Design, Fabrication and Programming of Smart City Parking.

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Abstract **The issue of parking is more at the forefront of urban development than one might believe. In fact, academic studies have shown that roughly 30% of city traffic is due to drivers circling city blocks attempting to find an open spot. Due to such congestion people often avoid urban centers and downtown areas for shopping or dining because parking is such a hassle and assumed to be unavailable. If drivers knew where parking was available in real time, they could proceed directly to open spaces as opposed to their congestion-inducing attempts to park. A better solution would guide people to available parking and may help re-vitalize downtown areas. The problem of knowing whether or not an available spot exists, however, is complex. While many solutions to detecting available parking have been tried, we focused on magnetometer-based vehicle sensors placed in each parking spot. We built a sensor comprised of a low-cost magnetometer, a radio, a micro-controller, and a battery on a custom printed circuit board. Our idea is that such a sensor could be placed in each parking space and monitor for vehicles. When a vehicle arrives, the magnetometer detects a change in the magnetic environment, and then radios the presence of the vehicle in a space to a central server that aggregates and disseminates parking data to drivers and city officials.**

Keywords —issue of parking, avoid down town areas, drivers knowing available parking, magnetometer based parking, providing solution.

I. INTRODUCTION

Parking is an everyday chore that can be optimized in a variety of ways. One such area, the area of this study, is the seemingly simple problem of knowing whether or not a car is physically present in a parking spot. These slow moving drivers, repeatedly circling city blocks near their destination, create increased traffic congestion and pollution on already crowded downtown streets. If the location of empty parking spaces were known in real time, drivers (human or autonomous) could simply input their destination into a parking-aware navigation system (envision Google maps) and could be guided directly to the nearest available space, thereby reducing circling-induced congestion and pollution. Additionally, tracking detailed parking usage data over time can help a city price parking so that supply meets demand. This data-driven pricing could encourage some drivers to select less desirable parking spaces (e.g., around the corner from Starbucks, not right in front) in exchange for a lower price, freeing more desirable spaces.

To achieve this vision of reduced congestion and pollution with increased downtown utilization of parking, however, parking space occupancy information must be available in real time to assist drivers. One approach to providing this information is to install a magnetometer-based sensor in each parking space. These sensors detect a change in the Earth's magnetic field caused by the presence of a vehicle in the parking space. Several commercial enterprises have developed these sensors, but data on the sensor's ability to detect different types of vehicles (e.g., sedans, sports cars, or trucks), in different parking scenarios (e.g., parallel parking, head-in, angled), and the detection algorithms used are closely guarded secrets. Furthermore, there is opportunity to explore and perhaps improve the existing technology in terms of cost and accuracy.

II. LITERATURE REVIEW

[1]The paper describes an attempt of using magnetic detectors as an effective alternative to existing vehicle detection systems, which are a key factor in intelligent transportation systems (ITS). The detectors created within the project use the phenomenon of anisotropic magneto-resistance to report about the appearance of vehicles on the basis of Earth's local magnetic field distortion caused by them passing. This paper presents utilized and developed technologies, advantages and disadvantages of magnetic detection in comparison to other detection systems and problems that arose during the project implementation.

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[2]In this paper, the goal was to provide a rigorous foundation that may help smart transportation systems of the near future reduce urban congestion and pollution while increasing downtown utilization of available parking. Such motivation stems from their desire to contribute to a more sustainable future as well as aid in a current problem facing all major cities across the world.

[3]The development of devices that can connect to the Internet and transmit data has been a source of inspiration for smart city designs. The common problem in our cities is the difficulty of finding free parking slots. The parking problem causes traffic to congest and people who go to work are looking for a place. In this study, navigation and reservation based parking proposal system was developed for smart cities. The proposed method involves the development of small devices that send data to the internet using the internet of things (IOT) technology. The free parking space closest to the current location is found by genetic algorithm. The proposed method is tested for different scenarios and accurate results are obtained.

[4]In this paper, with the increasing growth of automotive industry, the demand for intelligent parking service is expected to grow rapidly in the near future. This emerging service will provide automatic management of parking lots by accurate monitoring and making that information available to customers and facility administrators. Wireless sensor networks have a great potential toward providing a cost effective solution to this service for a variety of reasons, such as their ease of deployment in existing parking lots without having to install new, expensive cabling, and the flexibility to couple them with sophisticated but cheap sensors with different modalities that can accurately keep track of vehicles. Moreover, information gathered by each node can be collaboratively processed in a distributed or centralized way to evaluate other meaningful metrics such as duration of parking, automatic billing and payment, etc., to the benefit of users and administrators.

