A SHORT SURVEY ON CONSTRUCTING AN IOT-BASED INTELLIGENT ROAD SYSTEM

F. O. Okorodudu, G. C. Omede and S. A. Otegbalor

Department of Computer Science, Faculty of Sciences,
Delta State University, Abraka, Nigeria

ABSTRACT

Road construction is a crucial component of modern infrastructure since it greatly facilitates travel between various areas.Sustainability, Progress, and Transformation refer to the upgrading of roads employing communication, lighting, and control transmission mechanisms that may promote sustainability, road progress, and a better driving experience for users.Smart roads that are connected to the Internet of Things (IoT) devices make it possible to drive more efficiently, sustainably, and safely.For this reason, the range of smart road technology like actuators, sensors, and solar power along with software infrastructures like Artificial Intelligence and big data are now made standard in all new roads. This article provides a framework for patients to employ speech-to-text chatbots to conduct treatment. Using chat-box technology, we have implemented cognitive therapy as a solution.

KEYWORDS

smart road, sensor, raspberry pi, connectivity, Arduino

1. INTRODUCTION

The development of the road system is considered to be an important component of contemporary infrastructure since it affects the flow of transportation from one location to another.

Self-driving vehicles, guidance applications, and ride-hailing services are all things that everyone is familiar with. A network of numerous inventions might arise out of the very fabric of the road itself. Road upgrades using communication, lighting, and power distribution technology, which can support sustainability, the safety of travel, and alter the road user's driving experience, are possible. The internet of things (IoT) increases the safety and efficiency of smart roadways. As more and more smart road technologies, such as sensors and solar-system software infrastructures like Artificial Intelligence and big data, are put into roadways, they enable a wide range of smart capabilities. Even while they provide important transportation connections, in many respects the roads themselves symbolize enormous amounts of wasted road space. Due to wireless connection advancements, cloud computing, data analysis, remote sensing, and artificial intelligence, "smart city" initiatives are proliferating around the globe. Transportation is essential in almost all of these proposals, although smart roads are increasing in significance as transportation alternatives. These concerns, among others, may now be addressed thanks to modern technology. IoT is the connection of inanimate things to a network of electronics, software, actuators, sensors, and networking hardware to enable these inanimate objects to act and exchange data. The IoT allows little amounts of data to be distributed throughout a network in which they may be accessed almost anywhere.

DOI: 10.5121/ijcsit.2022.14406

More efficient transportation, using computer-based systems to combine the physical globe, and with this an added benefit of economic and accuracy, is produced. The equipment becomes an order of the universal class of cyber-physical systems when it is outfitted with sensors and actuators, and augmented with connected systems.

To be identified during the embedded computer system, every object is outstandingly recognizable. However, it is also able to inter-operate with the current internet infrastructures. To stay ahead of rapidly changing transportation, public services, conservation, and public safety needs, fast innovation in transportation, public services, conservation, and public safety is required. Due to the rising demand for mobility in cities, demand for public transportation infrastructure has increased, leading to a backlog of projects and an increased risk of vehicle congestion.

2. LITERATURE REVIEW

A city's growth, in addition to helping it be safer, smarter, and greener, depends on effective road infrastructure. To meet the difficulties caused by increasing urbanization, governments in many parts of the world have established initiatives that include smart city technologies, traffic management, intelligent transportation systems, and road safety measures.

Road safety is a combination of measures that reduce the danger of road crashes for cyclists, motorists, pedestrians, vehicle passengers, and public transit passengers. The Internet and other communication technologies allow cities and transportation authorities to give their transportation and services more prominence to help their economies thrive.

