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Technology Enriched City and Home (T.E.C.H)

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Abstract - *Cities around the world are getting smarter everyday through the implementation of IOT devices. In practical terms this means that cities are using low cost sensors and Wi-Fi enabled smart devices to talk to people. Smart homes and smart cities are emerging in response to an increasingly urbanized world dealing with scarce resources and a desire to improve energy efficiency. In this paper, we propose a system to implement few of the features of Smart City and Smart Home. The proposed system focuses on providing practical solutions to certain problems regarding Smart cities and Smart Homes. Also, the proposed system aims at providing better future using technology thereby showing how we can help in making Smart cities and Smart Homes much better by improving its features. The objective of representing Smart City and Smart Home is achieved through hardware implementation of certain features. Hardware implementation includes Traffic Management Monitoring, Garbage Monitoring, DTMF Home Automation and Anti-Theft Monitoring. The implementation is carried out along with a model of representation for each feature under Hardware implementation. The objective of representing Smart City and Smart Home is also achieved through software implementation of certain features. Software implementation includes Smart Parking Monitoring, Smart Streetlight Monitoring, Smart Transportation Monitoring and S.O.S System. The software implementation is carried out through a desktop application PYQT5 software using Python which provides simulation of certain features of Smart City and Smart Home implemented through software.*

***Key Words*: IOT, PYQT5, Smart City, Smart Home, Traffic Management Monitoring, Garbage Monitoring, DTMF Home Automation, Anti-Theft Monitoring, S.O.S System**

1. INTRODUCTION

Cities with heavy populations escalate burden on energy, water, buildings, public places, transportation and many other things. Therefore, we need to find out solutions that are **"Smart"** which means they are efficient and feasible for economic growth of the city and society as well. The smartness of a city describes its ability to bring together all its resources effectively and seamlessly to achieve the goals and fulfil the purposes it has set for itself. The perfect solution for this is, mobility of all resources and adapting to the new technologies as and when they come. The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. The IoT concept hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on. The IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations. This paradigm indeed finds application in many different domains, such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and many others.

The application of IoT paradigm to an urban context is of particular interest, as it responds to the strong push of many national governments to adopt ICT (Information and Communication Technology) solutions in the management of public affairs, thus realizing the so called Smart City concept. Although there is not yet a formal and widely accepted definition of "Smart City," the final aim is to make a better use of the public resources, increasing the quality of the services offered to the citizens, while reducing the operational costs of the public administrations. This objective can be pursued by the deployment of an urban IoT i.e., a communication infrastructure that provides unified,

simple, and economical access to a plethora of public services, thus unleashing potential synergies and increasing transparency to the citizens. An urban IoT, indeed, may bring a number of benefits in the management and optimization of traditional public services, such as transport and parking, lighting, surveillance and maintenance of public areas, preservation of cultural heritage, garbage collection, salubrity of hospitals, and school. Furthermore, the availability of different types of data, collected by a pervasive urban IoT, may also be exploited to increase the transparency and promote the actions of the local government toward the citizens, enhance the awareness of people about the status of their city, stimulate the active participation of the citizens in the management of public administration, and also stimulate the creation of new services upon those provided by the IoT. Therefore, the application of the IoT paradigm to the Smart City is particularly attractive to local and regional administrations that may become the early adopters of such technologies, thus acting as catalysers for the adoption of the IoT paradigm on a wider scale.

2. Methodology

Smart cities use a combination of the Internet of things (IoT) devices, software solutions, communication networks and user interfaces (UI). The IoT is a network of connected devices such as vehicles, sensors or home appliances that can communicate and exchange data. Data collected and delivered by the IoT sensors and devices is stored in the cloud or on servers. The connection of these devices and use of Data analytics (DA) facilitates the convergence of the physical and digital city elements, thus improving both public and private sector efficiency, enabling economic benefits and improving citizen's lives. The IoT devices sometimes have processing capabilities called edge computing. Edge computing ensures that only the most important and relevant information is communicated over the communication network. A firewall security system is also necessary for the protection, monitoring and control of network traffic within a computing system. Firewalls ensure that the data constantly being transmitted within a smart city network is secure by preventing any unauthorized access to the IoT network or city data.

Smart home is a term that refers to modern homes that have appliances, lighting and/or electronic devices that can be controlled remotely by the owner, often via a mobile app. Smart home-enabled devices can also operate in conjunction with other devices in the home and communicate information to other smart devices. Smart home-enabled devices can include appliances like refrigerators, washing machines, dryers, and toaster ovens, as well as heating and air conditioning units and lighting devices. Some examples of smart home-enabled electronic devices are audio and video entertainment systems, camera and security systems, and computers, laptops and other electronics mobile devices. Classic smart home, internet of things, cloud computing and rule-based event processing, are the building blocks of our proposed advanced smart home integrated compound. Each component contributes its core attributes and technologies to the proposed composition. IoT contributes the internet connection and remote management of mobile appliances, incorporated with a variety of sensors. Sensors may be attached to home related appliances, such as air-conditioning, lights and other environmental devices. And so, it embeds computer intelligence into home devices to provide ways to measure home conditions and monitor home appliances' functionality. Cloud computing provides scalable computing power, storage space and applications, for developing, maintaining, running home services, and accessing home devices anywhere at any time. The rule-based event processing system provides the control and orchestration of the entire advanced smart home composition.