[5]In this paper, we mainly focus on designing a new smart parking management system that assists users to find parking spaces in a specific parking area by using the android application. In addition, an important goal of the system is to reduce the traffic searching for parking, hence reduce energy consumption and air pollution. This paper mainly focuses on simplifying car management system at both ends i.e. users and parking owners. The application will be a middleware for connecting user to the owners. This greatly facilitates the owner as his parking space is put on a spot on an area increasing his functionality. Amongst the suggested area the user gets the choice to select which enhances the usability of the app.

[6] 3D printing is a rapid prototyping mode without mold making. It is also known as the material additive manufacturing. Based on the 3D digital model file, it constructs the object through printing the materials layer by layer. this technology needs the raw material much less than the traditional one which uses rough pruning forming.

[7] This paper proposes a Smart Parking System based on android technology for avoiding the parking problems which provides process of pre-booking the slots through the use of a simple and interactive Android application. This application is expected to provide an efficient and cost-effective solution to the effluent vehicle parking problems. The paper describes the overall system architecture of our application. The user needs to have an Android enabled device to reap the benefits of this application. After installing the app, user needs to mandatorily register with the application. Booking of the slot at user's desired location should be done four hours prior to the arrival. Payment services are made available using Google Wallet in the future, so the user is required to own a credit card or debit card. Penalty will be levied on late arrival as well as on over use of the slot after user specified entry and exit time. The places where security surveillance (CCTVs) is made available will be used by the administrator to keep a track of the vacant or occupied slots. Else, physical presence of the administrator at the slot site will be required. During reservation process the client needs to provide with details that includes booking person's name, vehicle number, expected entry and exit time.

[8]The particle material extrusion (fused particle fabrication (FPF)/fused granular fabrication (FGF)) has the potential for increasing the use of recycled polymers in 3D printing. This paper extends this potential to high-performance (high-mechanical-strength and heat-resistant) polymers using polycarbonate (PC). Recycled PC regrind of approximately 25 mm2 was 3D printed with an open-source Gigabot X and analyzed. A temperature and nozzle velocity matrix was used to find useful printing parameters, and a print test was used to maximize the output for a two-temperature stage extruder for PC. ASTM type 4 tensile test geometries as well as ASTM-approved compression tests were used to determine the mechanical properties of PC and were compared with filament printing and the bulk virgin material. The results showed the tensile strength of parts manufactured from the recycled PC particles (64.9 MPa) were comparable to that of the commercial filament printed on desktop (62.2 MPa) and large-format (66.3 MPa) 3D printers. Three case study applications were investigated: (i) using PC as a rapid molding technology for lower melting point thermoplastics, (ii) printed parts for high temperature applications, and (iii) printed parts for high-strength applications. The results show that recycled PC particle-based 3D printing can produce high-strength and heat-resistant products at low costs.

[9]The aim of this study is to characterize and optimize the parameters such as layer thickness and PLA build material which is mixed with recycled PLA material. Tensile and flexural or bending test are carried out to determine the mechanical response characteristics of the printed specimen.

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Taguchi method is used for number of experiments and Taguchi S/N ratio is used to identify the set of parameters which give good results for respective response characteristics, effectiveness of each parameter is investigated by using analysis of variance (ANOVA).

[10]Specific aim of the project is to develop the metalizing technology suitable for the surface integrity enhancement of IM thermoplastic parts to enable their direct application in developing functional prototypes for real world problems. Technical scope of the proposed project includes studies on surface preparation / surface activation of ABS, electro-less and electro deposition of metallic layers, strength characterization of metalized IM parts. The proposed research is interdisciplinary in nature as it demands synergistic application of the concepts of material science, mechanical engineering and chemical engineering, for fulfilling the projected research goals.

[11] This paper highlights the difficulties faced by customers when searching for spaces while parking vehicles, showcases the difference between manual and automated parking systems, and how a dynamic slot allocation is done and the devices required implementing it. using the concept of smart parking they developed a technology that digitizes any type of parking for best Return on Investment (ROI) possible. Its suite of services makes a complete smart parking ecosystem which serves the suppliers (API integration), parking management (enterprise solutions), government (smart city) and the consumers (discovery and transaction app).

