ISSN No:-2456-2165

A Proposed Model for Enhancing Traffic Problem in Egypt - Internet of Things

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Abstract:- The problem of traffic congestion has become a very important issue to any country, because of the increase in the number of vehicles, the appearance of continuous traffic congestion, traffic accidents, a collision of vehicles, and so on. Which makes it important necessary to obtain traffic data with high quality. This paper used the Internet of Things (IoT) by a Light Detection and Ranging (LiDAR) sensor was installed at the roadside for data collection to continuously track traffic.

Keywords:- *Internet of Things (IoT), Light Detection and Ranging (LiDAR), Urban Traffic Management.*

I. INTRODUCTION

According Lu (2016) Intelligent Transportation Systems (ITS), based on Information and Communication Technologies (ICT), for road transport, are rapidly developing for more than three decades, intending to improve safety, solve the problem of traffic congestion, and traffic efficiency. According Akinlade (2018) traffic collisions often appear due to factors such as nature of the road and vehicle, the skill level of the driver, over speeding which may lead to loss of life and appearance of traffic congestion. There is a need to reduce congestion of traffic, make the driving experience on roads safe for both drivers of vehicles and avoid a lot of problems in the traffic. According Yoneda (2020: 1181), Zhang (2019), and Anand (2019) LiDAR sensors are used to measure distance and accurate data of surrounding objects by illuminating them with laser light (Radiation) pulses and receiving the reflected pulses. Based on the time difference between received and transferred laser lights (Radiation) and the speed of the laser light, it creates a 3D of objects. LiDAR's ability to capture 3D information makes it very useful in many fields like Intelligent Transportation System. A LiDAR is operated remotely. The sensor data can be transmitted through a reading of vehicles on the road and this transfer of data can enable the sharing of updated traffic and road condition information. By LiDAR sensors that are placed in a particular location, either permanently or temporarily. They measure local traffic data and reflect overall traffic conditions in the whole traffic system.

II. PROBLEM STATEMENT

A. LiDAR Sensor

First, This paper talks about how to use LiDAR Sensor to help for solving the problem of road traffic density and how to find a solution to avoid congestion and help the driver to find an alternative way to reduce traffic congestion and traffic density that causes many problems, including accidents, waste of time, fuel, and many losses caused by traffic density and helping decision-maker by proposing a better road to the vehicle, to reducing a busy road and choosing a road with less traffic density to solve the complex problem of the traffic in Egypt.

B. Internet of Things

In the addition, Internet of Things (IoT) is used for solving the problem of traffic and to avoid congestions and collisions of vehicles via LiDAR sensors that collect data from the road to determine the traffic congestion that is placed in a particular location.

III. LITERATURE REVIEW

Several case studies analyzed this field and used different methods to manage and control Traffic Management Systems.

Singh (2020) proposed infra-red sensor-based technology for collecting speed and progress data on highways under mixed traffic causes. They used a traffic detector device based on IR sensors, named Transportable Infrared Traffic Logger (TIRTL), a large amount of accurate speed and progress data were obtained on Indian highways that exhibit heterogeneity in their traffic composition. Used this data, the probability distribution functions of speed and headway for various traffic flow and density levels have been studied. Therefore the study presented that speed and progress data follow various probability distribution functions under various traffic flow and traffic density levels. Banerjee (2019) proposed A Multi-sensor System for Traffic Analysis at Smart Intersections. They used a multi-sensor system for vehicle and pedestrian traffic analysis and visualization at intersections to discover trajectory patterns and anomalous traffic behavior. The result showed how clustering in the context of signal information may help us to detect anomalies concerning vehicles violating signals. Cruz (2018) proposed the use of the magneto-resistive sensor for the detection of vehicle traffic.

