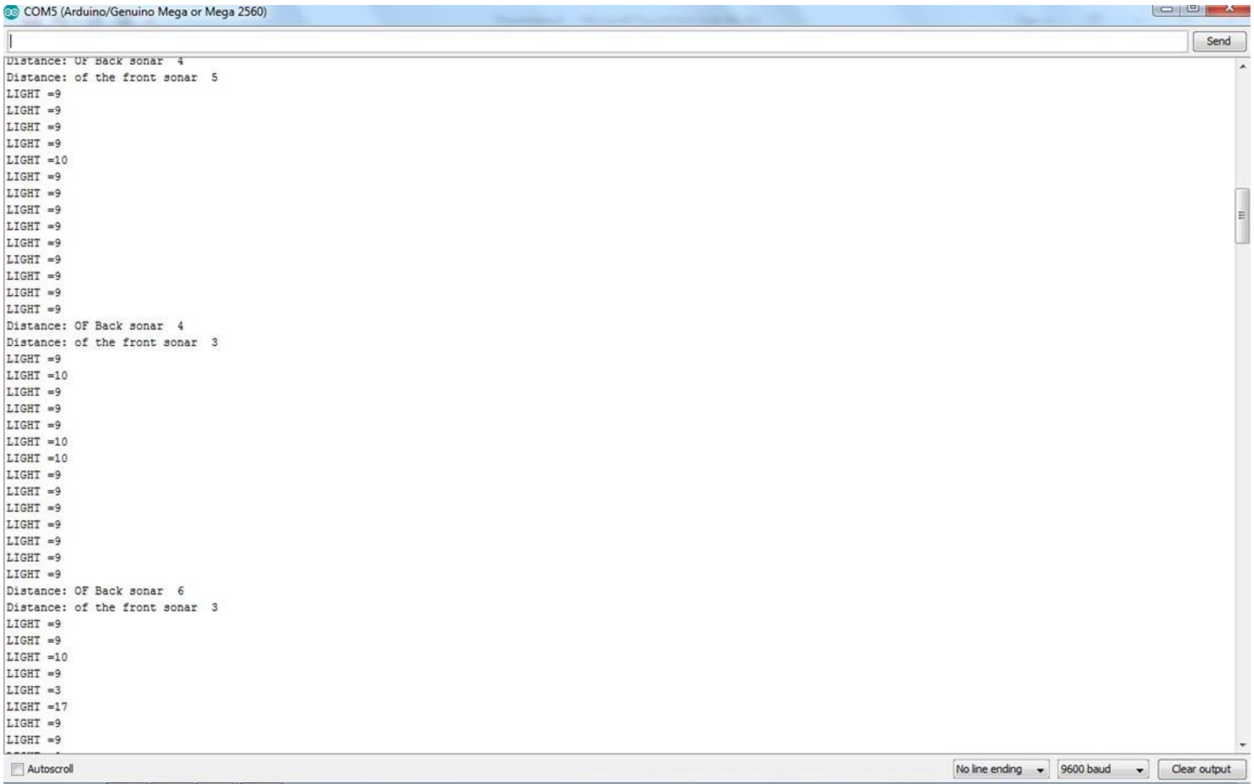


Fig 6.7 The sonar values are low which intern means there is some obstacle's(vehicle)

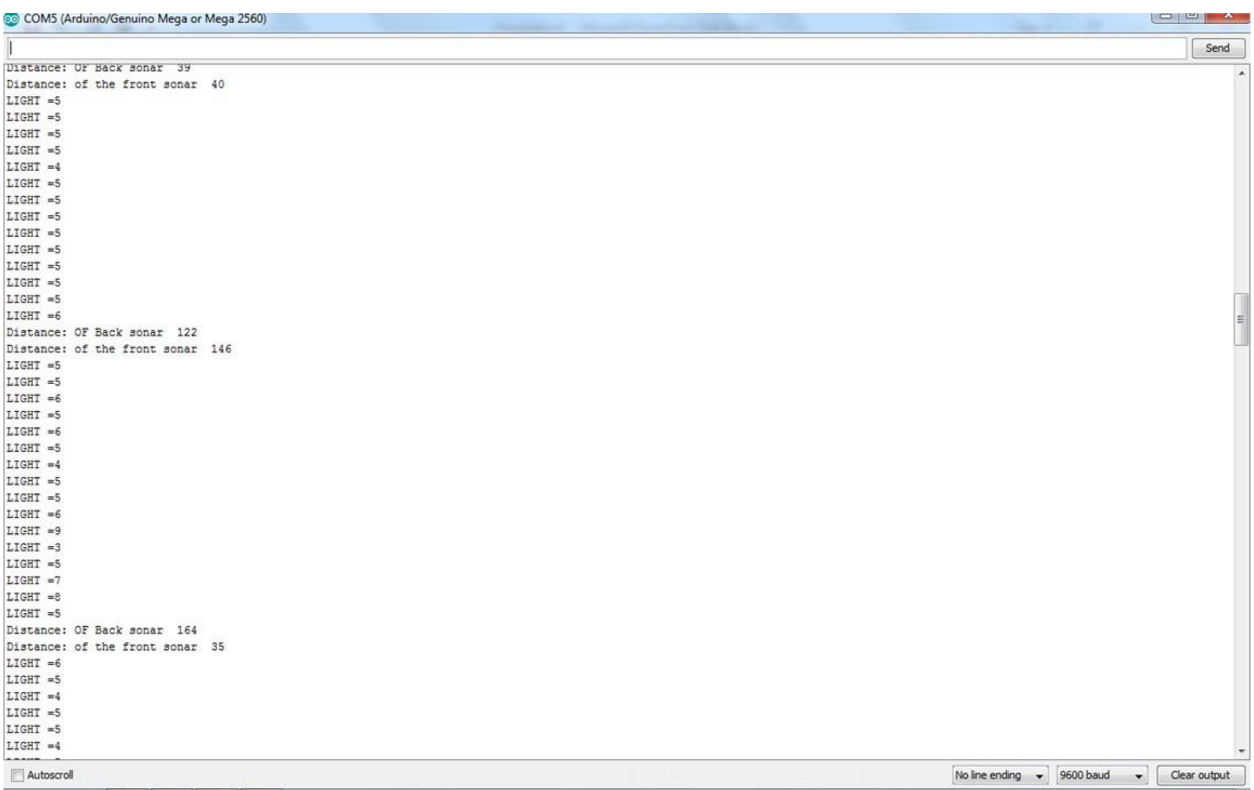


Fig 6.8 The Light values are less which intern means there is absence of sunlight (night time)