Cities may respond to the needs of today by utilizing new monetization methods, a greater role for public-private partnerships, and important Edge technological developments. Cities must invest in ubiquitous edge compute, 5G, road-side units, and intersection technology to get the local advantages of autonomous buses, shuttles, and cars. In 2017, the researchers, known as Chandana *et al*,[1], designed a model that efficiently resolves the challenge of managing traffic in the event of traffic congestion by using IoT devices to regulate traffic as well as to prioritize emergency vehicles. There was a primary focus on controlling traffic congestion using the internet of things (IoT), the system only sends out warnings and is unable to regulate road lights, and would not provide potential routes to drivers. Okorodudu *et al* [2] believe that in developing countries, roads are constructed to enable road users to travel at fast speeds in the same space and time. For traffic system management, effective road planning and design are crucial. According to Okorodudu and Okorodudu [3], the vehicle equipped with motion sensors can provide a continuous electrical path for monitoring traffic volume and the predicted time that traffic will last on a particular route. This information is stored and calculated by a timer and digital calculator for road traffic information. Safety, less use of power, and reduced traffic are the primary objectives. They included these innovative new technologies by employing Light Sensors, Ultrasonic Sensors, Cameras, Motion Sensors, IoT Devices, Interactive Lighting, Solar Roadways, Glow in the Night, and Wind Powered Light Systems [4]. Traffic has emerged as a major concern in India because of the wasteful use of fuel, time, and pollution.

Crowded roads are likened to evil, impulsive times in Indian traffic, and the journey from one location to another is a serious inconvenience that is polluted and noisy. It was all about making sure people's safety was secured, the power used was reduced and the traffic that used to go through the area was avoided. Researchers think that in the early stages of a new mobility era, artificial intelligence, transport, and the smart city all present an opportunity for change with the potential to lead to sustainable transitions [5]. While artificial intelligence (AI) has the capabilities to enable machines to solve problems that could revolutionize the cities we have

identified for decades, this technology can also be utilized as a tool to assist machines in understanding and analyzing complicated problems. One of the major areas that their work focused on was redefining transport, mobility provision, and the impact that this has on inner-city development [5]. While a Transport-as-a-Service (TaaS) transport platform could support smart mobility initiatives for unmanned and manned Personal and Unmanned Aerial Vehicles (PAVs and UAVs), connected and autonomous vehicles (LAVs), and mobility-as-a-service (MaaS), that platform would not control traffic lights or select the available route. According to Vasantha*et al* [6], Intelligent Highways uses a Warning Message and activates Diversions to point out potential locations of vehicle accidents. It is a program of novelty that connects diverse viewpoints on topics, such as industry trends, with ideas related to new technologies and business opportunities in smart ways. Additionally, they focused on the necessity of road safety and how it has become a major concern because of an increase in car accidents, and there are certain locations where crashes are common, like intersections. The intelligent Highway system, W.A.L.T. congestion, and weather-related accidents are among its primary concerns, but there is currently no way to control lighting on the road, and this limits the project's potential. It is important to have reliable infrastructure, as well as a working method and measures in place for smart road maneuvers [7]. Smart Road is similar to a predictable highway in that it's made up of static and dynamic physical entities, but the key distinction is that it has the necessary electronic gadgets to capture both. Traffic safety has turned into a huge concern for those in power, who have mandated its control within available resources. Also observed is that it is not possible to accommodate increased traffic volume on the transportation infrastructure. A study of the Muscat Express Highway's Smart Road Technology for Traffic Management and ITS Infrastructure Assessment focuses on traffic management, but the lighting on the road cannot be controlled [8]. We can monitor traffic using various Internet of Things (IoT) devices. From their perspective, they believe that traffic congestion is a critical issue in Indian cities and throughout the world. Traffic congestion results from an exponential increase in the number of cars due to the significant population growth of the country. It is also because of the infrastructure that already exists and can't be expanded to meet the increasing need for traffic control. In addition, traffic congestion may also influence day-to-day living by polluting the environment, wasting fuel, increasing commuting time, and so on. Intelligent traffic systems are created to track traffic and, to achieve an increase in the movement of people, cars, and cargo, to improve transportation safety, mobility, and efficiency. They note as well that It is capable of identifying various traffic congestion, traffic rule violations, car smart parking space provision, and speed limit exposure as well. It is important to note that employing a wide variety of IoT technologies, such as infrared sensors, video analysis, wireless sensor networks, inductive loop detection, RFID, and many others, provides traffic management (or traffic management systems) with a key function in the Internet of Things (IoT) [9]. Real-time Smart Road Construction: The Internet of Things (IoT) allows for efficient process management and for people's lives to be greatly improved. Soon, the Internet of Things (IoT) will up the ante when it comes to automation [10]. IoT is still in its nascent years, which they admit. But for certain use cases and applications, IoT architectures are still being built. It must be noted, however, that as the number of apps and IoT frameworks grow, the number of interfaces, protocols, and standards rises as well. Interoperability across many systems has become much more challenging as a result. Due to the breakdown of gathered data and real-time communication amongst various players (such as paver, contractor, and transporter), road worth is increased significantly because of the improved maneuverability of the different technological resources.