The developed traffic detection system allows an approach of the number of vehicles per hour on two-lane roads. The traffic detection in this study uses a minimum algorithm with top counting. Overall, the study presented that magneto-resistive sensors can be used as a tool in determining traffic volume cause with a percent accuracy of 91.67%. Dester (2019) proposed a traffic model for the link traffic, which is composed of deterministic and stochastic parts, and perform a study of throughput, delay, and packet waste for this link traffic in a central node of the wireless sensor network through Machine-to-Machine communication (M2M) or machine type communication (MTC) in the form of communication in which devices communicate with each other and with servers on the Internet without human intervention. El Hassak (2019) proposed Solutions for Smart Traffic Lights using Machine Learning and Internet of Thing. To come out with solutions to these problems, different traffic management systems have been placed in a lot of cities all over the world for example TRANSYT, SCCOT, and SCATS. In general, to optimize the waiting time, the proposed solutions have aimed to optimize the following three elements; time cycle, green light time, and phase. Ali (2017) proposed an RFID-based system used to recognize traffic lights status and avoids the problems that usually occur with the normal traffic lights recognition systems. The approach provided high performance and a low-cost system. The paper also presented an RFID-based system used to recognize road signs. During run tests, all signals are recognized correctly. Dandıl (2017) proposed Arduino microcontroller-based traffic signalization automation system that is remote-manageable with a web service is used for period scheduling of traffic lights. In the study, a prototype is formed on the breadboard and the results are noted on this prototype. Therefore, significant gains are predicted for the traffic signalization systems in terms of time and financial costs. El Abdallaoui (2018) proposed a decision-making system for the analysis of traffic accident data to extract information relevant to the prevention of road risk, to solving road accidents and detect problematic sites. Data analysis aims to choose the most accurate extraction process after validation, by analyzing the characteristics of the data and their relationship to the analysis and extraction process. Vadhwani (2020) proposed Intelligent Transportation System involves the improvement in public safety using much-emerging technology like wireless sensor network and internet of things. Intelligent transportation system works on the main application area for the development of smart cities in the present situation. One of the ITS applications i.e. vehicle discovery and analysis of moving vehicle in the accident notification system was applied using Arduino Mega 2560 microcontroller and Node MCU device.

IV. PROPOSED TRAFFIC MANAGEMENT SYSTEM

In this paper we used the LiDAR sensor name of the product is TFmini from Benewake (Beijing) Co. Ltd with Arduino Uno to collect data of passing vehicles in the road to know the density of traffic in the roads and put a proposed solution to help the driver to avoid traffic congestion and reduce a lot of problems in the roads.

A. The characteristics of Arduino Uno and Lidar Sensor:

➢ *The Arduino Uno:*

Is probably the most popular Arduino. It is activated by an Atmega328 processor operating at 16MHz, contains 32KB of program storage, 1KB of EEPROM, 2KB of RAM, has 14 digital I/O, 6 analog inputs, and both 5V and 3.3V power rails. The Arduino Uno has a pin header arrangement that is quickly becoming the manufacturing standard for improvement boards, making it compatible with most improvement board shields on the market. A power jack is contained on the Uno, allowing it to be powered by an external wall wart. There is also a VIN option existing for connecting the Uno to batteries. The physical dimensions of the Uno (69mm x 54mm) make it a small development board that can easily fit into lots of projects and the four screw holes permit designers to securely fit them into place. Uno" means one in Italian.

➢ *LiDAR Sensor Information:*

According Yue (2019:1354), Tian (2017) LiDAR is short for light detection and ranging, and it is an innovative sensing technology for contactless sensing. The LiDAR system uses the time difference between emitting the light to the return of the light to calculate the location of the object. The pulse usually has a very high frequency. Hence the detection looks like “real-time”.

The LiDAR sensor is connected to the Arduino Uno (Micro-controller) and using the Arduino software (program) to put codes on the LiDAR sensor, to operate and running the LiDAR sensor, to help it to read objects passing through it.

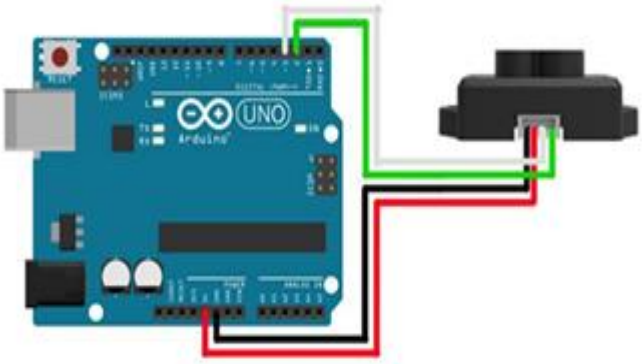


Fig. 1: Schematic Diagram of Connection between LiDAR Sensor (TFmini) and Arduino Uno Board, Benewake (Beijing) Co. Ltd. Tian (2017).

B. How to use LiDAR Sensor with Arduino Uno?

The figure 2, The LiDAR sensor is placed on the road to read all the passing vehicles. The LiDAR sensor sends and receives signals to the vehicles passing through it and by reading the LiDAR sensor for vehicles, the LiDAR sensor measures the count of vehicles in every road to determine the density of traffic in every road.