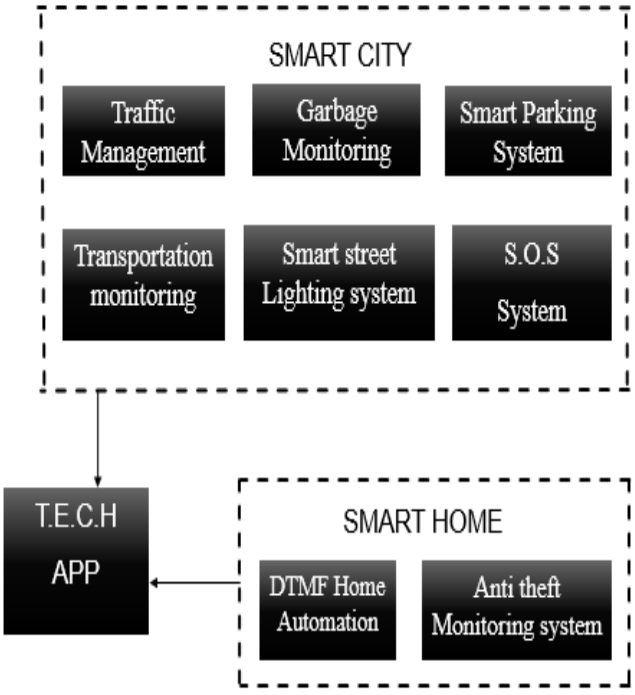

Fig -1: Block Diagram of Technology Enriched City and Home (T.E.C.H)

3. IMPLEMENTATION

There are two ways of implementation of our project Technology Enriched Smart City and Smart Home (T.E.C.H) i.e. Hardware and Software Implementation.

3.1 SOFTWARE IMPLEMENTATION

The software implementation of the features of Technology Enriched City and Home (T.E.C.H) is achieved by using PYQT5 Python GUI software. The user interface as soon as he/she opens T.E.C.H application is show in the below figure Fig -2.

Fig -2: User Interface of Technology Enriched City and Home (T.E.C.H)

1. **SMART PARKING SYSTEM:** With improving number of vehicles on the road along with the mismanagement of available parking space, leads to parking associated concerns as well as enhanced traffic congestion in urban areas. Thus it is necessary to develop an automated smart parking management system that would assist the driver to find out some worthy parking space for their vehicle. Smart Parking systems give choices to car owners for parking lots. This helps in effective management of parking space that will manage the space efficiently. An End-to-End Parking Management System is one of the main feature designed in this T.E.C.H app. Here we implement this feature in PYQT5 software and the results are simulated. When the user clicks on the Smart Parking System in the T.E.C.H application a dialogue box appears with multiple level parking. This works well for multi storeyed parking system. The user can select the desired level by clicking on the push button of the particular level. Further, another dialogue box appears where there will be multiple parking slots. The GUI provided is such that, the slot which is full will be indicated in Red color and the empty parking slot will be indicated in Green color. Here we are randomly providing the colors to the slots from a pre-defined database for simulating purpose. Also if the user clicks on red slot, the details of the already parked vehicle will be displayed.

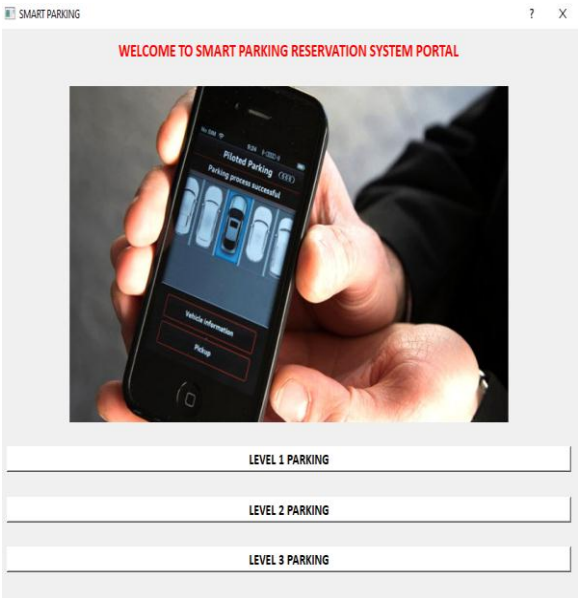

Fig-3: Smart Parking System User Interface

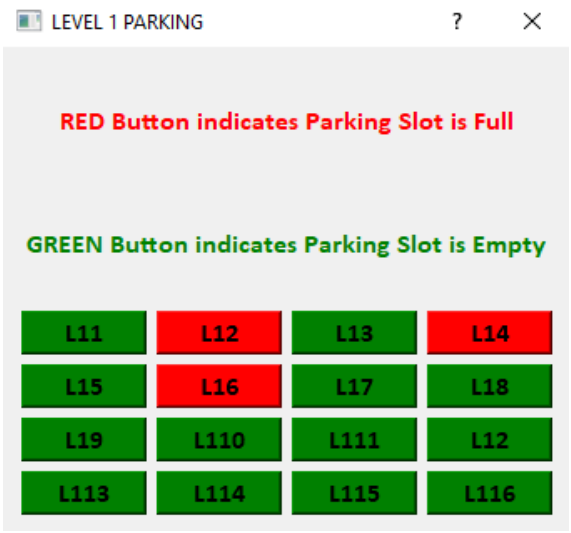

Fig-4: Level-1 Parking GUI

Each slot will be assigned with a randomly generated parking id which is a unique number for that slot. With this the user can easily get to know the vacancies for his vehicle parking. On selecting a particular green slot of his wish, the user is supposed to add his details to the database. The details include Driver name, Vehicle name, Vehicle type (2 wheeler or 4 wheeler) and Vehicle number.