But even with the use of different protocols and data storage, they're still missing connectivity and interoperability. In this case, their work has allowed for the development of a middleware that enables on-demand transmission, validation, and information sharing in such varied settings. Hamid and Mo did a demonstration and field test in road construction for their middleware and tested and validated it using a use case and a field test in road construction. With the rapid

increase in the world population alongside the preference to live in cities, the city will be faced with a serious challenge. The human requirements cannot be met in traditional cities with their common traits. The overall impact of a smart city is that it draws the attention[11].

In the long run, a smart city/community, where all data is gathered from various locations, and where choices are made to serve the many aspects of the system, would be the ideal form of a city. To be more specific, the smart district is a huge data topic that is made up of many different facets of study, and that must join researchers with various specialties to solve it. Rapid population growth leads to a general lack of efficiency in cities that are already struggling to deal with the growth. With the great capability for accelerating technologies, this problem offers the best opportunities for establishing future opportunities for everyone on the planet. Technological advances lead to dramatic changes, as demonstrated by quantum leaps in society.

While the relationships between a city's population growth and emerging technology are complicated, nevertheless, certain patterns may be identified. The fast industrialization that occurs in today's globe raises several problems for the city administration of the past. To put it another way, we will never be able to handle all of humanity's basic requirements until we grow our cities to a whole new level.

Data collecting, data analysis, computing, networking, and making decisions based on the data flow are all factors of the notion of the "smart city." In today's connected world, one of the major reasons that are contributing to smart cities is the Internet of Things (IoT). Smart cities cannot exist without IoT. Because of the Internet of Things (IoT), we have a new approach to providing infrastructure in which physical equipment is connected to sensors, software, electronics, and connection. They believe smart cities are a new catchword for the Internet of Things (IoT), a proposal to construct a more connected and collaborative society maximized with data. This system that uses Internet of Things (IoT) energy is frequently broken, and as a result, cannot be lowered at all in some situations. The solar-based mechanism is implemented in place of conventional components [12]. Each light on the roadway works for 12 hours per day, i.e. from sunset until dawn the next day. Although roads, cities, and urbanized regions around the country are opting for solar-based highway lights, which are a one-time expenditure, it is nonetheless true that they are becoming more prevalent. Despite solar-based Highway lights being utilized, some kind of energy is always used up whenever lights are necessary because it is not necessary for vehicles to be driving on the highways to use them.

Furthermore, they noticed that although solar power is not available during nighttime hours, lights require electricity only during the night. Light is important at a specific period, but in the other portion of the time, it is completely disrupted. Adjustments should be made to Highway light settings to conserve energy.

Thus, for Highway lights, it is best to install a Lighting System because it is known that the majority of the energy is lost in that manner. Lights on the highway are used mostly at night, although when there are no vehicles on the road, lights can be turned off. The data have been collected and computed on slab rates considering all the variables. And by combining Raspberry Pi with Highway lighting, energy may be conserved. You may use the proximity sensor, LDR, current sensor, relay, and the raspberry pi to manage them. Any vehicle movement that occurs may be detected by utilizing motion sensors and LDR lights can be switched on.

Light functioning may be monitored in real-time using server-client software.