[12] In this paper, they have presented how they made an application where user can view various parking areas also he can select it to view whether parking slot is available or not. If the parking slot is available in parking then user can book it for some specific time slot also, this system provides an additional feature of cancelling the bookings. It also utilizes the open ground for parking with security. So, it will solve the parking and traffic problem. In this there is no need to use additional costly camera and scanner device for verification purpose. In this system Registration certificate (R.C) book is use for verification purpose, so it reduces the extra cost also.

In existing situation, advance technology for city parking is bounded up till reserved parking lots. What if the same technology is deployed all over the city in which each and every person can handily access the same technology and save their valuable time? This project emphasizes on this very important point. Smart parking system is nothing but a broader concept which comprehends various aspects from vehicle detection to providing a user real time data with the assist of wireless magnetometer sensors, cloud system and an application. For an area with legal parking to begin with, a sensor mounted on road surface will detect a vehicle parked on it. This sensor will be communicating with the Cloud server in terms of readings which will be showcased on the application in form of whether available parking space is present or it is engaged. But in scenarios in case of illegal parking we have proposed to switch CCTV cameras in place of sensors which would provide real time image of the vehicle with identification and after a term the owner would be receiving an e-ticket corresponding to the time occupied.

In existing situation advance technology for city parking is bounded up till reserved parking lots which is functional for the time a human is using parking lot. What if the same technology is deployed all over the city in which each and every person can handily access the same technology and save their valuable time. This project exactly emphasizes on this important point. Smart parking system is nothing but a broader concept which comprehends various aspects from vehicle detection to providing a user real time data with the assist of wireless magnetometer sensors, cloud system and an application. For an area with legal parking to began with, a sensor mounted on road surface will detect a vehicle parked on it. This sensor will be communicating with the Cloud server in terms of readings which will be showcased on the application in form of whether available parking space is present or it is engaged. But in scenarios in case of illegal parking we have proposed to switch CCTV cameras in place of sensors which would provide real time image of the vehicle with identification and after a term the owner would be receiving an e-ticket corresponding to the time occupied.

III. METHODOLOGY

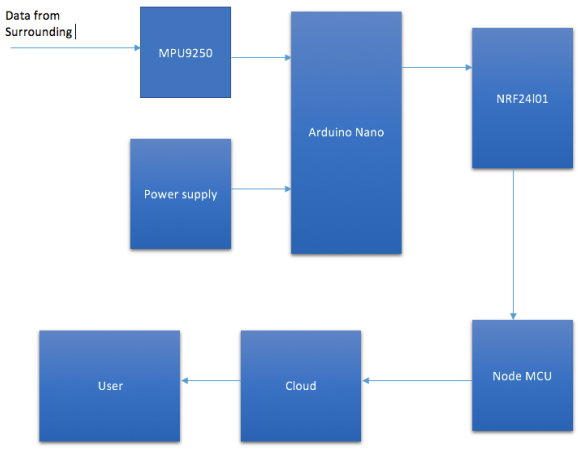

Fig 1 - Overview of the whole sensor system

Figure 1 shows the flow of data right from the detection of the vehicle to update information on a phone of user. It also provides the information of the sensor and the information about the whole sub-system that is going to be needed for the user to operate. The chassis of vehicle is made of steel which depict magnetic properties. This advantage of the magnetic property will be used for detection of the vehicle. The process starts right when a vehicle is being rested on the sensor. Vehicle detection is

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the key element of the parking sensor. HMC5883L magnetometer module and IR sensor module are the two responsible components in the parking sensor which will detect and provide this information further to the back end system. HMC5883L uses magneto resistive sensor arranged in a bridge circuit, which is made of nickel-iron (Ni-Fe magnetic film) material. Earth's magnetic field is present in space which points towards the magnetic magnetic north. Current carrying conductor also generates a magnetic field around itself. Hence, whenever a current carrying conductor is placed in space, it experiences the effect of the earth's magnetic field affecting the flow of the electrons through that conductor. These changes in the flow of the electrons are used for identifying the heading or direction of the magnetic field. This is the basic working principle of the magnetometer.