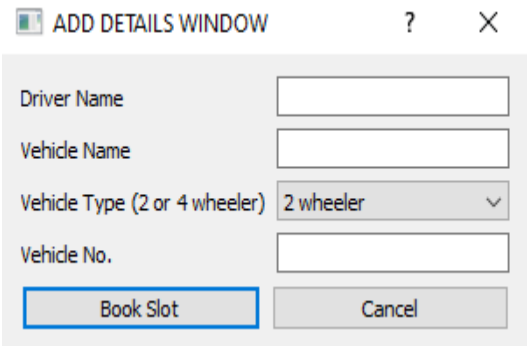

Fig-5: Obtaining details from the User

As soon as the user enters his details, the time is also noted (which is regarded as the entry time) and this later helps in estimating the parking charges. After entering the details he can book his slot and the particular slot immediately turns red and also gets a confirmation message that you have successfully reserved your slot and the slot is booked. Smart Parking can be utilized in private parking lots, hospitals, hotels, shopping malls, public parking garages, offices, etc. to make the parking hassle free and time consuming. This intelligent parking system enables drivers to book the parking spots in advance and also get real-time accessibility of the parking spaces on their mobile devices.

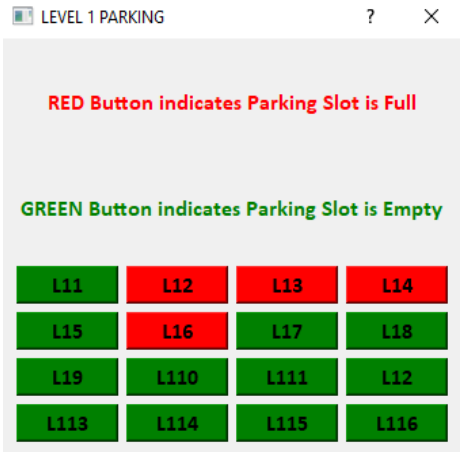

Fig-6: Status of Button L13 changes after user updates his details

2. **SMART STREET-LIGHT SYSTEM:** The Smart Street Light System which is a part of T.E.C.H application is implemented using PYQT5 software. The main aim here is to enable the users to lodge a complaint to the authorized offices whenever they face issues related to the street lights in their locality. The GUI along with other features is so provided, like the user can switch to the smart street portal and enable his location. When he does so, it takes him to the window displayed as **"Welcome to the smart street light portal"** where a set of roads along with their numbers in the form of push buttons will be displayed.

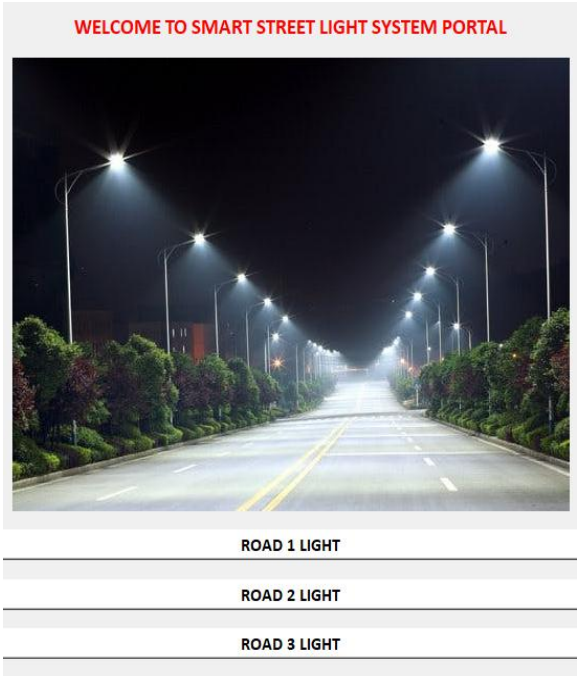

Fig-7: Smart Street-Light System User Interface

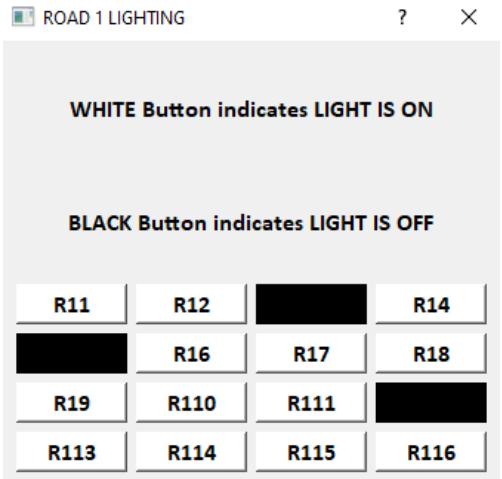

Fig-8: Road 1 Street Light representation in the form of pushbuttons

It is necessary for him to select his road number/ main road number within his locality. As soon as the road is selected, a window pops up again with a hint given as **"Black button indicates light is OFF"** and **"White button indicates light is ON"** with which the user is able to understand the status of the lights. The user here is given with a provision to click/select on the dark shaded button which indicates malfunctioning lights and when he does so immediately a complaint dialog box appears where the user can write the query like not working, faulty, damaged etc. to the concerned authority.