While this is true, they went on to say that there are periods of the day when solar power is not available yet lights require electricity just during nighttime hours. Light can be helpful at a

specific moment, but it is never crucial for the rest of the time. Adjustments should be made to the highway lighting to save energy.

It is often considered a good idea to build a Lighting System just for Highway lighting, as most of the energy is lost that way. At night, when the road is deserted, these highway lights are essential. The data have been collected and computed on slab rates considering all the variables. And by combining Raspberry Pi with Highway lighting, energy may be conserved. You may use the proximity sensor, LDR, current sensor, relay, and the raspberry pi to manage them. Any vehicle movement that occurs may be detected by utilizing motion sensors and LDR lights can be switched on.
Light functioning may be monitored in real-time using server-client software.

3. SYSTEM DESIGN AND IMPLEMENTATION

3.1. Objectives of the Design

The developed solution is an IoT-based Smart Road System. These design objectives include the following:

i. To develop a system that will raise road users' awareness of traffic hazards; and
ii. The purpose of this technology is to control the lights on the road automatically.
iii. To offer a system that warns road users of pollution, fire disaster, and road danger in the same system to ensure road users' safety.
iv. To provide a system that could automatically set fires and irrigate crops on the side of the road

Figure 1. Main Menu

3.2. System Specification

A full explanation of the system's behavior is a requirement for the system. It consists of a collection of scenarios describing the many ways in which the end users would engage with the program. It outlines the system's characteristics. To design that satisfies the needs of the user requirement, the system blueprint must be strictly followed see figure 1 above.

3.3. Hardware Specification

Blynk Database is the database management system that's being utilized for the website. Tables were created using the database. ADO.Net enabled complete database access via ADO.NET connections. The records were queried and updated using SQL commands.

4. DESIGN REQUIREMENT ANALYSIS

The Software used for the development of this project is:

i. An Operating System (Windows 10 Operating System)
ii. Arduino IDE
iii. Blynk Application

Hardware requirementsare;

A Pentium iv system with the following configurations

i. 1.2GHz of processor speed and above
ii. 80 gigabytes of hard disk
iii. 512 megabytes of Ram and above
iv. 1024 * 768 screen resolution

4.1. Component Specification

For the design of this system the following components were used:

i. NodeMCU
ii. Relay Module
iii. Jumper Wire
iv. Breadboard
v. Water Pump

4.2. Features & Specifications

1. Operating Voltage: 2.5 ~ 6V
2. Operating Current: 130 ~ 220mA
3. Flow Rate: 80 ~ 120 L/H
4. Maximum Lift: 40 ~ 110 mm
5. Outlet Outside Diameter: 7.5 mm
6. Outlet Inside Diameter: 5 mm

