A FEASIBILITY SOLUTION FOR INTELLIGENT TRAFFIC MANAGEMENT AND ROAD SAFETY SYSTEM BY INTERNET OF THINGS (IOT) ENABLED 5G TECHNOLOGY

Abstract

As per the growing of population and introducing of modern vehicles in the automobile industry and also utility of vehicles making high traffic, pollution, in-convenience to traffic control the city people that cause vehicle accidents as well as health problems. It is an essential and responsibility to control and management heavy traffic. In our proposal an intelligent system to control the traffic and provide facility for the city to control heavy traffic causing heavy pollution. In this proposed paper we are introducing a real-time an architectural design of a framework that supposed to control traffic in the city by applying Internet of Things (IoT), 5G and Artificial Intelligence technologies. IoT is a next generation of Internet to sense, connect and communicate real world objects with sensors devices, actuators, network, protocols to generate real-time data via Internet. The Application layer protocols of IoT MQTT protocol managing vehicle data over the Cloud. 5G is next generation of mobile communications by e MBB (Enhanced Mobile Broadband), Latency Communication), m MTC (stands for massive Machine Type Communication) u RLLC(Ultra Reliability and Low Latency Communication) for better communication and automation of vehicle control in the City. The Artificial Intelligence (AI) used for better prediction and data analysis. AI with Robotics for patrolling the city for tracking the information in a city. Nature Inspired Computing Algorithms like Ant Colony Optimization (ACO) are to optimize shortest distance to route for better connectivity of road paths for vehicles moving around the City. Our aim is to build an Architecture Design Framework in an efficient

Authors

Dr. Subrahmanyam Voore
Associate Professor
Department of CSE
Anurag University
Hyderabad (Telangana State)
subrahmanyam.voore@gmail.com

N. Santosh Ramchander
Associate Professor
Department of CSE
Sreyas Institute of Engg.& Tech
Hyderabad (Telangana State)
nsramchander@gmail.com

Mahesh Kumar Thota
Assistant Professor
Department of IT
Kakatiya Institute of Tech
Warangal(Telangana State)
tmk_it@kits.ac.in

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way to control traffic, accidents and health system. Our Intelligent Transport System is introduced a technology features of Vehicle-To-Vehicle(V2V) communication, Autonomous Driving Vehicles, Road Safety Measure, IoT Protocols with Cloud, Navigation System and AI Drones(UAV) Robots.

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I. INTRODUCTION

Day-by-Day increasing of large amount of vehicle traffic will be complicated in the city transportation. It will cause congestion, fuel costs, pollution, vehicle collisions and mainly loss of time. IoT technology is one of the best solution to manage traffic control efficiently because IoT having features of sensing, monitoring, connectivity, identity for involving for efficient traffic management in the city. By introducing Internet of Things(IoT), 5G mobile communication, Artificial Intelligence and NIC(Nature Inspired Computing) algorithms are to manage and control effectively the Transport system to make an Intelligent Transportation System(ITS) in the City. ITS should improve the traffic efficiently and eradicate frequently occurs accidents. ITS system integrate with various heterogeneous devices such vehicles, road-side-units(RSU), traffic lights, CC cameras, Access Points, Wireless Sensor networks, digital cameras, Drones Robotics[1,2]

In our proposed system Internet of Things(IoT) is connecting various vehicles via cloud with effective monitoring to control traffic control to reduce the congestion of the road to minimize accidents. Internet of Things is an enable technology to connectivity real objects via Internet. IoT technology based sensor devices to collect real-time information about traffic. Internet of Things(IoT) integrate with 5G technologies eMBB, uRLLC, mMTC to effectively manage traffic data and integrate with Cloud for better communication and control the traffic. The AI with Drone Robotics can patrolling the city to collect the traffic data and capturing the photos and videos for involving to control the traffic in an efficient way[3.4.5]

II. OBJECTIVES

The following objectives taken to consider for Smart Transport Management System as follows…

1. **Architecture Design:** We are proposing an Architectural Layered approach that supposed to our Planning & Vision to control traffic in the city for Smart Traffic Management and Road Safety System. An architectural design of a framework that supposed to control traffic, public health, road connectivity in the city by applying Internet of Things(IoT), 5G and Artificial Intelligence technologies to make smart transport management system in the City.

2. **Wide Roads & Radium Path Lines and Sensor Devices:** The main traffic problems arise in the City due to heavy traffic and congested roads. To control traffic effectively it is advisable to widen the roads. It is essential marking the path marked lines with radium affects for two wheelers, four wheelers and heavy vehicles. Especially in the nights the accidents are frequently happening. The CCTV Cameras to put wherever necessary to monitor &manage these vehicles properly driving in their allotted marked lines on the highway road.

3. **Iot Based Light Weight, Low Cost Helmets:** In our proposed system we are planning to design IoT based light weight, low cost helmets for two-wheelers to avoid accidents and their valuable lives. The proposed design of IoT based Helmets are providing signals and beep sounds for every 2 minutes to the two wheelers while crossing speed limits in the

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City roads to minimize accidents and maximize smart traffic management system to improve road safety.

4. **Iot Based Light Weight, Low Cost Stick For Blind People:** The pedestrians are facing many problems while crossing the roads at high traffic roads. The pedestrians are waiting huge time while crossing these roads because heavy traffic. It is advisable to provide underground tunnel / special platform to crossing these traffic roads. The main problem for blind people facing problem while crossing these roads. In our proposed system we design a IoT based Light weight, Low cost Stick for Blind people utilize this IoT based blind stick to safe cross the heavy traffic roads without fear and hesitation. We design IoT based blind stick with Ultra Sonic sensor and Arduino Uno with IDE program to monitor any object and gives beep sound(as a signal to blind persons) to avoid these objects to take right decision to crossing these roads safely. This is one of the method that includes to find road safety of traffic management system.