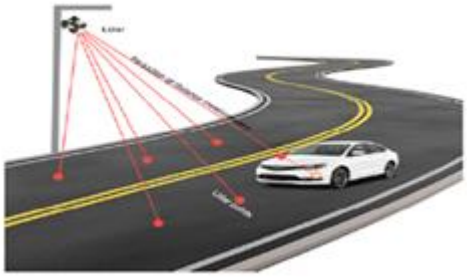


Fig. 2: LiDAR Sensor in the road. Lakshminarasimhan (2017)

The figure 3, presented predefined destination of roads to control of traffic management, first, read the account of the driver on the application that helps the driver to select the best road to move on it then driver determine the destination that wants to arrive in it, after that the application record the name of every road and appear to the driver the numbers of the roads that reach to the selected destination, the driver sees all the alternative roads and finally the driver knows all roads that help to arrive at the selected destination.

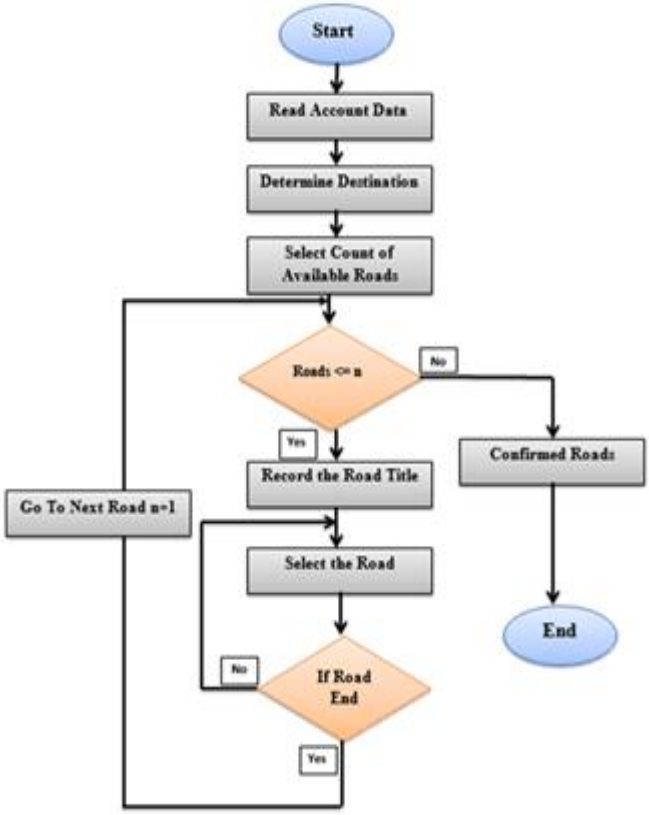


Fig. 3: Flowchart for Predefined Destinations.

The figure 4, we proposed a flowchart for how to make the best decision for select the best road with the lowest density of traffic, first, we predefined all selected destinations to arrive at the same point, then we displayed all available roads that help the driver to arrive in the selected destination and to control of the traffic then collect from the server all data of the passing vehicles in the same road that collect from LiDAR sensor to know if this road has traffic density or not then if the expected density of road is high, the driver selects another road and so on (the driver see all alternative roads to select the best road with the lowest density of traffic) to arrive at the selected destination after that check all alternatives roads to know which of them has the lowest density of traffic from passing of vehicles to help the driver to select it and finally this road (that has the lowest density of traffic) is the best decision to the driver.