i. Battery
ii. Proximity Sensor
iii. Fire/ Flame Sensor

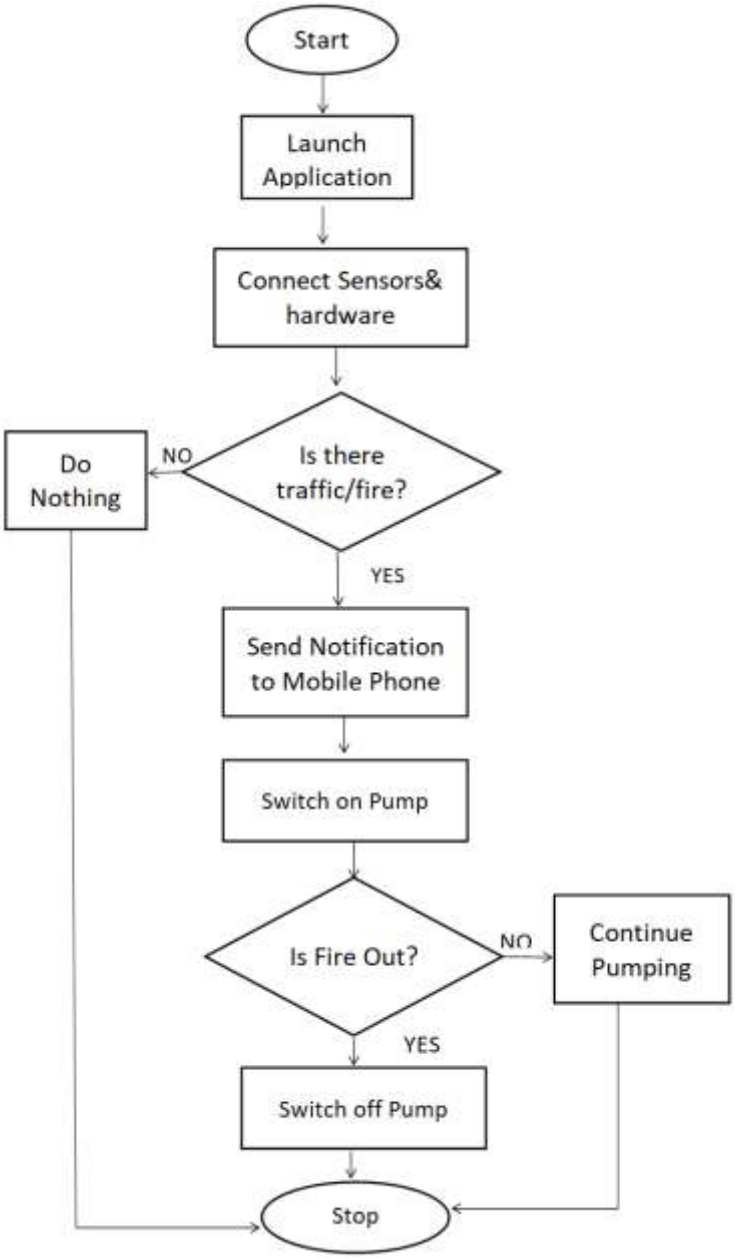

Figure 2. System Flowchart

4.3. Physical Structure of the Designed System

The image below shows the physical view of the designed system.

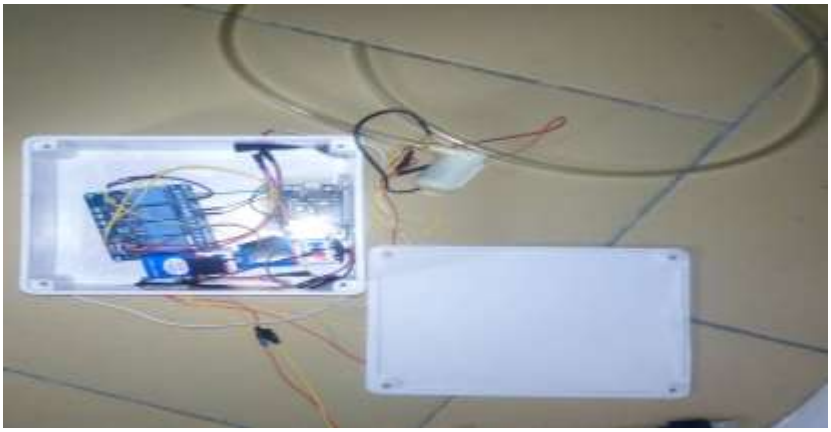

Figure 3. Physical Structure of the Designed System

5. SYSTEM IMPLEMENTATION

Figures 2 and 3 above depict the working relationship of the system and the implementation style which lead to the requirement needed to function effectively.

Hardware and Software Requirements

For the software to be implemented on a website, the following are required:

Hardware Requirement

A Pentium iv system with the following configurations

i. processor speed of 1.2GHz and above
ii. 80 gigabytes of hard disk
iii. Ram of 512 megabytes and above
iv. 1024 * 768 screen resolution

Software Requirement

i. An Operating System (Windows 10 Operating System)
ii. Arduino IDE (Front end)
iii. Blynk (back end)

6. RESULTS, DISCUSSION, AND OUTPUT

This new system has been rigorously tested and the results tally with expectations; concerningthe quality of service, decreased cost is achieved. Also, this approach is self-paced, learner-centered, and dispersed, as it was able to accommodate time and mobility needs while using the wireless infrastructure. Because of this, users of the program may get access to and utilize the system regardless of whether or not they own a computer. Also addressed was the overall system's flexibility, which allowed for other areas of knowledge to be included in the system.

