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LIFE: Emergency Traffic Controller

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Abstract - *Intelligent Traffic System is one of the most recent research topics in the Internet of Things (IoT). The ever-increasing number of vehicles in modern cities is creating heavy traffic congestion. To reduce the traffic congestion, several researches have already been done to provide a clear pathway to the emergency vehicles in the urban area. However, they often fail to meet the target travel time of an emergency vehicle. To address this issue directly, we are introducing an innovative application to control the traffic signal using the geofencing concept. LIFE (Light Innovation For Emergency) is an android application which can control the nearest traffic signal system to provide easy path to the destination for the emergency vehicles. The user of this application is required to register with Application. Once an emergency case occurs, user needs to switch on the GPS and Wi-Fi or data connection on his mobile phone. The application will start tracking the path of the emergency user and route him through the shortest path to destination. The traffic signal system in between the source and the destination will be under the control of this application. So, the green signal can be shown over the path of the emergency vehicle and thus eases the way to destination.*

Key Words: **IoT, Geofencing, ESP8266, Smart City**

1. INTRODUCTION

LIFE was developed as an effort to ease the congestion in metro cities with large vehicular density on roads. We believe that a few minutes saved from a traffic congestion can save a human life. In the current scenario the traffic control system works with an automatic timeout mechanism [1]. When a vehicle arrives at a signal junction, they must wait until their path to destination is cleared, here each route in the junction will be given an equal time slice. In this situation emergency vehicle must wait for a long time in the traffic pavement. The traffic lights in normal condition work according to a fixed pattern of colour change.

In our proposed system, we have developed a user-friendly traffic scheduler in which the user can generate an emergency route in a few clicks. Our system can used in many scenarios, where mainly the user can be any driver not necessarily an ambulance driver. Our system also removes the limitation to destination by allowing three categories of institutions: Hospital, Blood Bank, Police Station. The user creating emergency should have an android device to support our application. This application aims to provide an easy route to the destination. The traffic control system as it changes in a timely bounded manner. The traffic signal is controlled by our system which can change the route's backlogging if an emergency vehicle is stuck in a traffic congestion.

2. EXISTING SYSTEM

In the existing traffic control systems, the implementations are basically made by means of a programmed chip. The chip is usually programmed with a timer, where each of the signal colours are given a fixed cycle time [2]. The time is usually calculated based on the path densities, which does not have any capability to differentiate an emergency vehicle from normal vehicles [3]. It does not have a centralized control to make changes in future, making it expensive to maintain. To make a simple modification the entire system must be re-engineered, which is a costly solution which is not adaptable in most of the places [4]. In most of the developing countries there are police officers for controlling the traffic at busy peak points.

3. PROPOSED SYSTEM

Recent advancements in the communications and technology area was undoubtedly an effort from Cloud Computing and Internet of Things (IoT) sector. The cloud service is basically a large group of interconnected computers. IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure.

LIFE provides an Intelligent Traffic Signal system which provides a riskless movement of emergency-initiated vehicle to the required destination. LIFE system can establish a communication between the traffic signal and the emergency vehicle, so that the traffic signal can respond to the arrival of the emergency vehicle and respond according to that, which thus generates a free way for the emergency vehicle making it a real lifesaver.

LIFE android application adopts an innovative concept of Geofencing packed with the Google Maps API. LIFE implements the machine to machine communication through an android device equipped with GPS sensor and a traffic signal system programmed with a Wi-fi module which is connected to the central server. LIFE system has a centralized server which can be controlled by a government authority, with access to complete functionalities of adding new areas of

traffic signals, viewing user's list and adding geolocations of emergency institutions. LIFE make real time checks to find the arrival of an emergency vehicle towards a traffic island. On presence of an emergency vehicle the centralized server makes the programmed activations. The Geofence is created by the android application which is pre-configured with Google Maps API included in it. It creates a circular boundary around the traffic signal locations sent by the server. Whenever an emergency vehicle enters the geofenced area (circular area surrounding the traffic signal), the android application will generate an event, triggering the presence. This generated event will notify the server about the presence. The server then identifies the traffic island details sent by the server from its huge database and make establish a communication path with the intended traffic signal. Then the signal is triggered to GREEN for passing the vehicles in that direction.