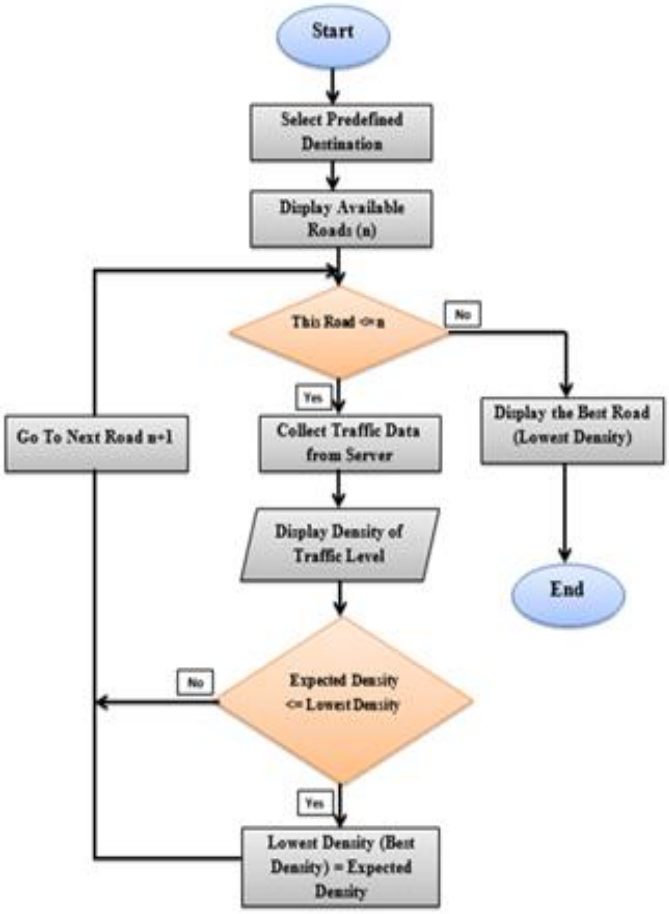


Fig. 4: Flowchart for Decision the Best Road.

C. Proposed vehicles density in the roads based on LiDAR sensor:

These figures are recommended all traffic situations in the road picture 5 shows the state of traffic density full of road and the presence of a lot of vehicles on the road that may lead to a large traffic prevent traffic and the occurrence of many accidents and the poor driving abilities of vehicles and the speed of traffic is low, and in the figure number 6 shows the situation of traffic in the moderate situation for the appearance of vehicles on the road and the path of vehicles well and where the distance of vehicles is greatly help to increase the speeds of the vehicles and reducing traffic congestion and reducing some problems that appear in traffic density in one road, but in figure no. 7 shows the spacing of vehicles between each other at large distances where this helps in the high speeds of vehicles on the road and traffic better, which is of the best levels and cases in all these pictures that make it easier for the driver to walk better and avoid many traffic problems and accidents and save money and wasted fuel in the roads.

ISSN No:-2456-2165

Fig. 5: A Dense Vehicle State. Akinlade (2018)

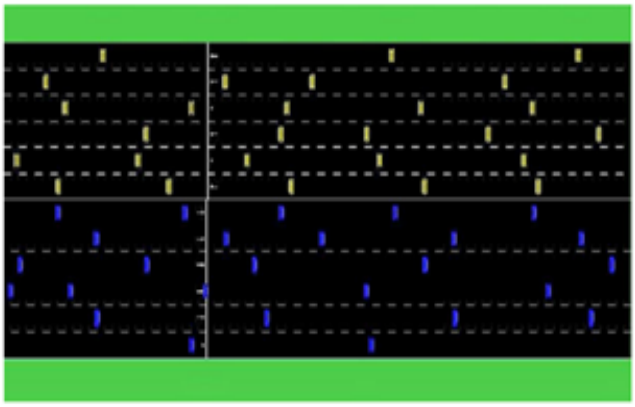


Fig. 6: A Moderate Vehicles Density State. Akinlade (2018)

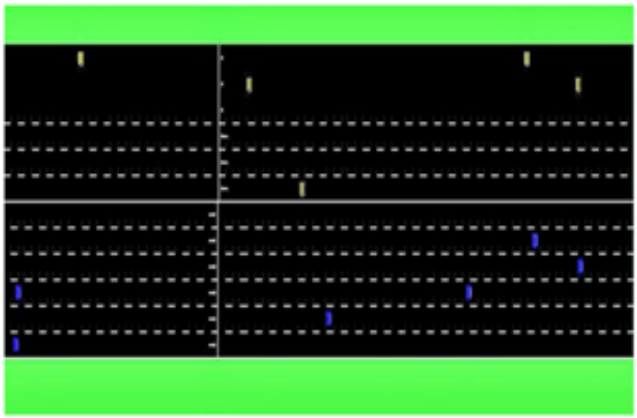


Fig. 7: A Sparse Vehicles Density State. Akinlade (2018)

These Figures 8, 9, and 10: the LiDAR sensor was connected and placed with the Arduino Uno and used the required codes on the Arduino software to read all the objects passing on the LiDAR sensor. In this Figure, the data showed the LiDAR sensor read and recorded as it shows at 10:00 a.m. the data was recorded, as well as the distance between the LiDAR sensor and each vehicle that passed on it and finally the signal that was between the sensor and the vehicles.