5. **CCTV cameras for Pedestrians while crossing highway roads by underground tunnel/Platform:** Traffic management and road safety system basic idea is not to find any accidents in the road. The pedestrians are facing highly problem while crossing the highway roads. It takes time consuming and waiting their time. It is an essential to provide an underground tunnel / a platform to cross roads. IoT based sensor devices and servers 24/7 continuously watch by centralized management traffic system to analyze and take decisions.

6. **Internet of Things(IoT) enabled Traffic Control:** The Internet of Things(IoT) with its ubiquitous nature enabled with 5G and AI to control traffic, control health issues, avoid accidents in the traffic management system in the city. The Internet of Things(IoT) based sensor devices to sense, monitor, access the real-time data and send to the cloud for store & process the data. The end user can verify the real-time data to take precautionary to control traffic in urban.

7. **5G enabled augmented reality (AR) and virtual reality (VR):** 5G will reduce latency, expand data pools, enable billions of IoT devices to communicate with each other, and support augmented reality (AR) and virtual reality (VR) functions for safety systems in transportation.

8. **Connectivity:** Internet of Things(IoT) enabled sensor devices sense and manage Vehicle-2-Everything (V2E) connectivity is about connecting vehicles (V2V), people (V2P), and infrastructure (V2I) [6,7,8]

9. **MQTT protocol with 5G-eMBB:** The IoT device i.e. Ultra Sonic sensor monitor the distance between vehicles while driving in the city. If these vehicles extend the distance above the 2 meters automatically the buzzer send a beep sound to alert the vehicle to safe drive in City. The Ultra sonic sensor(publisher) send a notification to the MQTT (message queuing telemetry transport) protocol (Broker) resides in the cloud. The alert messages send to the end-users(subscribers) to become alert to control accidents. The autonomous cars moving high speed with 5G. The uRLLC manage low latency to stop the cars suddenly to avoid accidents.

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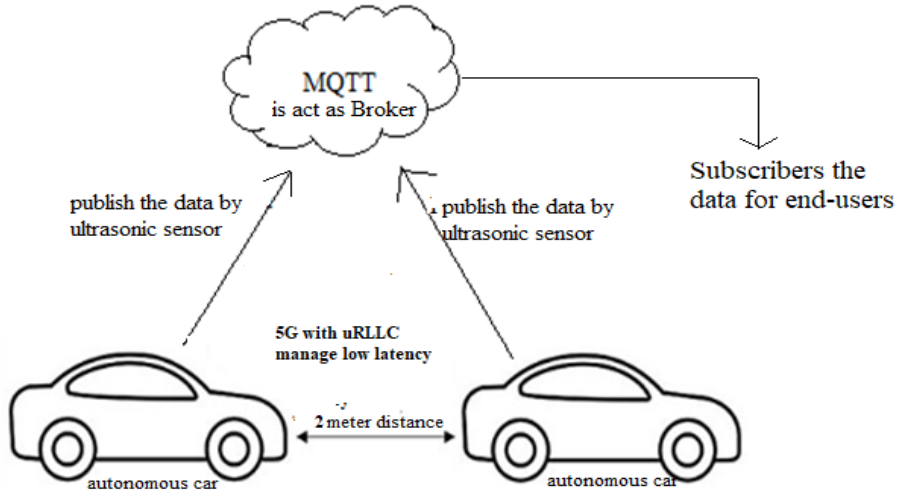

Figure 1: MQTT for Publish and Subscribe for Real-Time Transport data towards Cloud

10. **AI with Robotic Drones for patrolling the City:** To control traffic management and road safety in the City, the AI with Robotic Drones are patrolling day and night for tracking the information and to control traffic in a city. The Robotic Drones to monitor the traffic while patrolling in the City premises and it collects the photos and videos to share these to end users for better management of the transport system.

11. **Energy Conservation by IoT:** In the traffic management system, the electric appliances like street lights, LED bulbs are deployed either sides of the traffic roads to provide light whole night. The Street lights(SL) and electronic advertisement boards are consumes a high energy. IoT application these SL are automatically turn them ON/OFF whole night until early morning. When human or vehicle movement detected on the road than only street lights and LED bulbs are ON/OFF to minimize energy consumption. Our proposed model minimizes energy consumption by combination of various cut-edge technologies like IoT, 5G, AI and Cloud computing. These IoT based real-time controller are communicate with streetlights and other electric appliances to gather data from concerned sensor devices and send via 5G mobile communication channel to the cloud computing for further store the data and processing the data. The sensor devices detect motion as well as AI to make decisions to follow instructions. The control management will receive an alert signal when any problem arises of these street electric devices an appropriate action will be taken to consider.

12. **Road Side Units(RSU):** IoT based IR sensor devices providing services like traffic light optimization to improve traffic flow, real-time road condition updates, or even data-sharing among cars in close proximity to cut down on traffic accidents.

13. **Route Optimization by ACO:** Nature Inspired Computing Algorithms like Ant Colony Optimization(ACO) are to optimize shortest distance to route for better connectivity of road paths for vehicles moving around the City. ACO algorithm to avoid congestion routes to select traffic free routes to reach destination with shortest distance to minimize time, maximize energy efficiency of vehicles.