Once the emergency initiator i.e. user has reached the emergency institution, the user must upload a valid document that will be then verified by the admin. If the user, doesn't upload the required document, then the system will automatically terminate the user. So, the LIFE application guards the emergency vehicle to safely reach a destination.

In the user interface part of LIFE, i.e. an android application where the user can make registration to the system. For the authenticity, the registered user is also gets a verification email on successful registration. Admin has a central control on the user registration and termination. The users are given privileges to access the application by just providing their credentials on the login interface of the application. Once the user logged into his profile, to start the emergency by clicking on an emergency button. The user must select the type of institution (Hospital, Blood Bank, Police Station), from the list of the institutions mentioned by the admin. The app will provide institution suggestions based on the current geolocation of user.

4. IMPLEMENTATION

For the implementation for our proposed system we have divided it into three modules: Hardware part (ESP8266 connected with a traffic signal post), Android application (a user-friendly application with Geofencing functionality), a centralized server (to control the interaction between hardware and the android application). A basic description of the three modules used in our implementation model has been discussed below:

4.1 ESP 8266

The ESP8266 microcontroller is a low cost cheap WIFI enabled microchip with capabilities for TCP/IP stack. This ESP8266[5] was manufactured by a Shanghai based Chinese firm Espressif Systems. The expansion of the chip came into existence after introduction of ESP-01 module, produced by a third-party manufacturer, AI-Thinker.

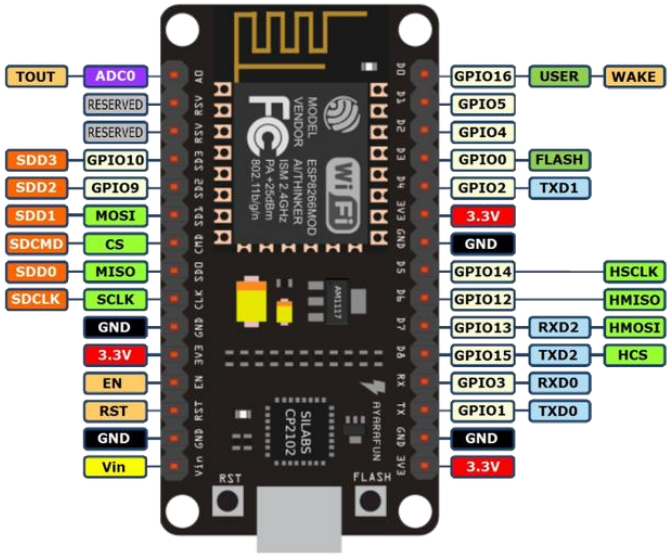

Fig -1: ESP 8266 Pin Diagram

This is a small chip with its length less than 10cm. Its capable of connecting to a Wi-Fi network and it performs TCP/IP connections using Hayes-style commands [5]. However, at the time there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.

The ESP8266 is a microcontroller with specification 1 MB of built-in flash, allowing for single-chip devices capable of connecting to WIFI. The successor to these microcontroller chips is the ESP32. NodeMCU is an open source IoT platform. It includes firmware which can run on the ESP8266 Wi-Fi SoC from Espressif Systems, and its hardware is completely based on the ESP-12 module. The term "NodeMCU" refers to the firmware rather than the developer kits. The firmware uses the Lua scripting language which is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266.

4.2 Geofencing

This technology was developed by Google Maps, it was used to perform a predefined sequence of actions when a user using the app has reached nearby a desired location.

The geofencing API [6] allows to define perimeters, also referred to as geofences, which surround the areas of interest. Your app gets a notification when the device crosses a geofence, which allows you to provide a useful experience when users are in the vicinity. For example, an airline app can define a geofence around an airport when a flight reservation is near boarding time. When the device crosses the geofence, the app can send a notification that takes users to an activity that allows them to get their boarding pass. The Geofencing API intelligently uses the device sensors to

accurately detect the location of the device in a battery-efficient way.