The system has achieved a novelty by integrating multiply IoT functions in one unit, resulting in a robust system that raises road users' awareness of traffic hazards; controls the lights on the road automatically; warns road users of pollution, fire disaster, and road danger to ensure road users' safety; and could automatically set fires and irrigate crops on the side of the road.

Figure 4. Output Design

7. EVALUATION BASED ON THE SOLUTION SELECTION MATRIX

Using the Solution Selection Matrix, in which solutionsare evaluated based on these 4 criteria: Sigma Impact, Time Impact, Cost Impact, and Other Impact. The table below shows the summary of our survey using the criterium above:

Table 1

Solutions / **Criteria**	**IoT-Based Intelligent Road System**	**A Smart Traffic Management System For Congestion Control And Warnings Using Internet Of Things (IoT) By Chandana *Et Al***	**A Novel Approach To Road Traffic Monitoring And Control System By Okorodudu & Okorodudu**	**Smart Roads Using IoT Devices By M. Aftab And A. Chetna**	**A Review For Traffic Management System Using Different IoT Devices By N.Snehal And P. Shruti,**
Sigma Impact (overall output achievement)	The system raise road users' awareness of traffic hazards, control the lights on the road automatically; warns road users of pollution, fire disaster, and road danger to ensure road users' safety, and could automatically set fires and irrigate crops on the side of the road	Controlling traffic congestion (system only sends out warnings and is unable to regulate road lights, and would not provide potential routes to drivers).	the vehicle equipped with motion sensors can provide a continuous electrical path for monitoring traffic volume and the predicted time that traffic will last on a particular route	Viewed innovative new technologies that canemploy Light Sensors, Ultrasonic Sensors, Cameras, Motion Sensors, IoT Devices, Interactive Lighting, Solar Roadways, Glow in the Night, and Wind Powered Light Systems	focuses on traffic management, but the lighting on the road cannot be controlled
Time Impact	Implementation time is short.	Implementation time is short.	Implementation time is short.	Can't be calculated as there is no implementable design	Implementation time is short.
Cost Impact	Cost-effective since IoT equipment is cheap and low-power drive.	Cost-effective since IoT equipment is cheap and low-power drive.	Cost-effective since IoT equipment is cheap and low-power drive.	Cost-effective since IoT equipment is cheap and low-power drive.	Cost-effective since IoT equipment is cheap and low-power drive.
Other Impact	It has a low-risk factor and portable and higher customers satisfaction	It has a low-risk factor and portable and high customers satisfaction	It has a low-risk factor and portable and high customers satisfaction	Not applicable	It has a low-risk factor and portable and high customers satisfaction

8. CONCLUSION AND RECOMMENDATION

Smart Roads can be considered an element that guarantees efficient cooperation between infrastructures, users, and vehicles, improving all the related performances while sharing data information. The action of these infrastructures is robustly related to automation and centralization, moving the concerned players on a micro-plane (drivers) and a macro-plane (fleet) see figure 4 above. Smart Roads are fundamental in the development of an intelligent ecosystem that will guarantee optimal automation processes, in symbiosis with two other essential principles/technologies: IoT (Internet of Things) and IoE (Internet of Everything): the first represents the capability of sharing data between devices; the second introduces the possibility to create new scenarios, starting from casual data collected after user behavior, tailoring the overall experience to fit specific interventions This system is highly recommended for use by roads users to enable individuals to get information of traffics and other hazards on the road. This study's primary subject was Smart Roads; this research work has brought up further fundamental aspects that will characterize the future of mobility across heterogeneous disciplines in the transport sector. To achieve an improved research management level, it's necessary to schedule and establish a precise distribution scheme.

A Smart Mobility context will have to be implemented to allow more comfortable and efficient traffic management; in fact, the implementation of the devices mentioned above has already begun, considering that in 2017 there were 8.4 billion IoT operating devices This system can be made smarter by improving the interface as while as other featuressuch as live footage and map direction.