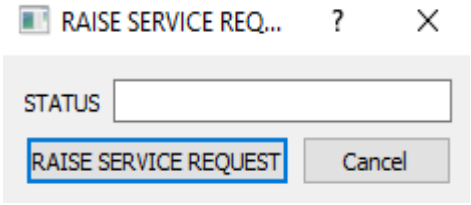

Fig-9: Raise Service Request Window

Once the user lodges a complaint he gets a complaint raised confirmation. Also to make sure that no complain for the same street light is lodged twice, as soon as the user registers to complain, the color of the complained street light button turns red and hence avoids multiple queries for the same Street Light. For the authority to take the necessary action with respect to the non-working(Complaint Raised) street light, each street light would have been provided with a unique number for that particular locality and this helps in identifying to which street light the complaint is raised and the issue can be resolved.

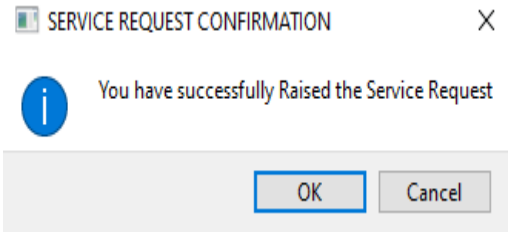

Fig-10: Service Request Confirmation Window

3. **SMART TRANSPORTATION SYSTEM:** The age old question of "Where's my bus?" can finally be answered. Here in our project, we aim to reduce the crowd at public places and where in people will come to know about the upcoming buses that have left the previous stop and are heading to the next stop soon. Therefore, by applying this approach a person need not see which bus is coming his/her way. He may sit and relax until his bus arrives from the previous stop. By using this designed system, we can come to know about all the buses that are heading towards the bus stop, their destination and the time they will require to reach the stop and distance between the stops. The Smart Transportation System which is a part of T.E.C.H application is implemented using PYQT5 software. By using this designed system, we can come to know about all the buses that are heading towards the bus stop, their destination and the time they will require to reach the stop and distance between the stops. The GUI displays list of bus stops in a particular route, list of buses available for the particular route, schedule of the buses, route map and tracking of the bus. All these information are simulated using PYQT5 GUI software.

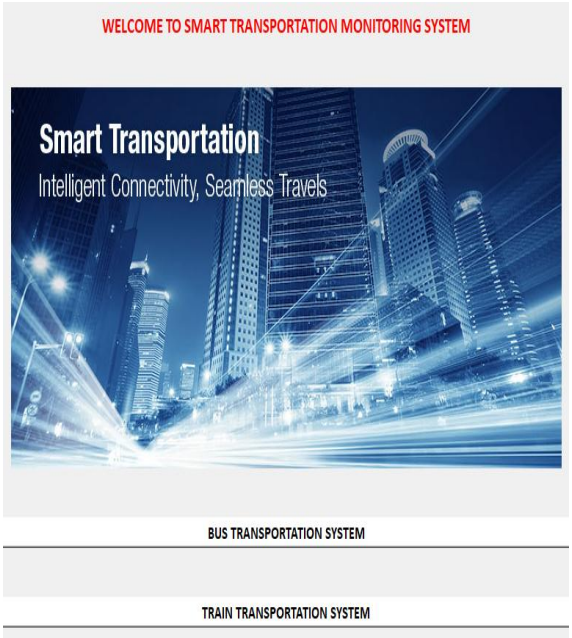

Fig-11: Smart Transportation System User Interface

When the user opens the T.E.C.H application the GUI displays the option of Bus Transportation and Train Transportation. When the user selects the Bus Transportation a dialog appears consisting of various routes among which when the user selects a particular route the GUI displays the buttons of list of bus stops available in that particular route, list of buses that travel in the particular route, schedules of the buses of the particular route, route map and the Track Bus option where the user can track the

location of the bus and can get to know the estimated time and distance between the current location of the bus and his/her current location. When the user reaches his/her destination stop then the application pops a message that the user has reached the destination. A person away from stop or anywhere at home or workplace can know the information about the bus, from which stop, at what time, within how much time the bus will reach destination and much more information about it through the internet. Also, we add on to the occupancy of the bus i.e. how many people board the bus and availability of the seats in the bus, which increases passenger satisfaction.