Receive notifications when users trigger your geofences:

Geofencing combines the current location along with awareness of proximity to locations of interest. To mark a location of interest, specify its latitude and longitude. To adjust the proximity for the location, specify radius for a circular range. The latitude, longitude, and radius define a geofence, creating a circular area, or fence, around the location of interest.

For each geofence, can ask Location Services to send you entrance and exit events, or can specify a duration within the geofence area to wait, or dwell, before triggering an event. Then limit the duration of any geofence by specifying an expiration duration in milliseconds. After the geofence expires, Location Services automatically removes it.

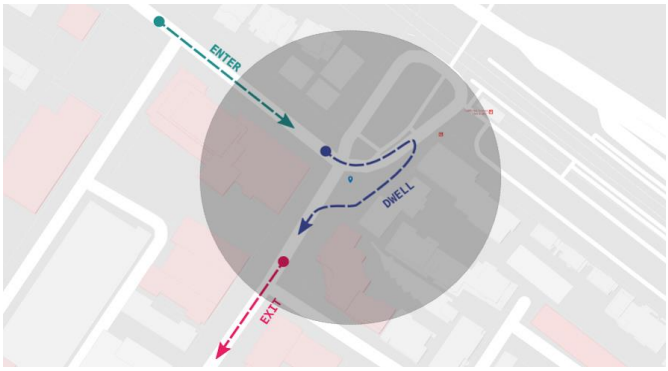

Fig -2: Geofencing Implementation View

As shown in the Fig 2, a geofence is a virtual perimeter of interest that can be set up to fire notifications when it is entered or exited, or both. So, by geofencing the traffic signal post, when a location-aware device enters or exits these geographic barriers, it gets notified to the microcontroller. Thus, the microcontroller can trigger a special lighting pattern. The traffic light continuously glows green in that lane, if the emergency vehicle exits the geofence and switches back to normal state.

4.3 Central Server

It is a huge data store computer, which has the complete operational data about the system. It has great computational capabilities to perform operations in the range of microseconds. It can support various powerful web-based languages. It also supports the connectivity of large number of devices into a single point. It also has a large database to store the incoming data which in our case could be the geolocations, user details, institution details, etc. The capability of the hardware can be more explored with a beast programming language.

4.4 Working Methodology

The proposed system works on below algorithm, where the vehicle driver has the android device connected to the server via internet. The android app has been integrated with the Google Maps API to guide the driver to nearest emergency institution. The details of the institutions and the details of the traffic island are stored in the server which is added and accessed by the admin module. The Traffic controller module is also connected to the same server, thus making it to update the status more quickly. The android application on trigger from the Geofencing API sends request to the server to inform about the traffic island ahead. On the request, server perform operations to clear the route for the driver. The following algorithm depicts the core operation steps.

LIFE operation Algorithm:

1. The vehicle driver selects the desired emergency handling institution in the android application and sets it as the destination.
2. Using Google Maps API, destination is routed.
3. Alerts are sent to the traffic control room, which are then forwarded to the corresponding officer in-charge.
4. Each Traffic signal post is equipped with an ESP8266 NodeMCU connected to a GPS sensor and a WIFI Hotspot.
5. With Geofencing we create a virtual circular boundary to the traffic post, so that we could track the in-out triggering of the emergency vehicle.
6. On reaching destination the driver will be asked to upload the necessary verification documents within a deadline.

5. RESULT ANALYSIS

The integration of edge in IoT with modern circuitry made the system less complicated. The LIFE application has given a breakthrough for fast emergency services and will be a boon in saving human life. The implementation of controller for traffic island with ESP8266 module reduces the need for the complex circuitry required, that reduces the implementation cost of hardware to 50% from the existing system implementation. Figure 3 shows Hardware cost comparison between the LIFE and existing system. Since the hardware of the LIFE being more robust and fault-tolerant, the maintenance cost of the system gets reduced to one-tenth of the existing system. Figure 4 represents maintenance cost comparison elucidate the implementation strength of LIFE over the existing system. This dramatic lower maintenance cost is due to the advantage of updating the controller remotely without much labour cost.