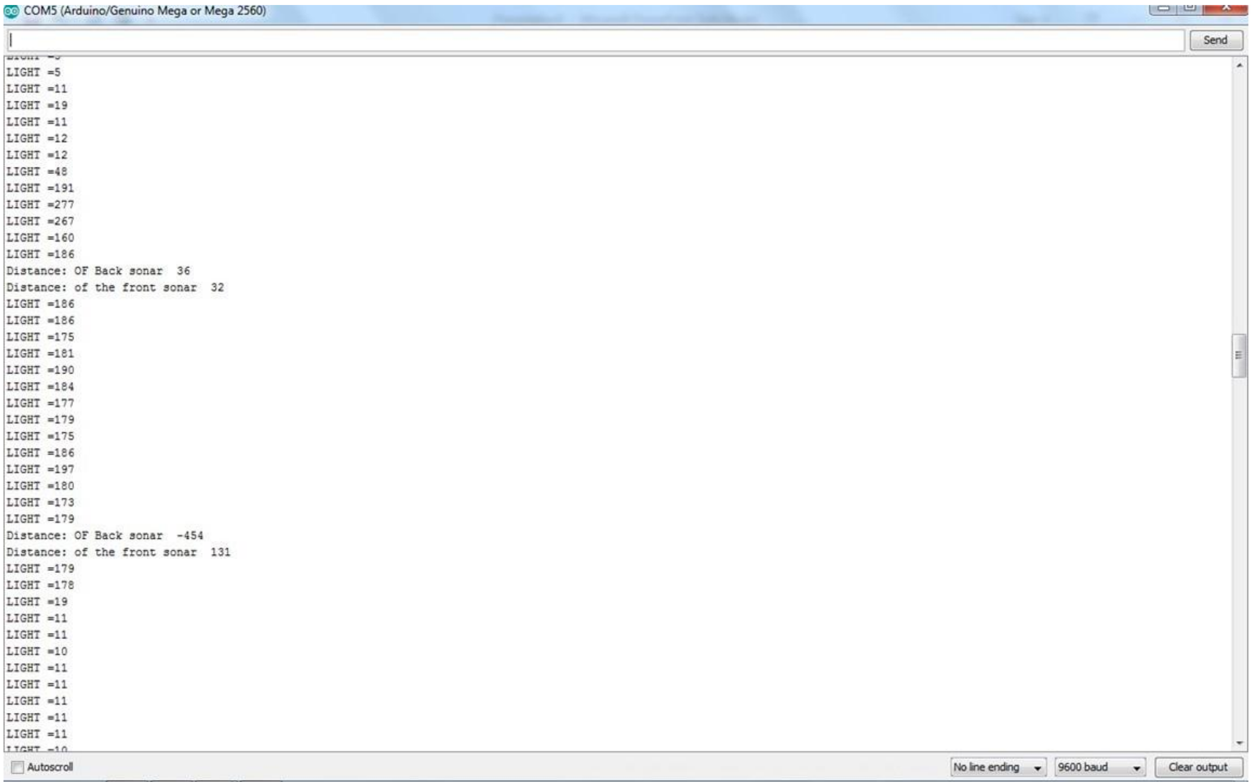


Fig 6.9 The Light values are high which intern means the intensity of sunlight is high