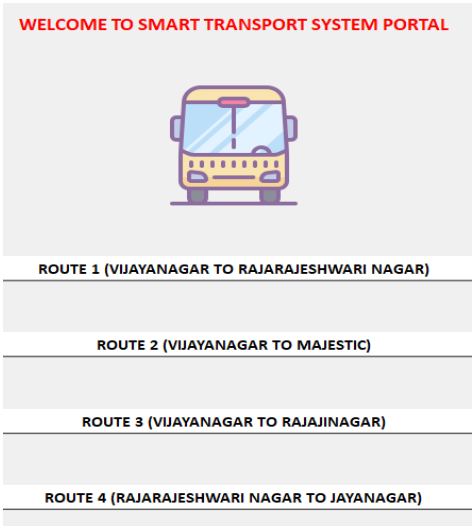

Fig-12: Various Routes User Interface

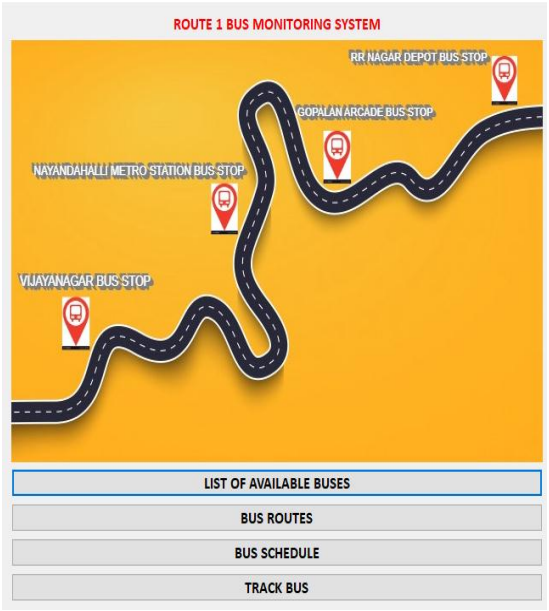

Fig-13: Route 1 User Interface Dialog

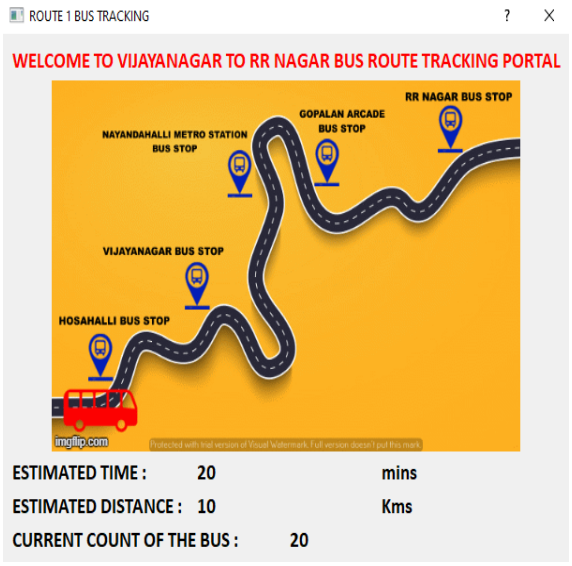

Fig-14: Simulation of Tracking the Bus at the position before User's Boarding stop

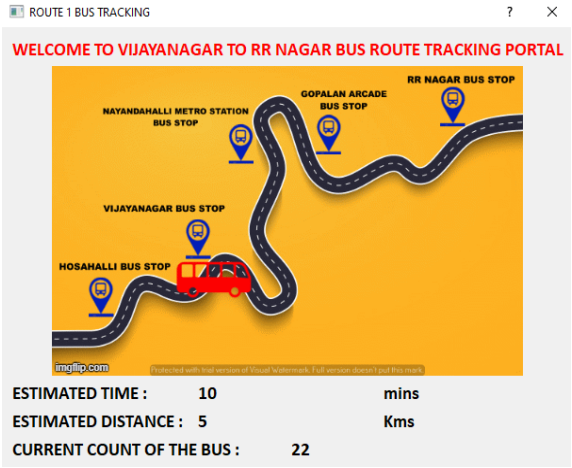

Fig-15: Simulation of Tracking the Bus at User's Boarding Stop

Fig-16: Simulation of Tracking the Bus at User's Destination Stop

Fig-17: Metro Transportation System Portal

Similarly, in Train Transportation as soon as the user clicks on Train Transportation button the GUI displays a dialog window which consists of routes of available Metro Train Transportation services which displays the position of the train and the estimated time to reach the destination and also the user can view the route map of purple and green line available Metro stations.

Fig-18: Simulation of Metro Train Transportation at the position before User's Boarding stop