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14. **Health monitor & control by IoT:** The control pollution in road transport is an essential to manage. Internet of Things(IoT) based sensor devices monitor the various health contaminated gaseous(Carbon monoxide, CO_2, and Nitrous oxide etc.) released by vehicles in the city. According to that we can take precautionary methods to control health issues by contaminated various gases released by vehicles and controlling methods. In our proposed research, will provide LCD screen to display pollution status at signals.

15. **Road Side Tree Plantation:** Roadside tree planting can make significant improvements to the quality of roads and the environment and can protect key natural resources. Tree planting include better soil formation by shedding dead leaves, increased water quality by reducing sediment flow, reduced erosion, road beautification, flood control as the trees slow and absorb road runoff, wind breaking, providing important pollinator habitats, improving peoples' health, and protecting crops. Roadside tree planting like reducing the air pollution levels in the country.

III. EXPECTED INPUT AND OUTCOME OF THE PROPOSAL

Day-by-Day increasing of large amount of vehicle traffic will be complicated in the city transportation. It will cause congestion, fuel costs, pollution, vehicle collisions and mainly loss of time. IoT technology is one of the best solution to manage traffic control efficiently because IoT having features of sensing, monitoring, connectivity, identity for involving for efficient traffic management in the city. By introducing Internet of Things(IoT), 5G mobile communication, Artificial Intelligence and NIC(Nature Inspired Computing) algorithms are to manage and control effectively the Transport system to make an Intelligent Transportation System(ITS) in the City. Intelligent Traffic Management System(ITS) should improve the traffic efficiently and eradicate frequently occurs accidents. ITS system integrate with various heterogeneous devices such vehicles, road-side-units(RSU), traffic lights, CC cameras, Access Points, Wireless Sensor networks, digital cameras, Drones Robotics.

To save ecology of the nature, now it is an essential to take precautionary methods to solve these air pollution, traffic management and road safety problems in the City. Every citizen should feel responsibility to co-operate and follow the rules of RTO to minimize accidents. It is an essential to control traffic, road safety, control pollution to make City clean, safe and green by Smart Traffic Management System.

In this proposal, we are taking for consideration of finding problem solving Fatal Road Accidents, Road Health to make Smart Traffic Management in the City. We are proposing an Architectural Design is a Framework that supposed to control traffic in the city. In our proposal we are taking inputs and gather various modules in every layer that are related to traffic management system. In our proposed methodology also consider popular technologies like Internet of Things(IoT), 5G and Artificial Intelligence to make Intelligent Traffic Management and Road Safety System.

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IV. PROPOSED MODEL

The proposed planning is to design an Architectural Model is a layered architecture with a specified components in every layer to consider our Vision and Problem solving to find a reliable solution for implementation for Traffic Management Problems in the city to control traffic and pollution.

The proposed planning is to design an Architectural Model a reliable solution for implementation and solving Traffic Management Problems in the city to control traffic and pollution. As per day-by-day newly Information technologies are introducing to provide a perfect solutions solving the problems systems, network, automobile and other communication problems are solving by Internet of Things(IoT), 5G Mobile Communications and Artificial Intelligence technologies. To consideration of these technologies we proposed an architectural design for well management traffic in a urban (city) areas. The proposed system is Traffic Management System and Road Safety that solving the problems of …

- Fatal Road Accidents,
- Road Health,
- Smart Traffic Management.

1. **Fatal Road Accidents:** The road accidents will be happen now-a-days frequently because of reasons increasing vehicles, negligence driving, over ride vehicles, not proper maintain RTO roles, drunken and drive etc. are cause accidents every day. It will be not possible to control the accidents when the vehicles driving by Vehicle-with-human. To control the accidents on road will be 100% sure Vehicle-with-IoT/5G/AI/Cloud technologies i.e. machine-to-machine communication, drive by avoiding particles/objects on the road is minimize accidents, minimize fuel cost, minimize time, minimize energy consumption, maximize energy efficiency.

   Autonomous driving technology promises great benefits to the future of transportation - not only freeing us from the tedious task of driving to focus on our work, leisure time or rest, it but also eliminating human error or recklessness and improving reaction times, increasing the efficiency of traffic flow and decreasing the rates of accidents on our roads and making these services cheaper and more widely available where manpower is limited.

   The Architecture of Design introducing related components of every layer is to built high communicated, accidental less and more convenient to management of traffic system in crowd areas in the city.

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V. PROPOSED ARCHITECTURE LAYERED DESIGN FOR TRAFFIC MANAGEMENT AND ROAD SAFETY