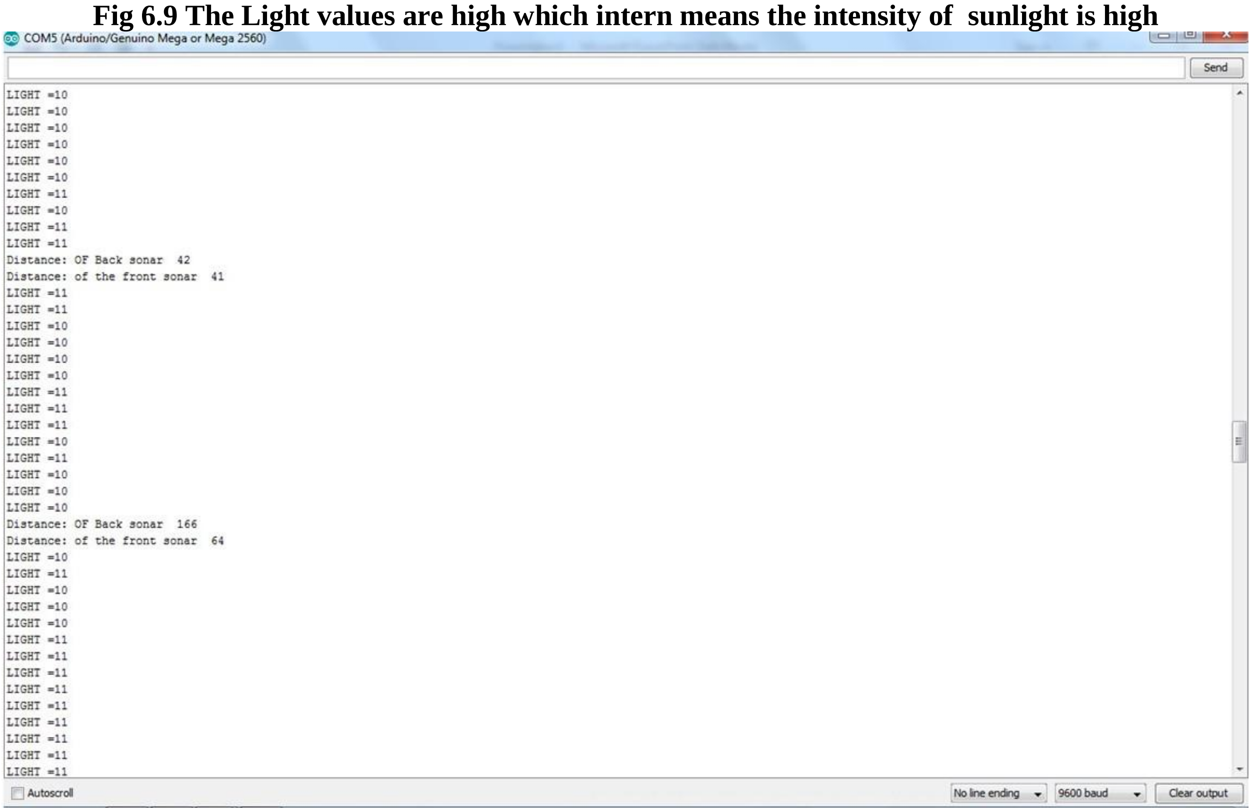


Fig 6.10 The Light values are constant which intern means there is sunlight

CHAPTER 7

RESULTS AND DISCUSSIONS

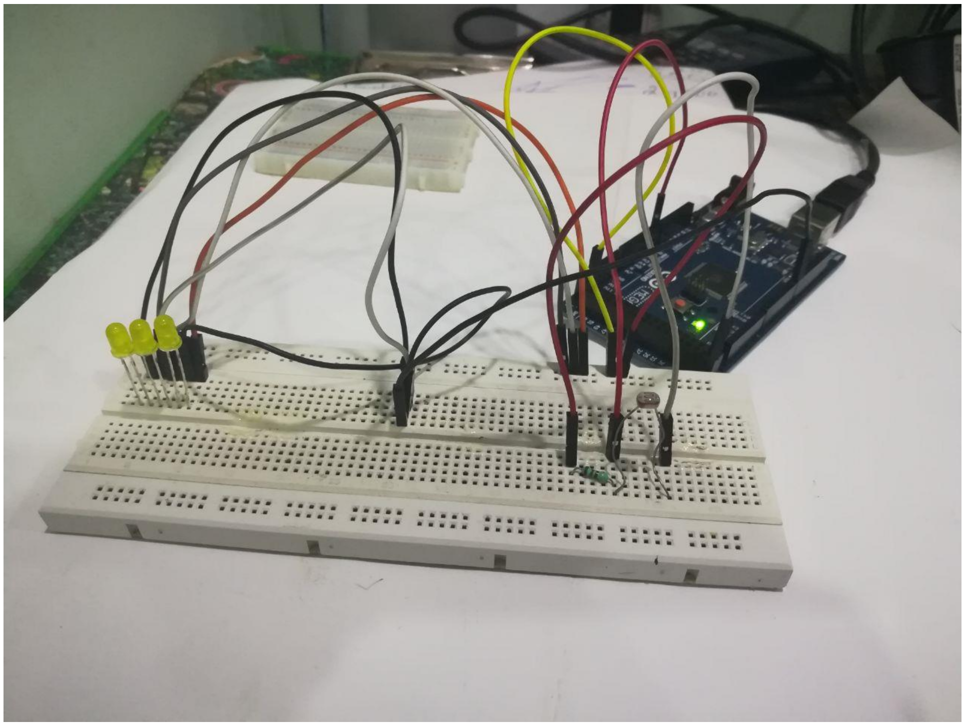


Fig 7.1 The test module of the LDR light sensor (street light)

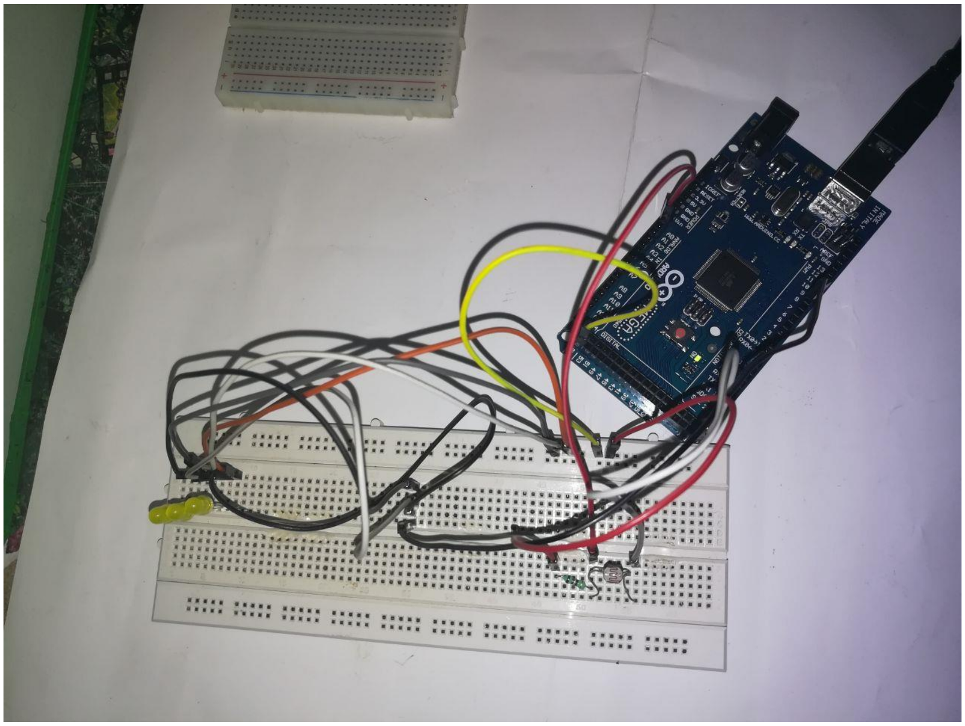


Fig 7.2 The test module and wiring for the LDR light sensor (street light)

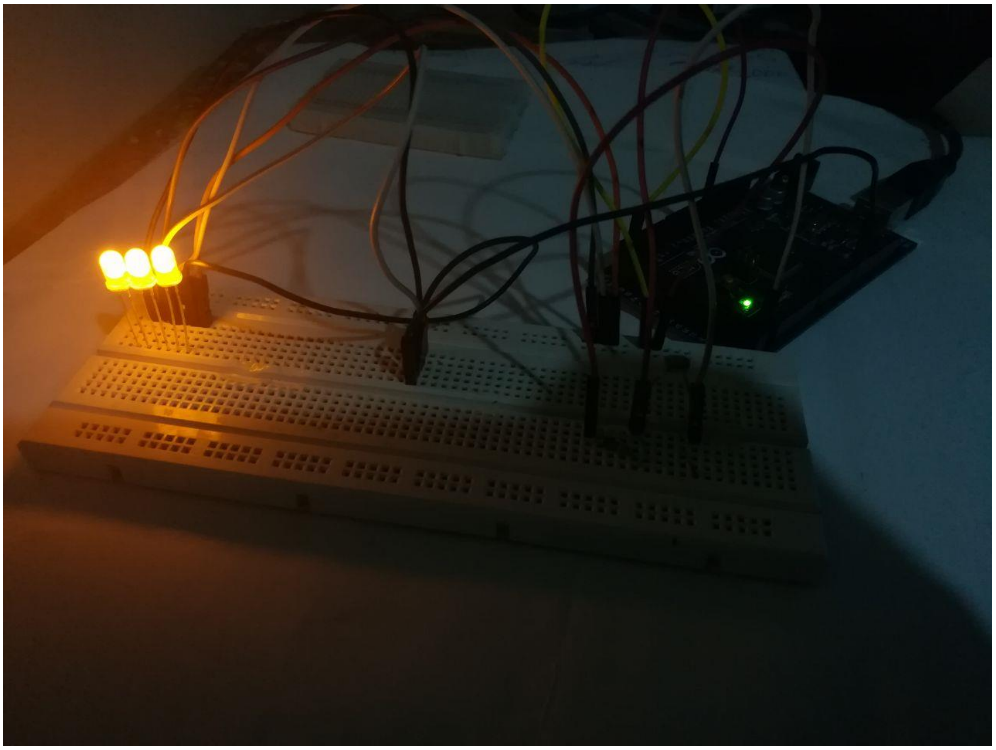


Fig 7.3 Lighting of street light when the LDR detects no sunlight.