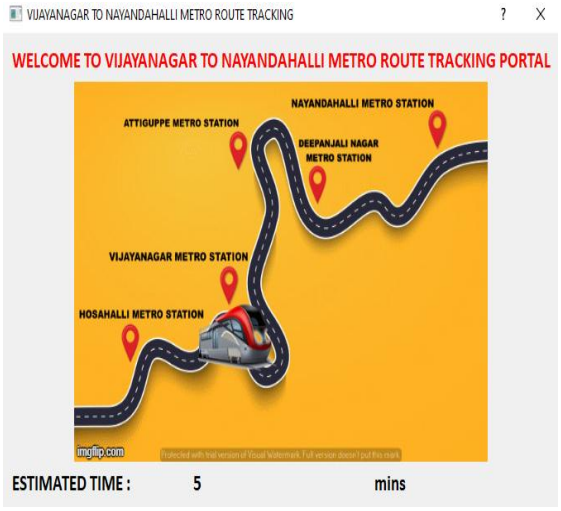

Fig-19: Simulation of Metro Train Transportation at User's boarding stop

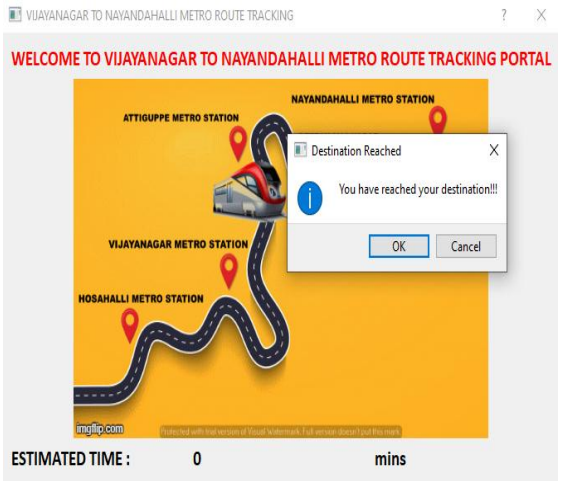

Fig-20: Simulation of Metro Train Transportation at User's Destination stop

Fig-21: Route Map for Green Line Metro Train

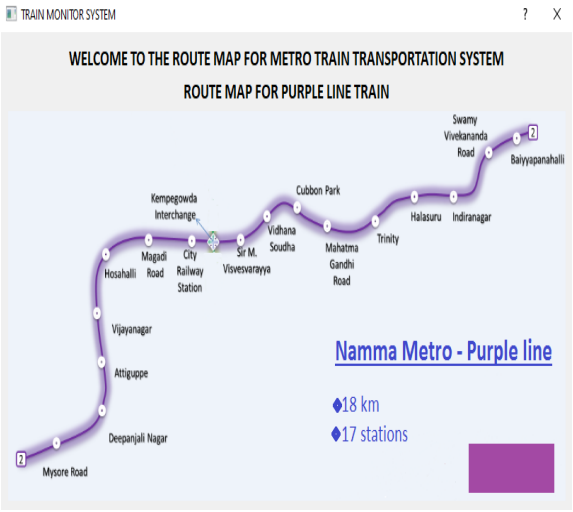

Fig-22: Route Map for Purple Line Metro Train

4. **S.O.S SYSTEM:** S.O.S refers to Save Our Souls. It is a Morse code which is used as a distress code to signal danger. The code signals that a person is in danger and needs immediate help. The SOS distress code is a sequence of three dots, three dashes and three dots without any space. In International Morse Code, three dots represent letter S and three dashes represent letter O. The S.O.S system in our project is also implemented using PYQT5 GUI software. The T.E.C.H GUI displays the options for the user as Women Safety, Medical Emergency, Burglary and Fire Emergency.

Fig-23: S.O.S System User Interface

When the user clicks on Women Safety button the GUI application asks the user to turn ON the location and share the location of the user with our without recording and the address of the user is captured by knowing the latitude and longitude values. The latitude and longitude values, address with or without audio recording based on the user's selection is mailed to the concerned authorities immediately so that immediate help is provided to the user. Also, the nearby safety places to the user's location is displayed for emergency so they can get immediate help.