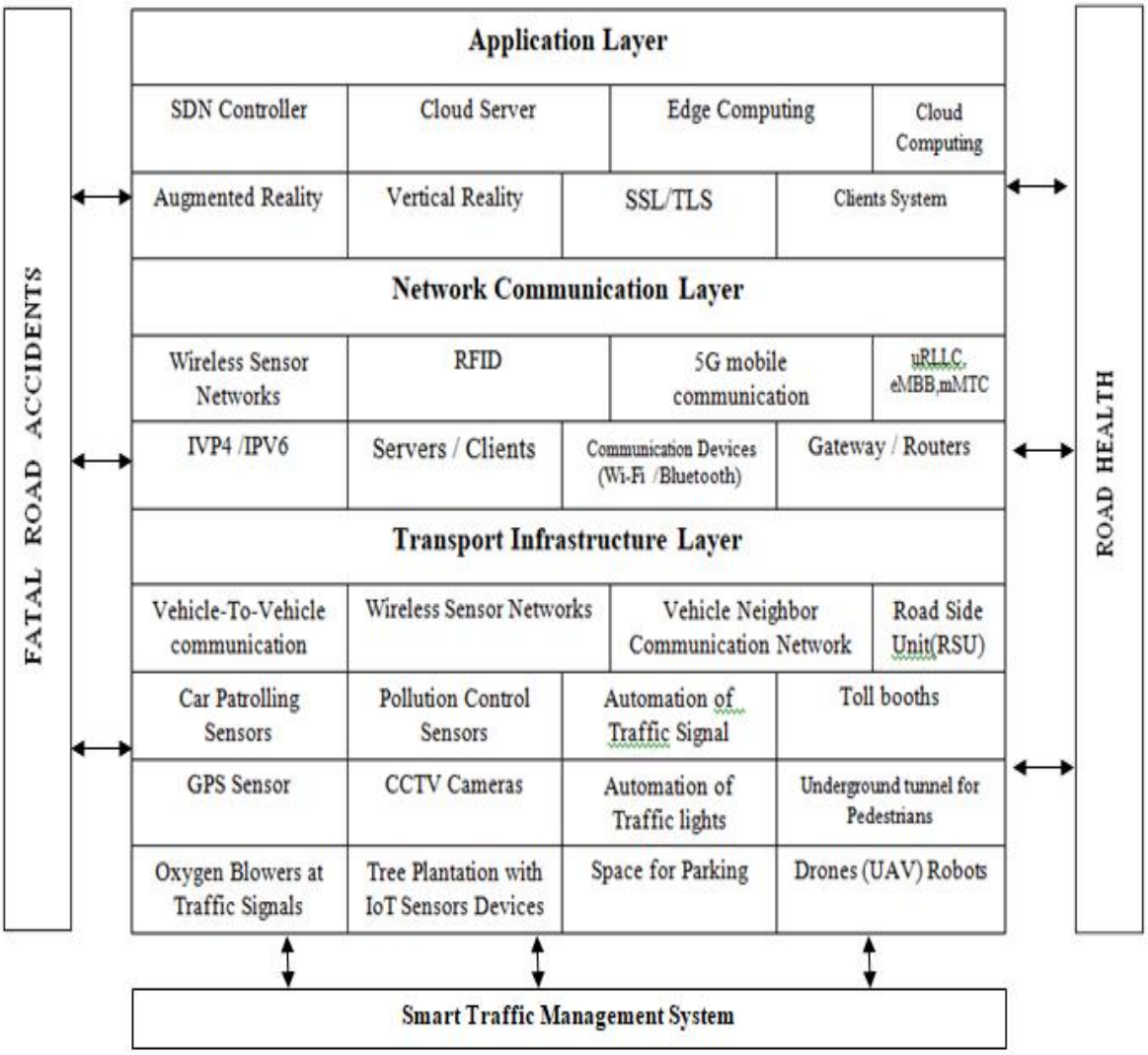

Figure 2: Architecture Layered Design for Traffic Management and Road Safety

IoT plays very vital role in the functioning of self driving cars. IoT can connect all types of device to the Internet to share information and use added-value. Autonomous vehicles are thus connected to share information from the on-board sensors, as well as from smart phones of pedestrians and cyclists, traffic sensors, parking detectors, etc. The Internet of Things (IoT) refers to the connectivity of multiple devices through the Internet.

Driverless cars utilize this connectivity when updating their algorithms based on user data. These autonomous vehicles require an enormous quantity of data collecting and processing. In this case, through IoT, the driverless car shares information about the road (which has already been mapped out). This information includes the actual path, traffic, and how to navigate around any obstacles. All the data of surrounding from sensors will shared on cloud and car will function analyzing this data.

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The IoT connectivity processes the feedback from these radar lasers, plots a path, and sends instructions to the car's controls (steering, acceleration, and braking). Each car is also equipped with obstacle avoidance and predictive modeling that conduct the vehicle to obey traffic rules and steer around certain obstacles.

5G is mobile communication technology having technologies include uRLLC, eMBB, mMTC. Daily demand for data and nonstop applications utilization, data flow and processing are always a challenge for the telecom industry and future network design. These same issues are now carrying over to the automotive industry where 5G is expected to boost services and safety features on next generation vehicles[9,10].

All vehicles will need to be connected both to each other and to roadside systems (such as traffic light systems, mapping and traffic monitoring / management systems, emergency services or road maintenance services). These connections need to be in real-time with ultra-low latency and ultra high reliability - and a new category of 5G service: URLLC (Ultra-Reliable and Low Latency Communications) promises to deliver this. It is important for telecom engineers to understand the purpose of ultra-reliable and low latency communications (uRLLC), as latency is defined as the time or delay the signal takes to transport from point to point.

URLLC can empower several technological transformations in the transportation industry, including automated driving, road safety and traffic efficiency services. These transformations will get cars fully connected such that they can react to increasingly complex road situations by cooperating with others rather than relying on their local information. These trends will require information to be disseminated among vehicles reliably within extremely short time duration. In fully automated driving with no human intervention, vehicles can benefit by the information received from roadside infrastructure or other vehicles. The typical use cases of this application are automated overtake, cooperative collision avoidance and high-density platooning, which require stricter end-to-end latencies and high reliabilities. For Ex: 5G is a high speed Internet for mobile communication. Its having features of high latency. When autonomous car is moving on the road with high speed, while at a sudden an object is across the road automatically the autonomous car will be sudden stop within seconds. The is latency is a feature providing by 5G with URLLC. MQTT is a message-centric wire protocol designed for Machine-to-Machine (M2M) communications that provides lightweight, simple implementation, open standard, reliability, and efficiency with regards to processor, memory, and network resources. The publish-subscribe communication model is used to transfer the telemetry-data in the messages format from publisher (device), along restricted environments and unreliable networks, to brokers across TCP/IP.