Both Magnetometer and IR sensor is connected to brain of the sensor which is the microcontroller. As per the complexity and algorithm to be used in the sensor Arduino nano is suited best to carry out the operation. When the HMC module detects vehicle it will sense and provide a true value to the microcontroller. Same process is applicable for IR module and will have an effective communication with the nano. When both the values of the detection mechanism are true then only the the vehicle will be detected which means that this mechanism follows the AND logic. The circuit is supplied current with 5V DC supply. These multiple sensors are interconnected with each other with help of a master server which is remotely seated at a distance. So it becomes crucially important for a sensor to communicate wirelessly with the remote server. Radio frequency communication is one medium for wireless communication. NRF24L01 module is a sensor which transmits data with wireless medium from one location to another. NRF24L01 is a single chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transmitter part of the NRF24L01 will be assembled to the microcontroller of the sensor and the receiver part will be connected to the remote server. The combined true valve detected by the magnetometer and the IR sensor will be communicated to the remote server with the help of NRF24L01. Like wise the receiver part of the sensor will be connected to 8266 node MCU. The combined structure of node MCU and NRF24L01 trans receiver will form the remote terminal unit which will communicate with the other sensors in surrounding. The true value from the remote server is then directed towards the back end of the system which will handle the data from sensors all across. Node MCU acts as a gate way for the data form remote server to the back end system. The work of back end system is to keep an update of real time data as per provide to it and to update the same to the uses using the application. Thus the user can get an update about any vacant sensor just by accessing his phone.

IV. Design For Sensor Body

A. MECHANICAL SYSTEM

HMC5883L uses magneto resistive sensor arranged in a bridge circuit, which is made of nickel-iron (Ni-Fe magnetic film) material. This means that it will detect any magnetic radiation in its field. If an outer casing is made up of material having metallic properties, the magnetometer will sense it and will produce a true reading all times which will is not feasible and hamper the whole reading system

So now the question arises that which material should be selected for the outer casing of the sensor as metals having conductive properties cannot be used for the project. This problem leads to a solution to use non ferrous metals like aluminum, copper, etc. But looking at different factors it is not economically feasible to manufacture this product with such costly metals. There are more different options like using polycarbonate (hard plastic) for this product. The sensor is going to be mounted on the road and thus there would be various rough conditions like heavy rain, dust and heat, etc. So polycarbonate is the best material for such conditions. Favorably fluorescent colors like yellow, orange should be used for the body as it will help in easy detection of the sensor.

First Design Consideration

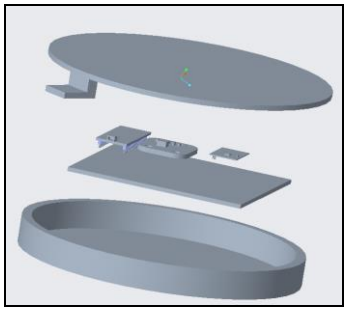

Fig 2- First daft of sensor

The motive after designing the first sensor was to determine the basic outer frame work of the parking sensor. Which means that we would understand how the sensor would look in first place. In initial design we had decided to provide a press lock fit arrangement to interlock the body and cover of the sensor.

Updated Design Considerations

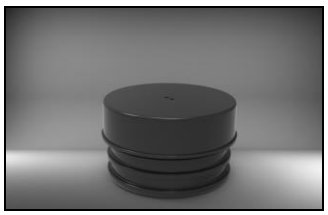

Fig 3- IR embedded adhesive based sensor

Fig 4- Adhesive parking sensor

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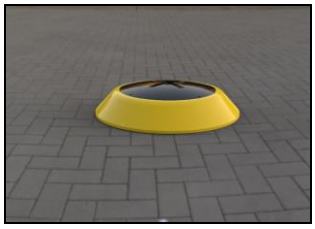

Fig 5- Flush mount sensor

From some anomalies considered from initial design some updates are made in the final draft shows in figure5. Three different types of sensor are proposed as per the use. Two different types of mounting techniques are used in design. One types are mounting on the surface and other method is to drill a hole in ground and then mount sensor in it.