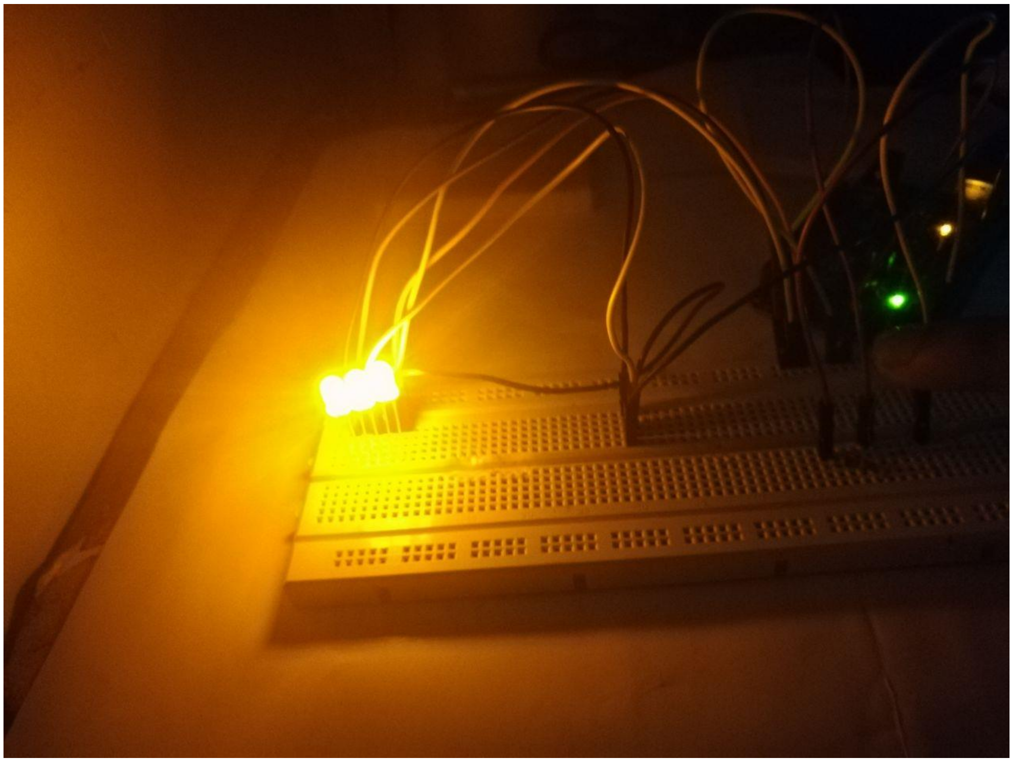


Fig 7.4 Lighting of street light when the LDR detects no sunlight.

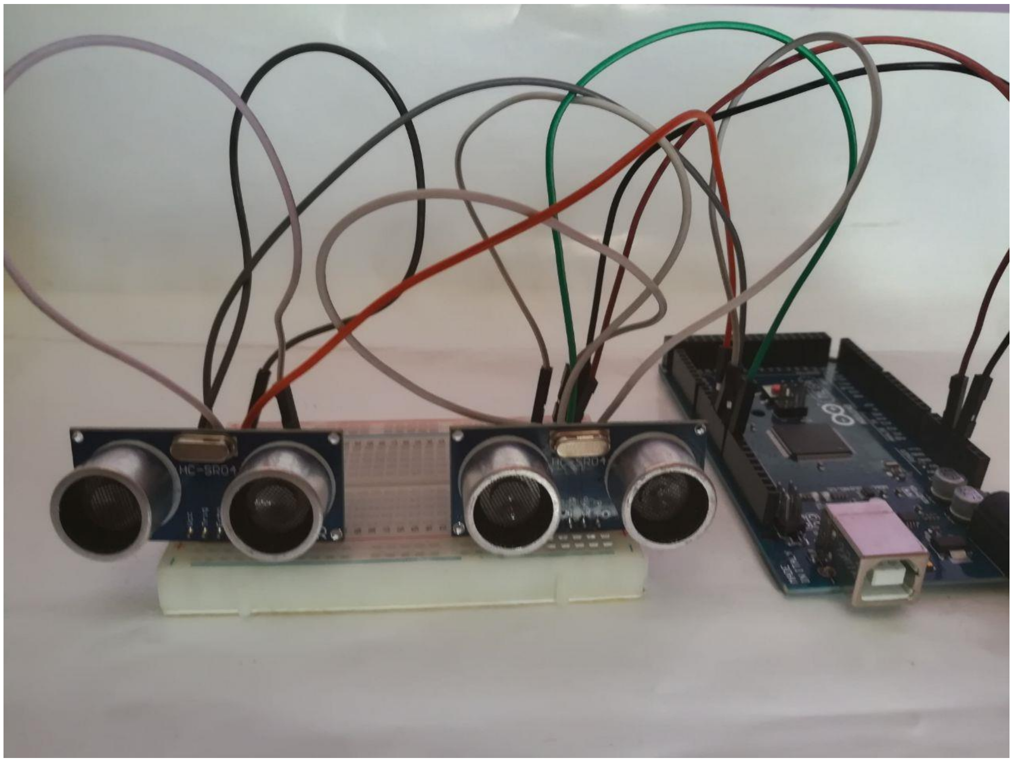


Fig 7.5 Test Module of Sonar.