MQTT is a message-centric wire protocol designed for Machine-to-Machine (M2M) communications that provides lightweight, simple implementation, open standard, reliability, and efficiency with regards to processor, memory, and network resources. The publish-subscribe communication model is used to transfer the telemetry-data in the messages format from publisher (device), along restricted environments and unreliable networks, to brokers across TCP/IP. Recently, the two main versions of MQTT are mentioned as follows: (i) MQTT version 3.1 has been developed to transmit data over Transmission Control Protocol/Internet Protocol (TCP/IP) and it is defined as the basic transport and network

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service and (ii) MQTT-SN which has been developed for transmitting data through User Datagram Protocol (UDP) over low-bandwidth wireless communication networks. MQTT has defined three QoS levels for data delivery. QoS level 0, a message is sent only once, which means that the message can be lost, and there is no guarantee that the message will arrive to the destination. In the QoS level 1, a message is sent at least once, and it will be retransmitted until a broker receives acknowledgement from subscriber by using PUBACK. As a result, a subscriber could receive message multiple times due to the message retransmission. In the QoS level 2, a message is sent exactly once by using a four-way handshake which guarantees that the message will not be lost QoS 1 is the default mode of data transfer. The several MQTT broker products have been used in a worldwide not only industries but also academic research[9]

MQTT is a lightweight protocol ideal for "things" with limited RAM and CPU. It provides basic pub/sub semantics, with persistent and non-persistent Quality of Service (QoS) delivery options, making it a great fit for simple devices. The key features of MQTT offers a Quality of Services(QoS). The QoS levels by MQTT are. QoS 0 i.e. Fire and forget (no guarantee) Whether message we publish there is no guarantee of delivery. QoS 1 i.e. Deliver at least once, the publisher message deliver to subscriber at least once. QoS3 i.e. Deliver exactly once The publish message will be delivered exactly once to the subscribers. We use Ultra Sonic Sensor to see the performance of a Autonomous car. We get real-time data and we can monitor in a dashboard. Now we will publish sensor data to Broker. Autonomous car and client device both are clients whereas Broker is a server. We can read the data send by Smart car. The Publish/Subscribe happened by TCP/IP. To ensure QoS the car (client) ping to Broker(server). The Secure MQTT is an extension of MQTT which uses encryption based on lightweight attribute based on encryption. The road data will be encrypted and un-authorized users and intruders will be able to modify it. By SMQTT the data will be more secure and maintain QoS.

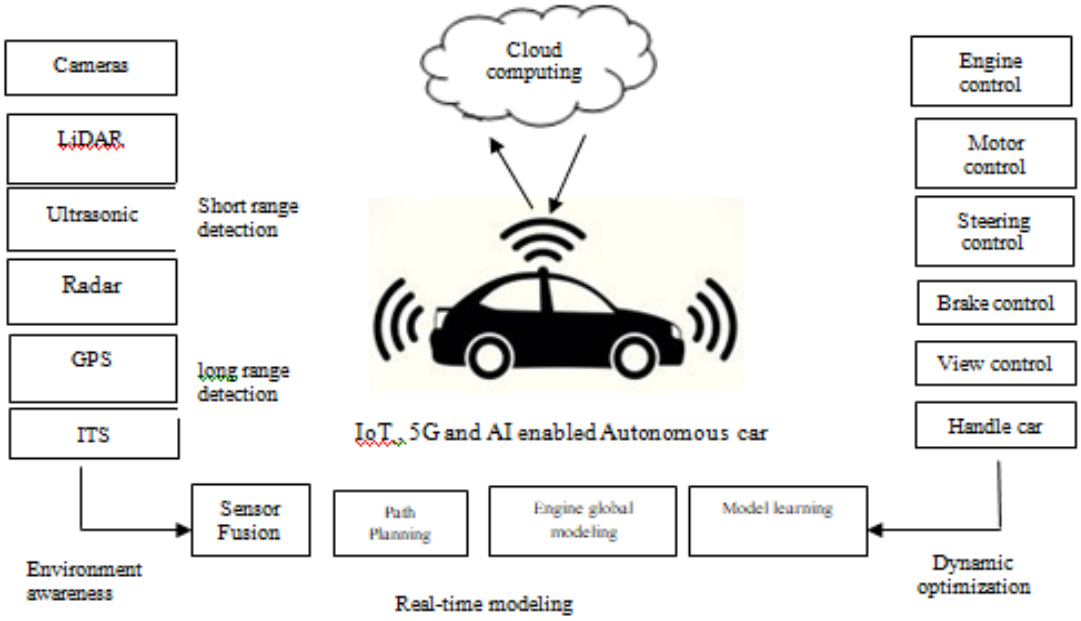

Figure 3: Energy efficient IoT , 5G and AI enabled Autonomous car

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2. **Road Health:** The 5G IoT reaches new dimensions in all aspects where 5G connects more IoT devices at higher speeds and makes things slow things non-existent. A world where accidents are minimal, would be a great world to live in. 5G IoT applications can enable the sharing of real-time information about traffic and road conditions among cars and other road users. Such smart mobility and driver assistance services require 5G communication devices in vehicles, with pedestrians, etc and roadside sensors infrastructure. By collecting and analysing real-time traffic data from the roadside infrastructure and the vehicles on the road, such Intelligent Transportation Systems would be able to timely warn drivers about hazardous road conditions, traffic blocks and safety compromising situations. As a result road safety and traffic efficiency will increase.