B. DATA ACQUISITION SYSTEM

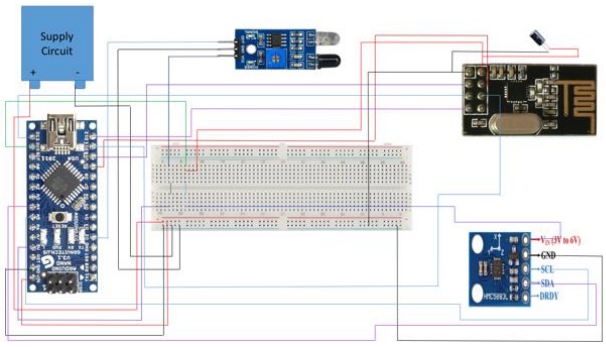

Fig 6 – Internal circuit diagrm for sensor

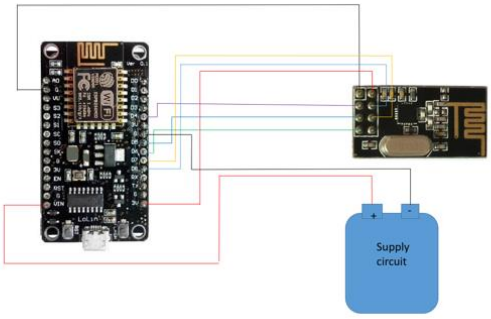

Fig 7 – Internal circuit diagrm for remote server

Above figures(6 and 7) describes the internal circuitry of the sensor and the remote server.In figure 6 The supply circuit which provides 5V power is connected to V_{in} of micro controller. And ground is connect to the ground of micro controller. Output of IR sensor is connected to D2 of controller. SCL and SDA of magnetometer are connected to A5 and A4 of the controller respectively. A 10 micro farad capacitor is connected in the circuit to provide a safe guard to the components.

The System works on fetching the data from the sensor with connecting the module with the servers using sql lite at the backend for DBMS using the amazon EC2 services by amazon web services, using java for the application development , various algorithms used for the predictions are liner regression , and SVM .Fig 8 shows the sample interface of application and flow chart of parking system.

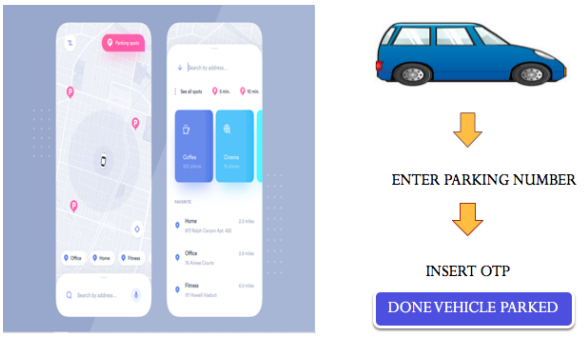

Fig 8- sample image of software interface and parking work flow

V. FABRICATION

Figures(9, 10,11,12 and 13) show the final draft of different sensor model. The body of model is supposed to be non magnetic in nature hence it becomes a bit difficult to manufacture it with the help of conventional method. The only option to manufacture is by using non-conventional methods. As this model is a prototype 3D printing is a viable option to consider. 3D printing is a rapid prototyping mode without mold making. It is also known as the material additive manufacturing. Based on the 3D digital model file, it constructs the object through printing the materials layer by layer. This technology needs the raw material much less than the traditional one which uses rough pruning forming. Through changing the model's configuration, it could respond to the consumers' demand more flexibly. More than one hundred of raw materials can be used for 3D printing. They include thermoplastic plastics, metal, nylon, acrylic, plaster, ceramic, and edible material.

The CAD model of prototype design is designed on CAD softwares. PTC creo parametic version 6.0. Its rendering was done on Key shot version 10. This CAD designing needs to be filtered for bad edges so the model regains its smooth features. This model is then sliced into layers to determine its co-ordinates and this information is transferred to the 3D printer machine. As per the information G-codes and M-codes are generated. For this prototype polyactic acid (PLA) is used. There are ready made PLA spools available in market which are required to load in the 3D printer. When the coil gets heated material gets softened and is layered as per the co-ordinates provided to the system. when the prototype is completed with respect to CAD design the spool gets cut off automatically and we get a final 3D model.