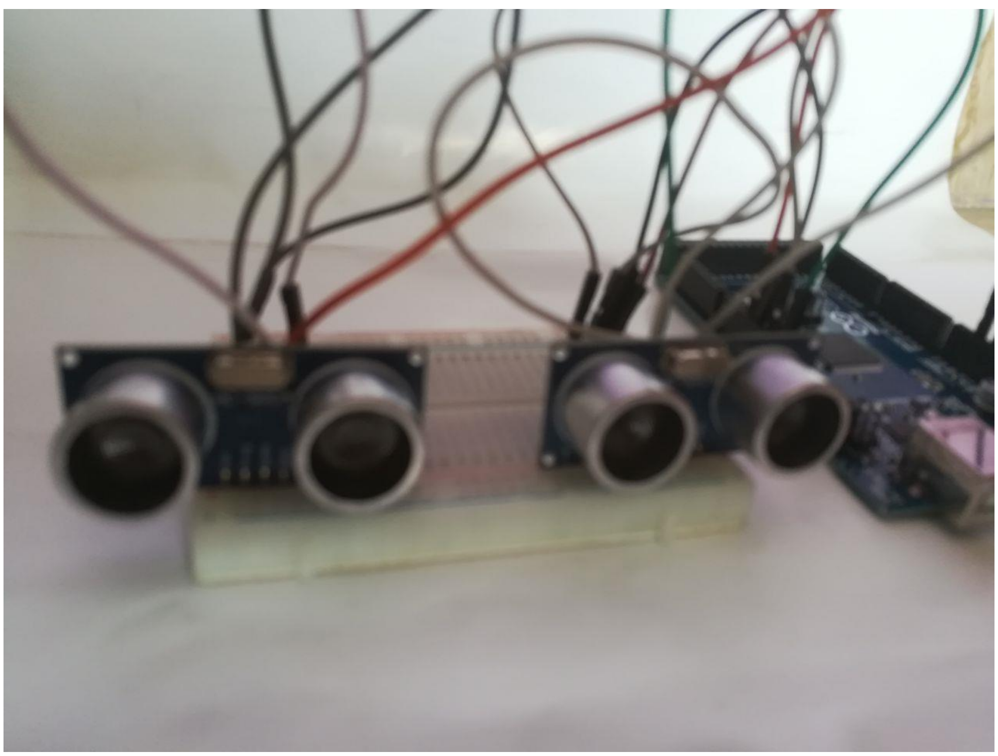


Fig 7.6 Sonar detecting the obstacle(vehicle).

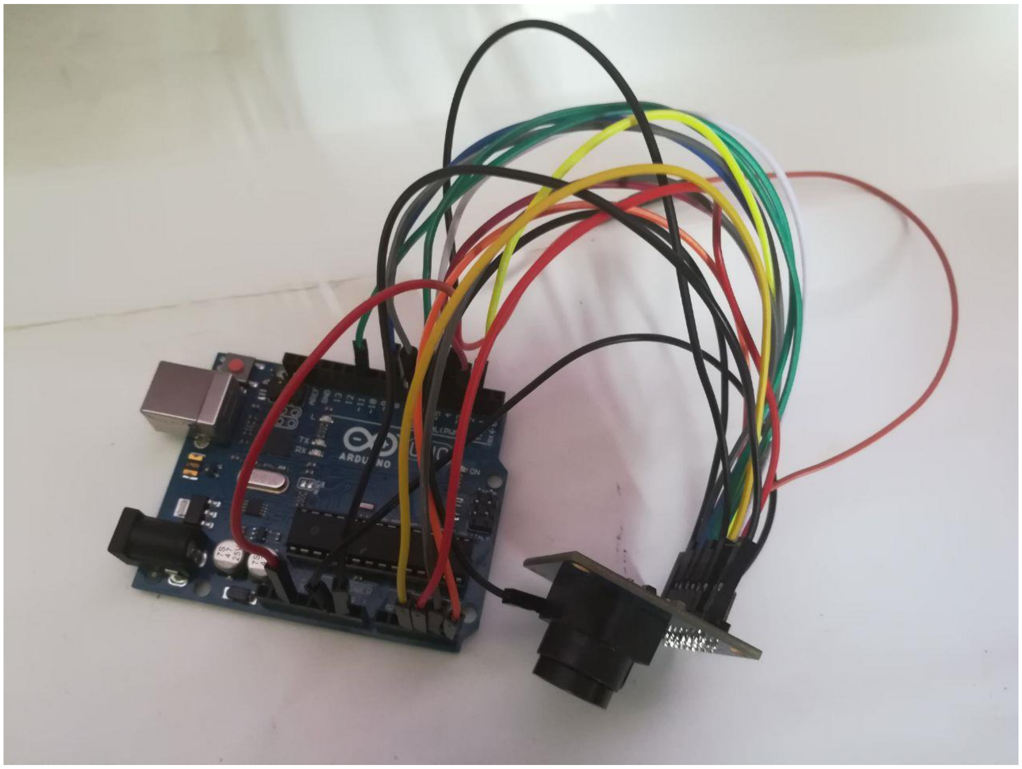


Fig 7.7 Test Module of Camera.

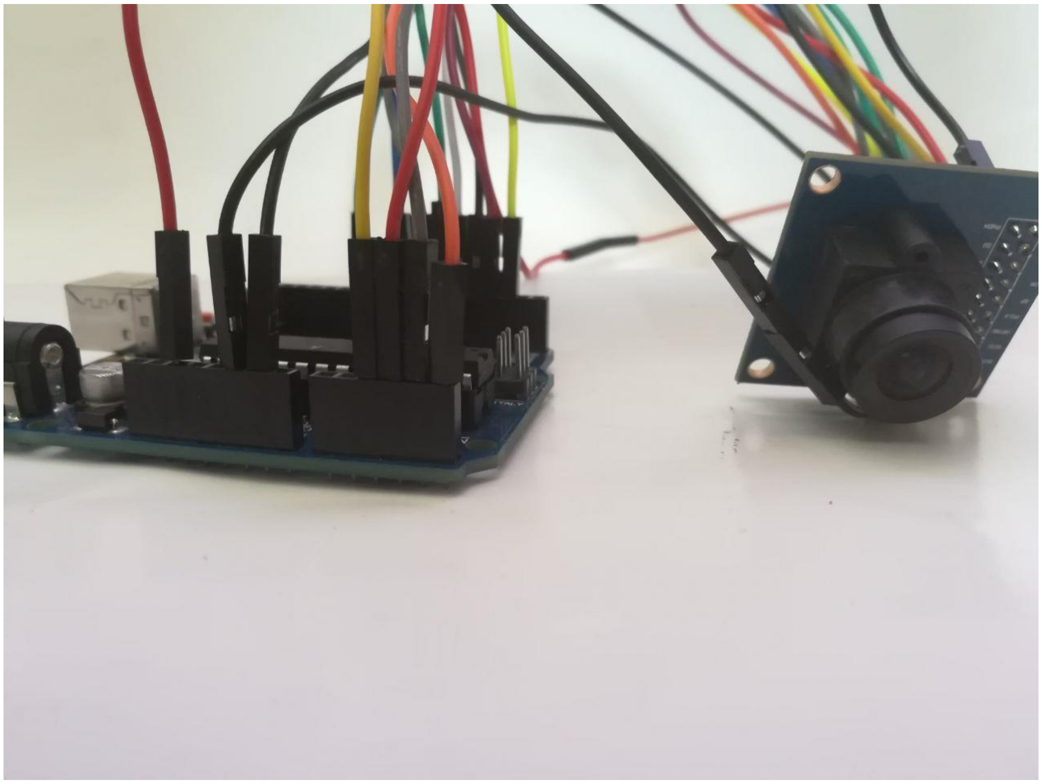


Fig 7.8 Camera Recording.