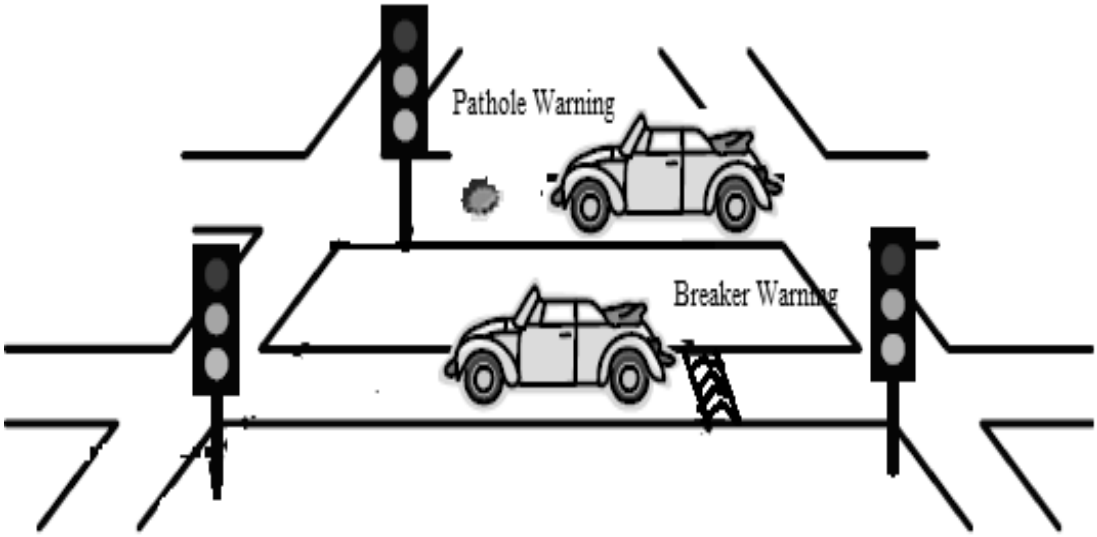

Figure 4: Road safety signal for Pothole warning, Road Breaker Warning by AI

There is a need for **remote patient monitoring** and communications with devices measuring vital signs such as ECG, pulse, blood glucose, blood pressure and temperature. The remote treatment and response based on monitored data can be life critical for a patient, requiring immediate, automatic or semi-automatic response.

The URLLC features are used for… remote surgical consultations and remote surgery. Remote surgery is about applications in a mobile scenario in ambulances, disaster situations and remote areas requiring providing precise control and feedback communication mechanisms for surgeons in terms of low latency, high reliability and tight security. In a remote surgery scenario, the entire treatment procedure of patients is executed by a surgeon at a remote site, where hands are replaced by robotic arms. In these two cases, the communication networks should be able to support the timely and reliable delivery of audio and video streaming.

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3. **Smart Traffic Management:** Our idea of approach implementations for the solution as follows...

   - **Smart Parking:** Implementation of Smart Parking by IoT to enabling real-time parking availability reduces congestion and enhance public parking resources.

   - **Automation of Traffic System:** Automation of traffic system by CCTV cameras to monitor and changing traffic lights as per the quantity of vehicles to control traffic properly without congestion [11]

   - **Automation of streetlights:** Automation of smart streetlights and electronic advertisement boards switched ON/OFF using LDR sensor and Ardiono UNO
     - As light intensity in the environment as per Day & Night
     - As per vehicle vibration on the road. Our experiment used to save energy consumption and better energy utilization.

4. **Robotic Drones are Patrolling in the City at day & night:** AI with Robotic Drones are patrolling day and night for tracking the information and to control traffic in a city.

5. **Optimization of Energy for Street lights and LED Bulbs in Traffic Management and Road Safety:** Energy optimization in city in an issue deployed a more number of inter-connected, communication devices are autonomous for continue operation lights in whole nights which consumes a high energy. In this proposal energy saving concept by Internet of Things (IoT), 5G, and cloud computing to make city as energy efficient traffic system and road safety model in a city. In this proposal to optimize energy consumption in smart cities like street lighting, LED bulbs, smart electric advertisement boards etc. A lot of energy has been consumed by devices of city road transport system in a city. We aim to energy optimization for efficient usage of these energy resources.

   The Street lights and electronic advertisement boards are consumes a high energy. These are automatically turn them on /off whole night until early morning. When human or vehicle movement detected on the road than only street lights and LED bulbs are on/off to minimize energy consumption. Our proposed model minimize energy consumption by combination of various cut-edge technologies like IoT, 5G, AI and Cloud computing. In the traffic management the deployed electric appliances like street lights, LED bulbs. These IoT based real-time controller are communicate with streetlights and other electric appliances to gather data from concerned sensor devices and send via 5G mobile communication channel to the cloud computing for further store the data and processing the data. The sensor devices detect motion as well as AI to make decisions to follow instructions. The control management will receive an alert signal when any problem arises of these street electric devices an appropriate action will be taken to consider[12,13]. In smart traffic management and safety system our proposed optimization model for minimize energy consumption of street lights and LED bulbs and other electric appliances is specially used to manage traffic and road safety in city. The various sensor devices for various applications are grouped individually as clusters. Cluster is the similar devices for a certain application. These clusters are Cluster1, Cluster2, Cluster3 i.e. (Streetlights, Street_LED, Advt_Boards3. For example Streetligths1 is a cluster for smart traffic system to optimize.