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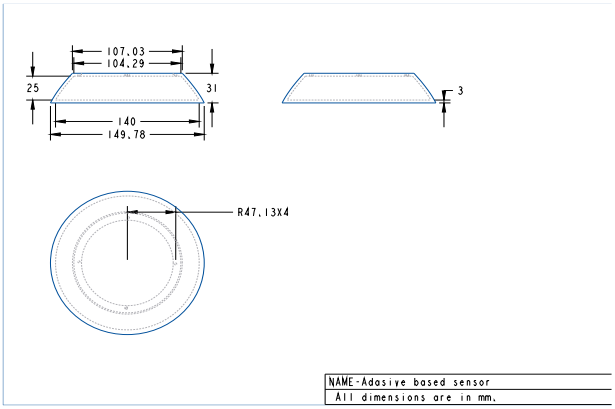

Fig 9 – Body for adasive based sensor

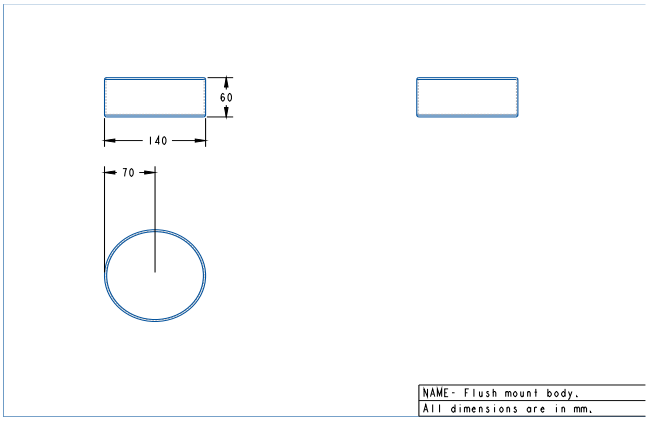

Fig 10- Body for flush mount sensor

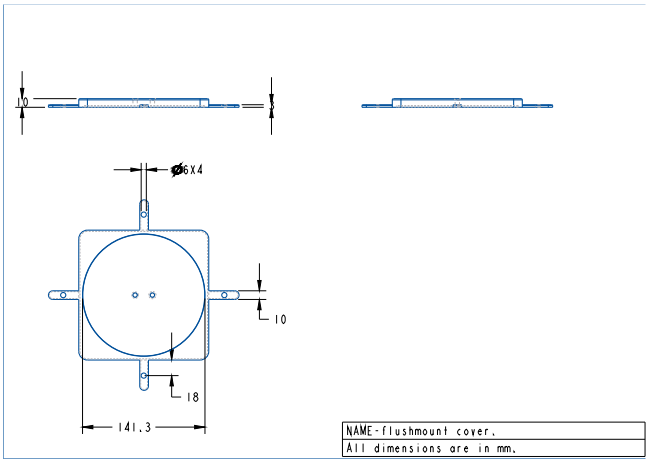

Fig 11- Top for flush mount sensor

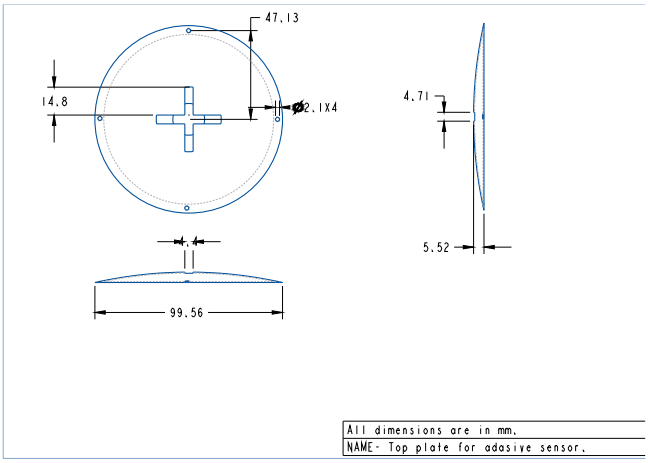

Fig 12- Top for adasive based sensor

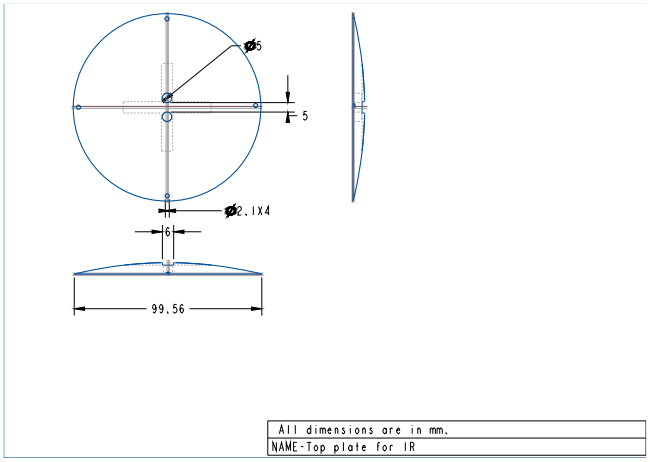

Fig 13- Top for IR adsive based sensor

VI. Plan For Testing

For testing purposes we will choose an area less crowded. For this very reason we will select a parking lot. Mount the sensor on the ground and move the vehicle over it for verification. we will evaluate using the magnitude of the X, Y, and Z readings to detect vehicles. This simple magnitude-based vehicle detection algorithm uses a pre-defined threshold. If the magnitude of the magnetometer's readings exceeds the threshold, then the algorithm indicates a vehicle is present in the parking space. If the magnitude of the reading is below the threshold, then the algorithm indicates the space in empty. We will use the following formula to calculate magnitude:

$$M = (X)^2 + (Y)^2 + (Z)^2$$

We will use a data table to plot the different accuracy achieved by changing the threshold value e.g., if magnitude exceeds 13.0 µT then indicate this space is occupied, otherwise indicate the space is vacant.

VII. Conclusion

Parking is and will remain an issue that affects everyone in the community, from traffic management and law enforcement. This survey helps in building the system for Online Parking System. It also focuses on the analysis of the parking space and managing the traffic control and generates the performance graph, based on previous and current traffic records. In this paper we have discussed about the internal working of sensor and the whole supporting mechanism of the sensor in detail.

VIII. References

[1] Marcin BUGDOL*, Zuzanna SEGIET, Michał KRĘCICHWOST, Paweł KASPEREK, Vehicle detection system using magnetic sensors, Volume 9, Issue 1.

[2] Luke Hudspeth, Evaluating the Efficiency of Magnetometer-Based Vehicle Sensors, Dartmouth Computer Science Technical Report TR2019-870 Dartmouth College, June 2019.