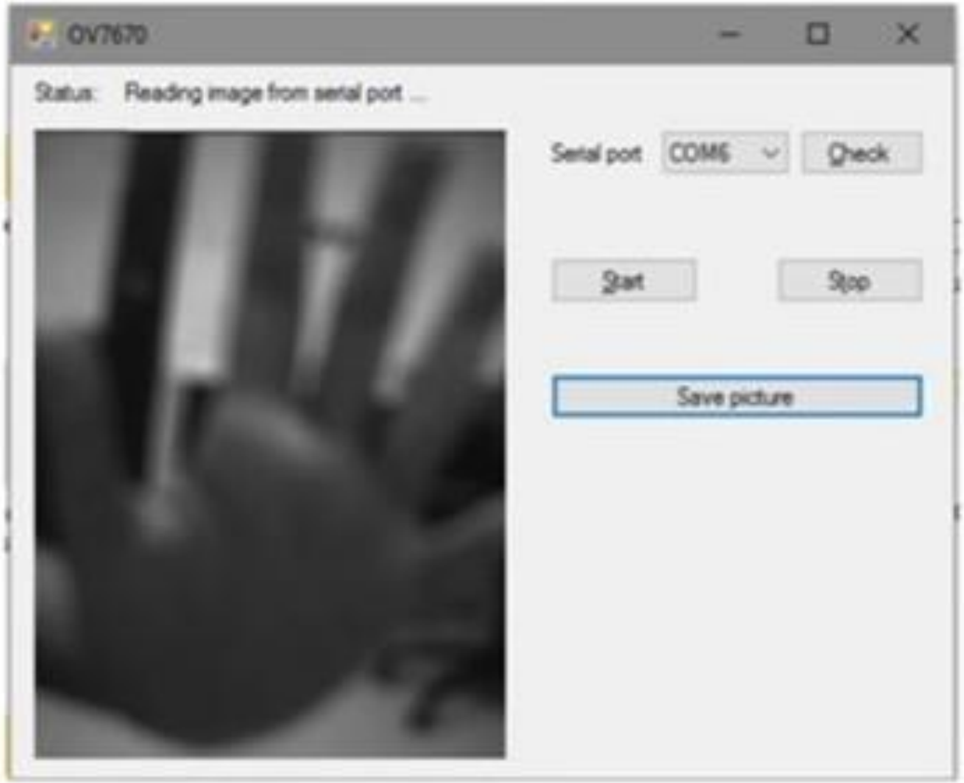


Fig 7.9 Software recording the video and saving clips.

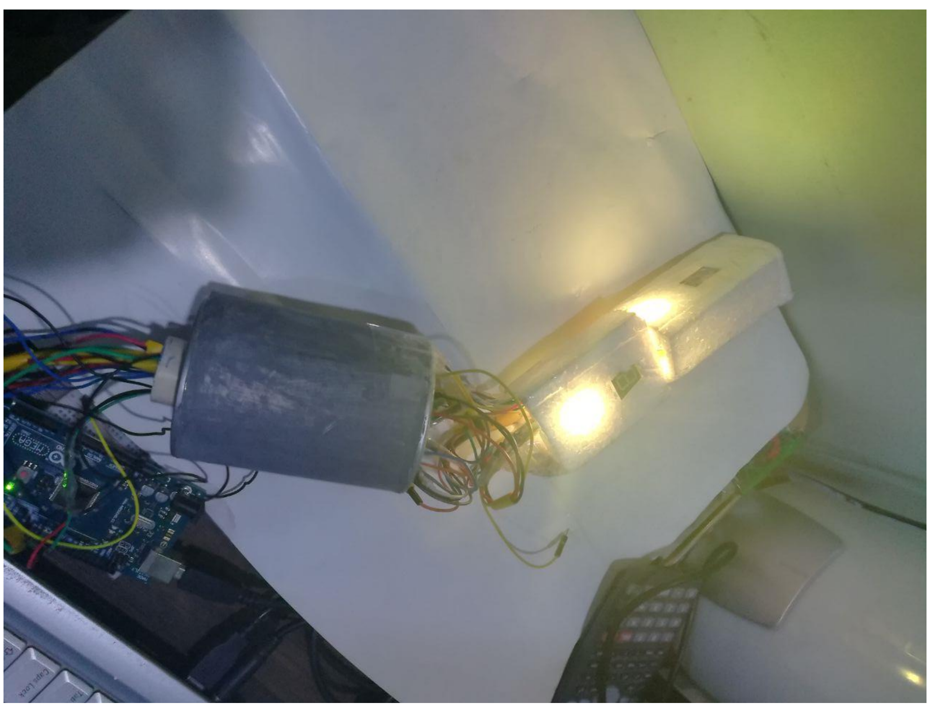


Fig 7.10 Test module of the Traffic Signal.

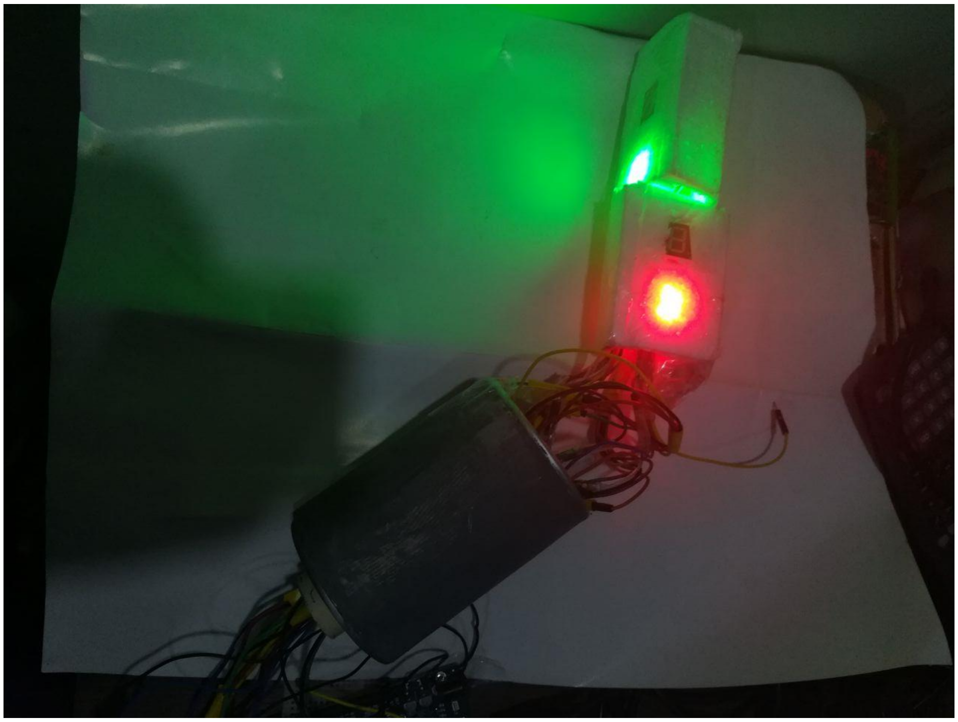


Fig 7.11 Working of the Traffic signal.