ACKNOWLEDGMENTS

The authors would like to thank everyone, just everyone!

.

REFERENCES

[1] K.Chandana, S.Meenakshi,D's.Cyana,N. Meghana andK.Navya, "A Smart Traffic Management System for Congestion Control and Warnings Using Internet of Things (IoT),"*Saudi Journal of Engineering and Technology*, Scholars,Vol-2, no 5, pp 192-196, May 2017.

[2] F. O.Okorodudu, P. O. Okorodudu, and L. O**.** Atumah,**"**A Novel Approach to Road Traffic Monitoring and Control System,"*International Journal of Multidisciplinary Science and Engineering*, vol. 9, no 1, Pp. 29-33,January 2018.

[3] F. O. Okorodudu and P. O.Okorodudu, "A New Approach to Automation and Monitoring in Road Traffic System". *In Proceedings of the 27th International Conference of the NigerianComputer Society on Digital Inclusion,* Ibadan 2018.

[4] M. Aftab and A. Chetna,"Smart Roads Using IOT Devices,"*International Research Journal of Engineering and Technology,*Vol-5, no 6, pp 1526-1529,June 2018. http://www.irjet.net/,p-ISSN: 2395-0072

[5] N. Alexandros, M. Kalliopi, T.Eric and K. Dimitris,"Artificial Intelligence, Transport, and the Smart City: Definitions and Dimensions of a New Mobility Era,"*sustainability Journal*, Sustainability Vol-12, no 7, pp 1-19,April 2020. doi:10.3390/su12072789, (Online) http://www.mdpi.com/journal/sustainability, sustainability-12-02789-v2.pdf, Pp 1-19.

[6] G. Vasantha, B. Pavithra, A.Poornima, G. Sriharisudheer, G. Sreenivasulu, and R.Rajagopal, "IOT Based Smart Roads Intelligent Highways With Warning Message And Diversions According To Climate Conditions," National Conference on Emerging Trends in Information, Management and Engineering Sciences (NC'e-TIMES#1.0) – 2018, ISSN: 2395-1303, Microsoft Word - NCETIMES19 (Online) http://www.ijetjournal.org/

[7] S.Zamzam and R. Srinivasa,"Smart Road Technology for Traffic Management and ITS Infrastructure Assessment: A Case Study of Muscat Express Highway,"*International Journal of Advanced*

Engineering, Management and Science (IJAEMS), Vol-3, no 5,pp 576 – 583, May 2017. ISSN: 2454-1311 https://dx.doi.org/10.24001/ijaems.3.5.28 (Online) http://www.ijaems.com/

[8] N.Snehal and P. Shruti,"A Review for Traffic Management System Using Different IoT Devices,"*International Journal of Scientific Engineering and Science*,Vol 3, no 11, pp. 1-4, November 2019.ISSN (Online) : 2456-7361, http://ijses.com/,

[9] S.Muddsair, M. Siegfried, D. Wim-Van and H. Peter,"Towards Real-time Smart Road Construction: Efficient Process Management through the Implementation of Internet of Things,"2017.https://www.researchgate.net/publication/318726906

[10] F. Hamid, and J. Mo "A Brief Survey on Smart Community and Smart Transportation," *In Proceedings of the IEEE 30th International Conference on Tools with Artificial Intelligence (ICTAI),*Greece 2018.

[11] A.Santhosh,P. SarathandD. Sudha,"A Smart Highway Lighting System Using IOT,"*International Journal of Scientific & Technology Research* Vol-8, no 12,pp 1968- 1977, December 2019. ISSN 2277-8616,(Online):http://www.ijstr.org/

[12] P. Dietmar,F. Möller, A. Fidencio, E. Cota, I.A. JehleandH. Vakilzadian "Cyber-Physical Smart Traffic Light System", *In Proceedings of the 2015 IEEE International Conference on Electro/Information Technology (EIT)*, USA 2015.