 DOI : 10.35291/2454-9150.2021.0490

[3] Ilhan Aydin , Mehmet Karakose , Ebru Karakose, A Navigation and Reservation Based Smart Parking Platform Using Genetic Optimization for Smart Cities, ICSG Istanbul, Turkey, 2017.

[4] Sangwon Lee, Dukhee Yoon, Amitabha Ghosh, Intelligent Parking Lot Application Using Wireless Sensor Networks, Sangwon Lee, Dukhee Yoon, Amitabha Ghosh Autonomous Networks Research Group Ming Hsieh Department of Electrical Engineering University of Southern California, Los Angeles, CA 90089, IEEE, 2008.

[5] Kapil Gajbhiye , Nikhil Dhoke , Bhushan Hiwase, Online Vehicle Parking Android Application: Smartpark, India,International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Issue 3, March 2018.

[6] Research on the Impact of 3D Printing on the International Supply Chain Zhen Chen1, China Received 5 December 2015; Revised 13 April 2016; Accepted 17 April 2016

[7] Mr K. Devendran, Su.Nivethaa, Assistant Professor, Android application for vehicle parking system, International Journal of Scientific & Engineering Research Volume 8, Issue 7, July-2017.

[8] Matthew J. Reich , Aubrey L. Woern , Nagendra G. Tanikella, Joshua M. Pearce, Mechanical Properties and Applications of Recycled Polycarbonate Particle Material Extrusion-Based Additive Manufacturing, 20 May 2019.

[9] Babagowda, R..S.Kadadevara, Goutham R, Srinivas Prasad K.R, Study of Effects on Mechanical Properties of PLA Filament which is blended with Recycled PLA Materials, IOP Conf. Series: Materials Science and Engineering, 2018.

[10] Jayanth.K.N, Ravi Kumar, Studies on Acrylonitrile Butadiene Styrene (ABS) and Electroplating on ABS, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Special Issue 15, December 2017.

[11] Lorraine D'souza, Mona Deshmukh, An Android/IOS Application for Car Parking System Using GPS, International Research Journal of Engineering and Technology, Volume: 05, Issue: 05, May-2018.

[12] Hina C. Parmar, Nisha N. Shirvi, Development of an Android Application for Smart Parking System, Department of Computer Engineering, IJEDR, Volume 6, Issue 2, 2018.

 DOI : 10.35291/2454-9150.2021.0490