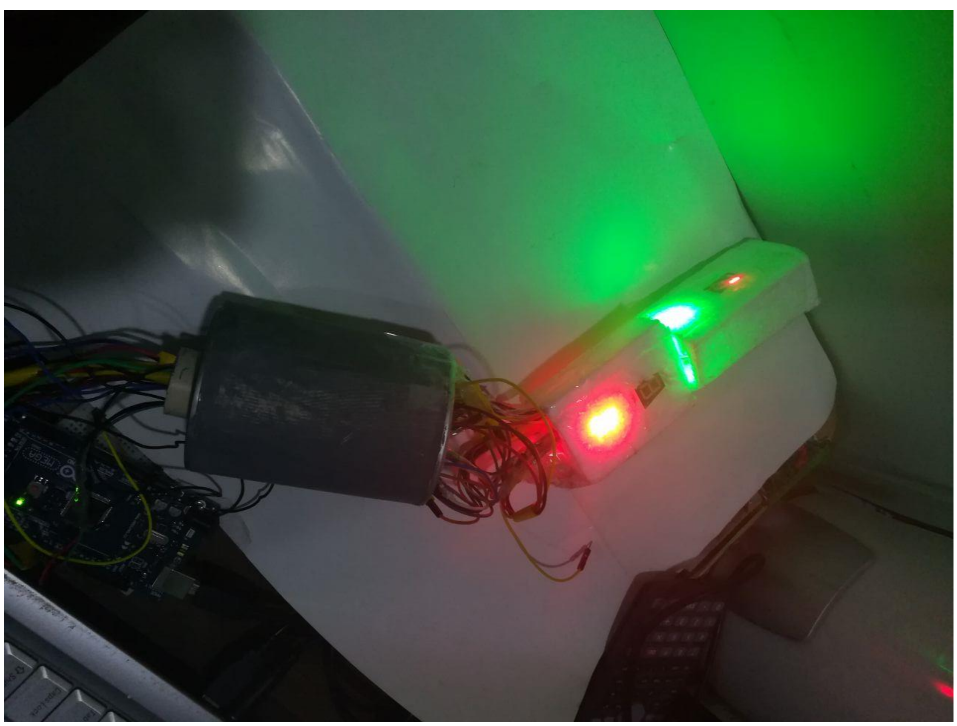


Fig 7.12 Traffic Signal glowing green and red light.

Fig 7.13 Virtual Scenario created to give real life example.

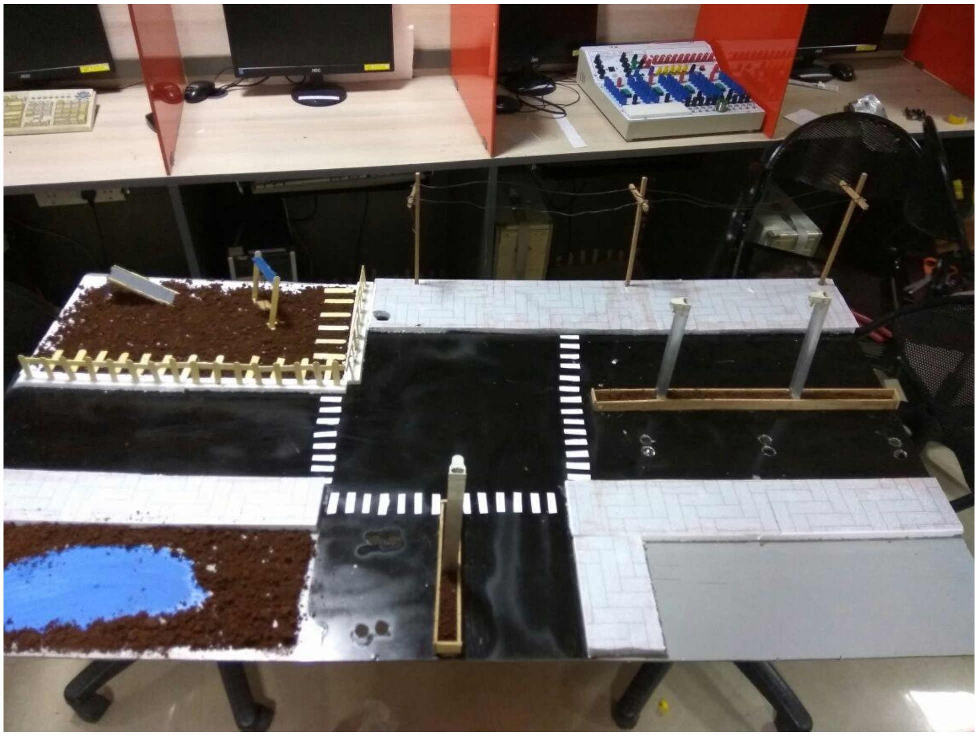


Fig 7.14 Virtual Scenario created to give real life example.

Fig 7.15 Virtual Scenario created to give real life example.

CONCLUSION

This study is significant in outlining general information about IoT, such as definition, market size, and status of IoT, which has become a hot IT topic nowadays, and in presenting applicable IoT business models to help business entities and research institutes participating in related projects build a smart city as part of the future vision of local governments by reflecting the new information paradigm of IoT. A limitation of this study, however, is the lack of available data in Korea that hinders the required empirical analysis on the benefits of IoT technology. We hope that more research in this field will be conducted in the future.

This Traffic Stimulator can be proved boon for the society, where traffic causes a lot of stress, day by day increase in pollution and wasting up of energy like electricity. It brings change in the environment and makes a city more developed and smart these technologies for betterment of a country.