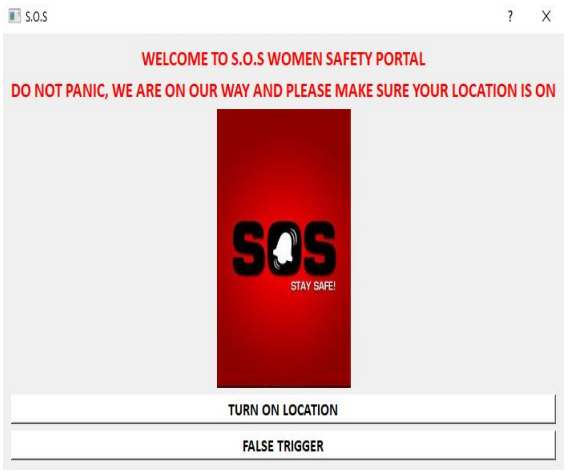

Fig-24: S.O.S Women Safety Portal

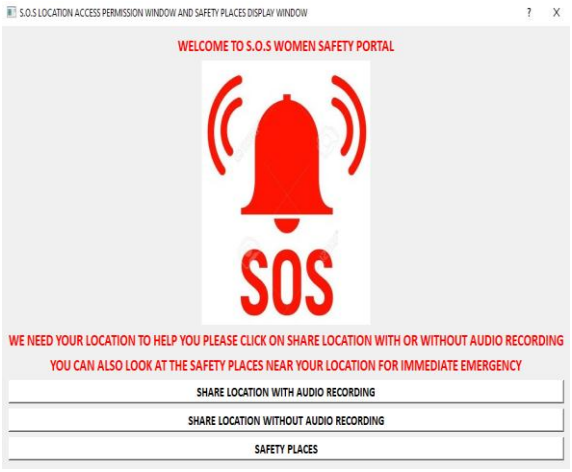

Fig-25: S.O.S Women Safety Portal Capturing User's Location Dialog

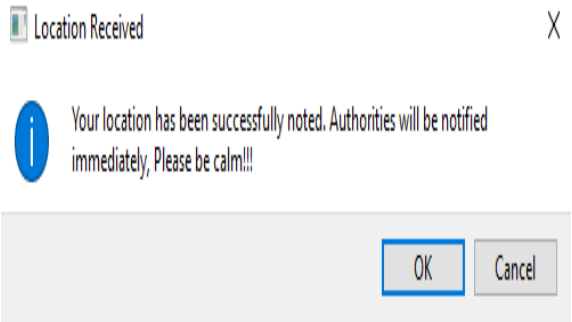

Fig-26: Recording Location of the User

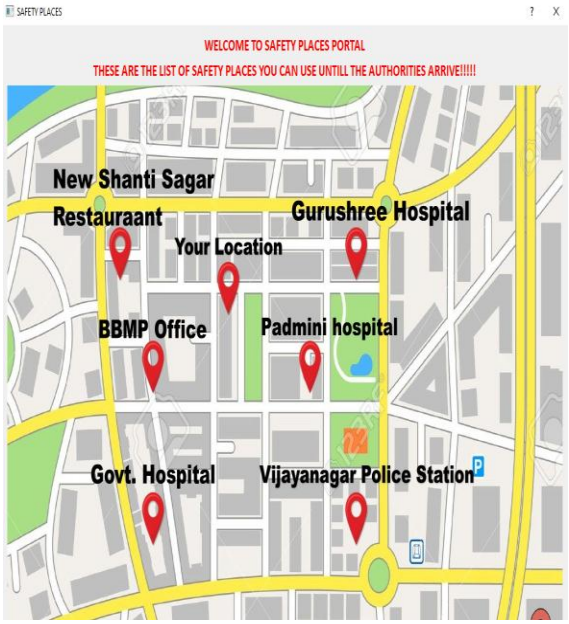

Fig-27: Safety places for the User near their location

Burglary and the Fire Emergency works the same way in which location of the user is captured with our without audio recording as per the user's wish and immediately notified to the authorities through mail about the location of the user with address. The Medical Emergency option provides user list of nearby hospitals available to the user so that they can get immediate necessary medical help or attention.

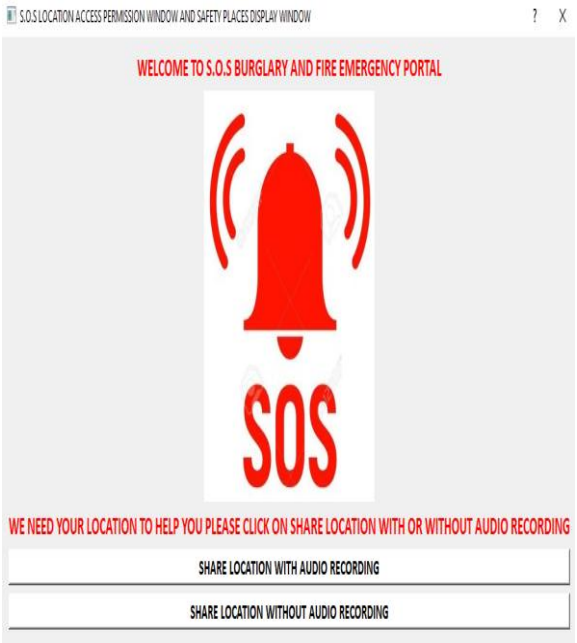

Fig-28: S.O.S Burglary and Fire Emergency Portal

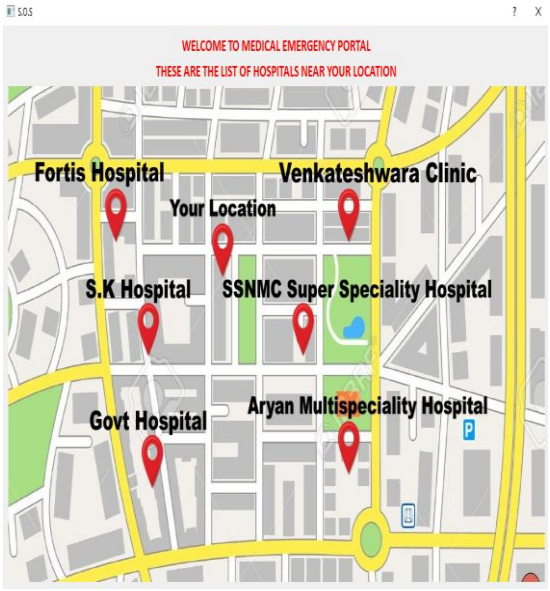

Fig-29: Nearby Hospitals to the User's Location

3.2 HARDWARE IMPLEMENTATION

1. **TRAFFIC MANAGEMENT MONITORING:** The existing Traffic Management system in our country is very bad as it is difficult to identify the Traffic violators. People just skip the signals, over speed or violate various traffic rules which includes wearing helmets or seat belts. There is no IOT based Traffic management System in our country instead the traffic management system in our country is very mechanical and strict action has to be taken in order to avoid the accidents and other damages. In our project T.E.C.H IOT based traffic management has been implemented which can be monitored based on density of traffic and also easy to find the path during the emergency condition for ambulances by alerting the drivers about traffic in that area and also alerting the police about the arrival of ambulances. The police can clear the traffic when the information is received and real time status of the traffic can be provided to the police to handle the situation. The density of the traffic can be monitored through Image Processing technique wherein the camera placed at the top and centre of the junction of four roads captures the image of the vehicles and the density calculation is performed. Based on the higher density of vehicles the traffic is cleared for that particular road to reduce the traffic that frequently occur in the cities. This implementation of Image Processing technique is performed using MATLAB software where the image captured is processed and then passed on to

the microcontroller which controls the traffic light. Depending on the signal received to the microcontroller the traffic light glows. The Ambulance arriving in a particular road is cleared based on RF technology where RF Transmitter and RF Receiver is used wherein the user presses the switch provided to him which is a unique lane number for each road which acts as a Transmitter. Depending the switch pressed the lane number assigned to that particular road is identified and then the traffic of the particular road is cleared due to the RF Receiver which captures the RF signal transmitted by the switch.