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$$\mathbf{Cluster1} = \sum_{i=1}^{n} \mathbf{street\_lights_i} = \begin{Bmatrix} \mathbf{1, i\ all\ street\_lights_i\ are\ functionng} \\ \mathbf{0, else} \end{Bmatrix}$$

Equation (1)

In the same method as per above equation, Street_LED is another cluster deployed in a street for optimized equation as follows.

$$\mathbf{Cluster2} = \sum_{i=1}^{n} \sum_{j=1}^{n} \mathbf{street\_led_j} = \begin{Bmatrix} \mathbf{1, i, j\ all\ are\ functionng} \\ \mathbf{0, else} \end{Bmatrix}$$

Equation (2)

In the same method as above, Advt_Elec_Boards is another cluster deployed in a street for optimized equation as follows.

$$\mathbf{Cluster3} = \sum_{a=1}^{n} \mathbf{advt\_elec\_boards_a} = \begin{Bmatrix} \mathbf{1, i\ all\ advt\_elec\_boards_k\ are\ functionng} \\ \mathbf{0, else} \end{Bmatrix}$$

Equation (3)

In the same method as above, Smart_Parking is another cluster deployed in a street for optimized equation as follows.

$$\mathbf{Cluster4} = \sum_{p=1}^{n} \mathbf{smart\_parking_p} = \begin{Bmatrix} \mathbf{1, i\ all\ smart\_parking_p\ are\ functionng} \\ \mathbf{0, else} \end{Bmatrix}$$

Equation (4)

As per smart_city_cluster1, smart_city_cluster2, smart_city_cluster3, smart_city_cluster4 having various sensor devices for different applications. The calculation has been done as the entropy of these above clusters(group of sensor nodes). In these, normal sensor nodes represents normal_nodes and motion sensor nodes represents motion_nodes. In below all equations Entropy(Cluster) is minimized.

$$\mathbf{Entropy(Cluster1)where\ Entropy(Cluster1)} = -\sum_{i=1}^{n} \left(\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_1}} \quad \mathbf{log2}\, \frac{\mathbf{Cluster_i}}{\mathbf{Cluster_1}} \right)$$

Equation (5)

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$$\mathbf{Entropy(Cluster2)where\ Entropy(Cluster2)} = -\sum_{\mathbf{i=1}}^{\mathbf{n}} \left(\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_2}} \quad \mathbf{log2}\,\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_2}}\right)$$

Equation (6)

$$\mathbf{Entropy(Cluster3)where\ Entropy(Cluster3)} = -\sum_{\mathbf{i=1}}^{\mathbf{n}} \left(\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_3}} \quad \mathbf{log2}\,\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_3}}\right)$$

Equation (7)

$$\mathbf{Entropy(Cluster2)where\ Entropy(Cluster4)} = -\sum_{\mathbf{i=1}}^{\mathbf{n}} \left(\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_4}} \quad \mathbf{log2}\,\frac{\mathbf{Cluster_i}}{\mathbf{Cluster_4}}\right)$$

Equation (8)

In the above equations from Equ5 to Equ8 are to minimize the entropy of clusters. The minimization of entropy is possible once removing of impurity from these clusters. Next step is to optimize the energy saving of every clusters by following Equ9.

$$\overbrace{\mathbf{E\_cons(smart\_city)}}^{\mathbf{Minimize}} = \mathbf{min\,F\,(norma\_nodes, motion\_nodes)}$$

$$= \overbrace{\sum_{i=1}^{n} \omega_i \cdot \frac{(f_i(cluster1) - f_i^0)}{f_i^0}}^{\mathbf{Minimize}} + \overbrace{\sum_{j=1}^{n} \omega_j \cdot \frac{(f_j(cluster1) - f_j^0)}{f_j^0}}^{\mathbf{Minimize}}$$

$$\overbrace{\sum_{a=1}^{n} \omega_i \cdot \frac{(f_a(cluster1) - f_a^0)}{f_a^0}}^{\mathbf{Minimize}} + \overbrace{\sum_{p=1}^{n} \omega_p \cdot \frac{(f_p(cluster1) - f_p^0)}{f_p^0}}^{\mathbf{Minimize}} + \quad \mathfrak{E}$$

Equation (9)

In above Equ9 where En_Con = energy consumption of every clusters. S_city=Smart city, Ɛ = estimation of standard error occurred. ω = weight value range {0,1} associated with the objective function. The energy will be optimize by using normal_nodes, motion_nodes for all cluser1,cluster2,cluster3,cluser4 for minimize energy waste. The sum of all energy consumption for the four clusters by applying multi-objective optimization(MOO) technique.