REFERENCES

[1] IBM, "The toxic terabyte: How data-dumping threatens business efficiency," IBM Global Technological Service, Tech. Rep., 2006. [Online]. Available: http://www-935.ibm.com/services/no/cio/leverage/levinfo_wp_gts_thetoxic.pdf (http://www-935.ibm.com/services/no/cio/leverage/levinfo_wp_gts_thetoxic.pdf)

[2] Cisco, "Cisco VNI forecast and methodology," White Paper 2015-2020, 2016. [Online]. Available: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html (http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html)

[3] Kahn, J., Katz, R., and Pister, K., "Emerging challenges: Mobile networking for 'smart dust'," J. Commun. Netw., vol. 2, no. 3, pp. 188–196, 2000.

[4] Thrift, N., "The promise of urban informatics: Some speculations," Environment Planning A, vol. 46, no. 6, pp. 1263–1266, 2014.

[5] Mumford, "Mumford on the city II, cars or people," J. Urbanism, no.9, 1963.

[6] Santi, P., Resta, G., Szell, M., Sobolevsky, S., Strogatz, S., and Ratti, C., "Quantifying the benefits of taxi trips in New York through shareability networks," PNAS, vol. 11, no. 37, pp. 13290–13294, 2014

[7] Nyhan, M., Grauwin, S., Britter, R., Mister, B., McNabola, A., Laden, F., Barrett, S., and Ratti, C., "Exposure track, The impact of mobile device-based mobility patterns on quantifying population exposure to air pollution," Environmental Sci, Technol., vol. 50, pp. 9671–9681

[8] Orchestrating Infrastructure for sustainable Smart Cities: http://www.iec.ch/ whitepaper/pdf /iecWP-smartcities-LR-en.pdf

[9]Smart Cities Background paper: https://www.gov.uk/government/uploads/system/uploads /attachment_data/file/246019/bis-13-1209-smart-citiesbackground-paper-digital.pdf

[10] Smart City 2020-Technology and Society in the Modern City:http ://www.microsoft. com/global/sv-se/offentligsektor/PublishingImages/Smart_city_2020.pdf

[11]WhitePaper – GIS for Smart Cities: http://esriindia.com/industries/government/~/media/esri-india/files/pdfs/industries/white-paper-gis-for-smart-cities

[12]European Innovation Partnership on Smart Cities and Communities: http://ec.europa. eu/eip/smartcities/files/sip_final_en.pdf

[13] The rise of Smart City: http://www.theneweconomy.com/technology/the-rise-of-the-smart-city

[14] Getting Smart with Urban Living:http://www.businessinfocusmagazine.com/2014/06/ smart-cities/

[15] The "actually existing smart city":http://www.spatialcomplexity.info/files/2014/09/ SSRN -id2477482.pdf

[16] A nation of Smart Cities: http://www.usibc.com/sites/default/files/A%20Nation%20Smart%20Cities.pdf

[17] Smart Cities and the Internet of Everything: The foundation for delivering next-generation citizen services: http://www.cisco.com/web/strategy/docs/scc/ioe_citizen_svcs_white_paper _idc_2013.pdf

[18]Network Architecture based on Virtualized networks for smart cities: http://smartcities.ieee.org/images/files/images/pdf/ngn_sdn_v3.1.0.pdf

[19] Smart Cities readiness guide: http://smartcitiescouncil.com/resources/smart-cities-readiness-guide

[20] Streetline – Connecting the real world: http://www.streetline.com/smart-cities/

[21] For or Against Smart Cities: Where should the planners stand? http://www.planetizen.com/node/67449

[22] Imran Zaman, "Whitepaper on Smart Cities" March 2015. [16] 100 Smart cities in India, Facilitating Implementation – Deloitte: http://in-imo-smart-cities-in-india-noexp.pdf

[23]. Legon-Okponglo, "Design and development of microcontroller based traffic system using image processing techniques". University of Ghana, published in ICAST, 2012 IEEE 4th International Conference.

[24]. Amrita Rai and Govind Singh Patel Multiple Traffic Control Using Wireless Sensor and Density Measuring Camera. Sensors & Transducers Journal Vol. 94, Issue 7, July 2008, pp. 126-132.

[25]. Muhammad Ridwan. "Development of a Low Cost Smart Traffic Controller System". Department of Mechanical and Materials Engineering Faculty of Engineering and Built Environment University Kebangsaan Malaysia, 43600 Bangi Selangor, Malaysia.

[26]. "Highway traffic model-based density estimation"-IEEE paper by Morarescu, Nancy Univ., France, published in American Control Conference(ACC), 2011.

[27]. W. Wen & C.L. Yang. "A dynamic and automatic traffic light control system for solving the road congestion problem".

[28]. “Iterative learning based Freeway density control”-IEEE paper by Jianye Li, Wuyi Univ.,China, published in Information Engineering and Computer Science(IECS),2nd International Conference

[29].http://www.edgefxkits.in/embedded/pic/density-based-traffic-signal-system-using-picmicrocontroller.

[30].http://www.ijater.com/Files/IJATsER_03_06.pdf

[31] Muhammad Ridwan. “Development of a Low Cost Smart Traffic Controller System”. Department of Mechanical and Materials Engineering Faculty of Engineering and Built Environment University Kebangsaan Malaysia, 43600 Bangi Selangor, Malaysia.

[32] Marco Wiering. “Intelligent Traffic Light Control”. Institute of information and computing sciences, Utrecht University.

[33] “Automatic Traffic Control System”. SMEU Astana Solutions Automatic Traffic Control System.htmKarmakar, N. , Handbook of Smart Antennas for RFID Systems ,Wiley-IEEE Press, Pages: 13 -56 .

[34] PIC16F877A, 8 bit PIC microcontroller, http://www.microchip.com.

[35] David Beymer, Philip McLauchlan, Benn Coifman, and Jitendra Malik, “A real-time computer vision system for measuring traffic parameters,” IEEE Conf. on Computer Vision and Pattern Recognition, pp495 -501, 1997.

[36] M. Fathy and M. Y. Siyal, "An image detection technique based on morphological edge detection and background differencing for real- time traffic analysis," Pattern Recognition Letters, vol. 16, pp. 1321-1330, Dec 1995.

[37] N. J. Ferrier, S. M. Rowe, A. Blake, “Real-time traffic monitoring,” Proceedings of the Second IEEE Workshop on Applications of Computer Vision, pp.81 -88, 1994.

[38] Rita Cucchiara, Massimo Piccardi and Paola Mello, “Image analysis and rule-based reasoning for a traffic monitoring system,” IEEE Trans. on Intelligent Transportation Systems, Vol. 1, Issue 2, pp 119-130, 2000.

[39] V. Kastrinaki, M. Zervakis, and K. Kalaitzakis , "A survey of video processing techniques for traffic applications,"Image and Vision Computing, vol. 21, pp. 359-381, Apr 1 2003.