Example of how to reading Vehicles on road by using LiDAR Sensor with Arduino Uno and Arduino Software (Program):

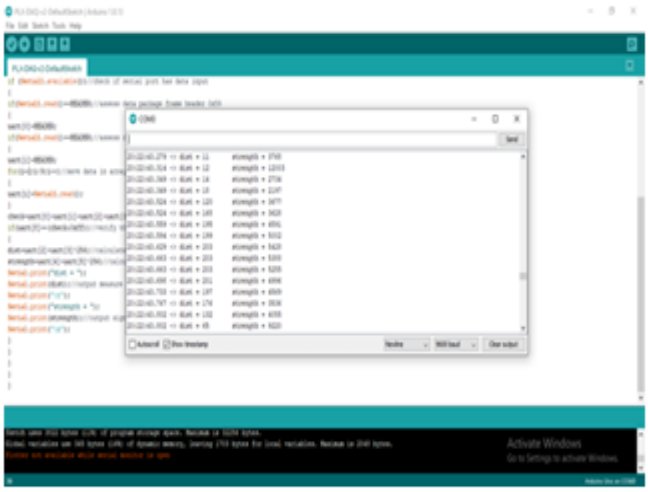
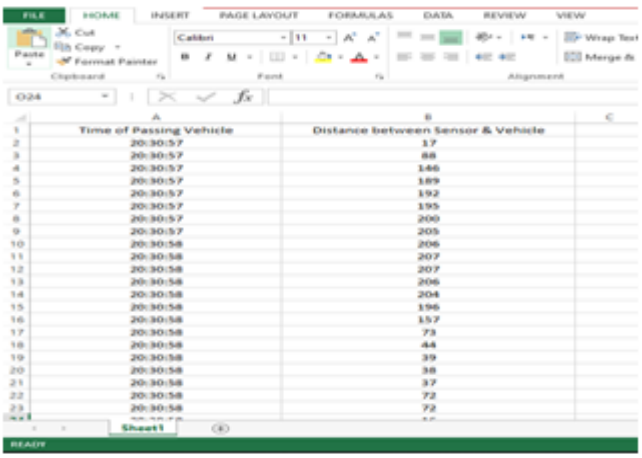


Fig. 8: Passing Vehicles to the LiDAR Sensor with measure the distance between LiDAR Sensor and Vehicles with appearing of the time.

Fig. 9: Chart of Passing Vehicles to the LiDAR Sensor with measure the distance between LiDAR Sensor and Vehicles.



Time of Passing Vehicle	Distance between Sensor & Vehicle
20:30:57	17
20:30:57	88
20:30:57	146
20:30:57	189
20:30:57	192
20:30:57	195
20:30:57	200
20:30:57	205
20:30:58	206
20:30:58	207
20:30:58	207
20:30:58	206
20:30:58	204
20:30:58	196
20:30:58	157
20:30:58	73
20:30:58	44
20:30:58	39
20:30:58	38
20:30:58	37
20:30:58	72
20:30:58	72

Fig. 10: Shows the data recorded from the LiDAR Sensor to Excel Sheet.

The figure 11, the LiDAR sensor begins to read the vehicles that pass through the road and send and receive radiation from passing vehicles in this road by collecting the data collected by reading all the vehicles that have passed along the road, knowing that this road is dense, and then sending it to the server of Traffic Management and assist Traffic Management Assistance in identifying traffic in each area of the road through the sensor on which it is located, Traffic Management then transmits all data regarding traffic density and assists applications such as mobile applications, television, and radio to provide citizens and the driver to avoid the dense road and choose an alternative road.

Fig. 11: Communication between LiDAR Sensor and Traffic Management.

V. CONCLUSION

The traffic density was determined, and this was done by automating the density by the LiDAR sensor in which the measure between the LiDAR sensor and the vehicle was placed, and also the time of the vehicle passed through the LiDAR sensor. From here the obstacles were found and solved, such as knowing all the vehicles in the traffic in real-time and determining the traffic density in each area on which the LiDAR sensor was placed then transfer data to the database of the server of traffic management after that informs the driver on various applications, such as mobile applications, radio, television, and so on which is the highest traffic density and less traffic density roads. Finally, the driver must choose the less traffic density road to avoid congestion, reduce traffic density, and avoid all problems of traffic, and helping to solve the traffic problem.

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