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The cluster1, cluster2, cluster3, cluster4 are minimized. The reasons are all these clusters are independent of each other, the sensor nodes are includes in all clusters. These sensor nodes are different applications for that reason they are will not be interleaved. The normal_nodes are sensor nodes that are operated on/off mode i.e. sensor switch on lights at night and switch off lights at day. The energy will be saved when auto-switching OFF by sunrise to sunset timings. The motion_nodes are intelligent motion detection sensors that save energy by sensing human and vehicle movement and switch on. The normal_nodes, motion_nodes are involving during operation, the energy will be saved as switching off time is increased when the absence of light and motion. The total energy consumed without sensor nodes. The Equ(10) as follows.

$$\mathbf{TES} = \mathbf{EC}(\mathbf{S_1}, \mathbf{S_2}, \ldots \mathbf{S_n}) + \mathbf{EC}(\mathbf{L_2}, \ldots \mathbf{L_n}) + \mathbf{EC}(\mathbf{A_1}, \mathbf{A_2}, \ldots \mathbf{A_n}) + \mathbf{EC}(\mathbf{P_1}, \mathbf{P_2}, \ldots \mathbf{P_n})$$

Equation (10)

In above Equ(10) TEC is total energy consumed and EC referrers to energy consumed. The normal_nodes save energy ck times and motion_sensors save energy (c+1)k times. C value in between {0,1}. C is a positive coefficient. K refers amount of energy for saved. The total consume energy showed in Equation (11).

$$\mathbf{TES} = \mathbf{EC}(\mathbf{S_1}, \mathbf{S_2}, \ldots \mathbf{S_n}) + \mathbf{EC}(\mathbf{L_1}, \mathbf{L_2}, \ldots \mathbf{L_n}) + \mathbf{EC}(\mathbf{A_1}, \mathbf{A_2}, \ldots \mathbf{A_n}) + \mathbf{EC}(\mathbf{P_1}, \mathbf{P_2}, \ldots \mathbf{P_n}) - \mathbf{ck} - (\mathbf{c}+\mathbf{1})\mathbf{k}$$

Equation (11)

When we compare Equations ..Equ(10) and Equ(11), the total energy consumed in Equ(11) is better than Equ(10). It is proved that our proposed system saves energy by minimize un-necessary energy consumption via Internet of Things(IoT) sensor devices.[14,15,16]

VI. CONCLUSION

The proposed paper implemented an architecture design for traffic management and road safety system to avoid accidents, reduce health issues, traffic congestion control, save route travel time, provide best route to reach destination and mainly save the our ecosystem in the city. In our proposed paper utilization of available technologies IoT, 5G and AI applied to control traffic system in the city. The Internet of Things(IoT) with its ubiquitous nature enabled with 5G and AI to control traffic, control health issues, avoid accidents in the traffic management system in the city. The Internet of Things(IoT) based sensor devices to sense, monitor, access the real-time data and send to the cloud for store & process the data further the end user can verify the real-time data to take appropriate decisions to properly manage traffic. In this proposed paper efficient management of smart traffic management and safety system is an optimization model for minimize energy consumption of street lights and LED bulbs and other electric appliances is specially used to manage traffic and road safety in city.

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REFERENCES

[1] Kaparias, Ioannis, et al. "Predictive road safety impact assessment of traffic management policies and measures." Case studies on transport policy 8.2 (2020): 508-516.
[2] Ajay, P., et al. "Intelligent ecofriendly transport management system based on iot in urban areas." Environment, Development and Sustainability (2022): 1-8.
[3] Sarrab, Mohammed, Supriya Pulparambil, and Medhat Awadalla. "Development of an IoT based real-time traffic monitoring system for city governance." Global Transitions 2 (2020): 230-245.
[4] Laghari, Asif Ali, et al. "A review and state of art of Internet of Things (IoT)." Archives of Computational Methods in Engineering (2021): 1-19.
[5] Mouha, Radouan Ait. "Internet of things (IoT)." Journal of Data Analysis and Information Processing 9.2 (2021): 77-101.
[6] Khanna, Abhishek, and Sanmeet Kaur. "Internet of things (IoT), applications and challenges: a comprehensive review." Wireless Personal Communications 114 (2020): 1687-1762.
[7] Agarwal, Piyush, Priya Matta, and Sachin Sharma. "Comparative Study of Emerging Internet-of-Things in traffic management system." 2021 5th International Conference on Trends in Electronics and Informatics (ICOEI). IEEE, 2021.
[8] Čolaković, Alem, Nazif Salihović, and Adnan Dželihodžić. "Adaptive Traffic Management Systems Based on the Internet of Things (IoT)." International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies. Cham: Springer International Publishing, 2022.
[9] D'Ortona, Cristian, Daniele Tarchi, and Carla Raffaelli. "Open-Source MQTT-Based End-to-End IoT System for Smart City Scenarios." Future Internet 14.2 (2022): 57.
[10] Wang, Wei, et al. "Realizing the potential of the internet of things for smart tourism with 5G and AI." IEEE network 34.6 (2020): 295-301.
[11] Gohar, Ali, and Gianfranco Nencioni. "The role of 5G technologies in a smart city: The case for intelligent transportation system." Sustainability 13.9 (2021): 5188.
[12] Yang, Yu-Sheng, et al. "An implementation of high efficient smart street light management system for smart city." IEEE Access 8 (2020): 38568-38585.
[13] Biswal, Anil Kumar, Debabrata Singh, and Binod Kumar Pattanayak. "IoT-based voice-controlled energy-efficient intelligent traffic and street light monitoring system." Green Technology for Smart City and Society: Proceedings of GTSCS 2020. Springer Singapore, 2021.
[14] Fantin Irudaya Raj, E., and M. Appadurai. "Internet of things-based smart transportation system for smart cities." Intelligent Systems for Social Good: Theory and Practice. Singapore: Springer Nature Singapore, 2022. 39-50.
[15] Ajay, P., et al. "Intelligent ecofriendly transport management system based on iot in urban areas." Environment, Development and Sustainability (2022): 1-8.
[16] Hilmani, Adil, Abderrahim Maizate, and Larbi Hassouni. "Automated real-time intelligent traffic control system for smart cities using wireless sensor networks." Wireless Communications and mobile computing 2020 (2020): 1-28.

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