2. **GARBAGE MONITORING:** Generally, in IOT based Dumpster/Garbage Monitoring System will tell us that whether the trash can is empty or full through the webserver and one can know the status of your 'Trash Can' or 'Dumpsters' from anywhere in the world over the Internet. It will be very useful and can be installed in the Trash Cans at public places as well as at one's home or apartment. But, in our project T.E.C.H Garbage monitoring is to ensure that people do not throw garbage near the empty areas available on the road or near empty sites and do not litter the surrounding as keeping our surrounding environment clean also comes under Garbage Monitoring. We have implemented this feature in order to make sure that people throw garbage only when garbage collecting vehicles come near the house and do not throw garbage on the roads. This system or ideology is implemented by installing cameras near the street poles to capture the images if people throw garbage on the streets. The image is recorded as soon as the movement is identified and if the image is verified as a person trying to throw garbage then the particular image is recorded and sent to the authorities to take a strict action by sending an alert E-Mail with the attachment of the image captured.

3. **DTMF HOME AUTOMATION:** There are various techniques to control home appliances such as IOT based home automation over the cloud, home automation under Wi-Fi through android apps from any smartphone, Arduino based home automation, home automation by android application based remote control, home automation using digital control, RF based home automation system and touch screen based home automation. But the home appliances can be controlled without the use of RF technology or Arduino based Bluetooth Home automation which may turn out to be expensive. In our project T.E.C.H Dual Tone Multi Frequency (DTMF) is the principle used to control the home appliances. The various appliances in our home can be controlled using a simple mobile keypad input. The advantage in our project is appliances are automated without any use of Arduino or RF or any other complex method. Here, in DTMF Home Automation DTMF tones are generated when a key is pressed from a mobile (can be a smartphone or a basic phone set) which acts like a DTMF Encoder. The DTMF tones generated are detected by the MT8870 DTMF Decoder module where in an audio jack cable or audio cable is connected to the receiver mobile which is in Auto-answer mode. A 5V Relay switch is connected to the output pins of the MT8870 DTMF Decoder module. Based on the output obtained from the DTMF decoder Relay switch enables the particular electrical component connected to the switch. These electrical components can be turned on through combination also, if more than one electrical appliances have to be turned ON. By pressing the same key again the appliance can be turned OFF.

4. **ANTI-THEFT FLOOR SYSTEM:** The safety and security available to the public during emergency time is not good enough to save themselves or their family. When a person or a family is being robbed or attacked then there is a delay experienced to save them or their belongings as the police are informed late and the attackers or the burglars could escape easily. Generally in order to provide safety and security, burglar systems with PIR and motion detection sensors are used to detect the burglar activity or any other attack by the thieves. In our project T.E.C.H Anti-Theft flooring system is used for security and guarding our homes in our absence. The system is secure with flooring tile being connected through IOT when we go out of the house, the system is to be turned on, then whoever comes inside the house it passes the information over IOT. When the device senses the burglar activity then immediately the message can be alerted to the nearest police station through SMS or E-Mail and also with the location of our house to the nearby police station. The police can take action based on information and stop the burglary. The

implementation is carried out wherein even if one single step anywhere on the floor is tracked then the user is alarmed over IOT. This system is powered by capturing images on movement when burglar activity is in progress. In our project two tiles are used for demonstration purpose. Whenever the thief enters in the house, and steps on the floor immediately it is sensed by the sensor which passes on the signal to the controller which turns on the camera to capture the image. After the image is captured the controller immediately sends the location of house and the image to the nearby police station or authorities through E-Mail through which even the user can be notified about an ongoing burglary and required action could be taken to stop the burglary or the attack.

4. CONCLUSIONS

The concept of Smart Cities have gained a lot of attention recently due to the technological advancements and for a better future. The features of Smart City and Smart Home implemented in our project Technology Enriched City and Home (T.E.C.H) are few of the many features of Smart Cities and Homes. The features are implemented by categorizing into Software and Hardware. The Software representation of features that have been implemented includes Smart Parking System, Smart Street-Light System, Smart Transportation System and S.O.S System. These features are simulated using PYQT5 software which provides a good interactive GUI for the user which enables him to use many features of Smart City under a single platform. The Hardware representation of features that have been implemented includes Traffic Management Monitoring, Garbage Monitoring, DTMF Home Automation and Anti-Theft Flooring System. These features are demonstrated through hardware components with the support of the hardware model. This project tries to point the importance of Smart Cities and Smart Home features that are available with the help of remarkable technologies around us and also makes us realize the importance of technological advancements.

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