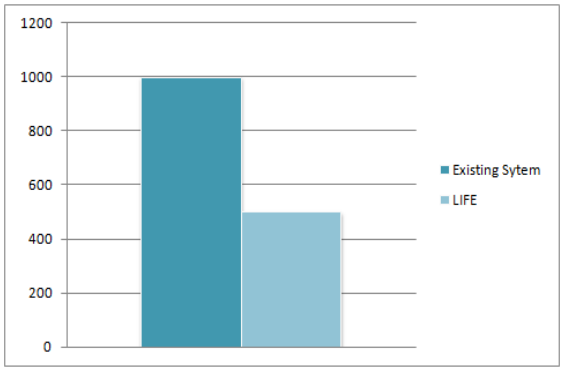

Fig -3: Hardware cost comparison

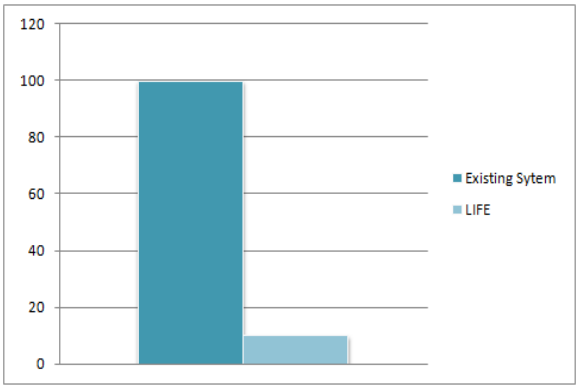

Fig -4: Maintenance cost comparison

The implementation of geofencing which causes the traffic signal to trigger in real-time, results in the less waiting time of an emergency vehicle at the traffic island. Figure 5 indicates the considerable reduction in waiting time by the implementation of LIFE

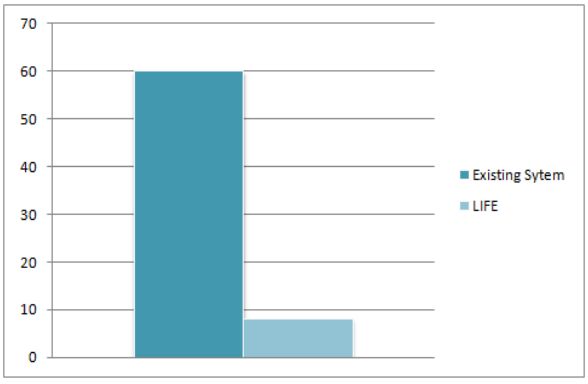

Fig -5: Minimum waiting time

6. CONCLUSIONS

LIFE is emergency traffic scheduler which helps emergency vehicles to pass through the traffic signal without being halted at signal. It provides an efficient way for automating the traffic signal based on geofencing concept. It gives the public an easy path to the destination within shorter span of time. The system tries to implement extra security to prevent from the fraudulent users by uploading a valid document within a specific period. So, the coordination of Internet of Things (IoT) and high-end security in LIFE provides an Intelligent Traffic System in the smart city. The system has an interactive user interface and design, making it simple and comfortable to the various actors and provides a fair solution to the existing system.

The system can be further extended to implement the traffic scheduler with right path prediction of the emergency vehicle in the case of a four-way junction. The next major concern arises is the security and safety, as the application is open for all users who want to create an emergency, there may be fraudulent users who may gain access for selfish purposes. In the era of data, another modification to our system would be to generate an efficient low energy system which can reduce the data transmissions between the IoT module and the server. Another risk lies in the use of a centralized server which is more prone to attacks and hardware failure.

With some improvements to the proposed system, it can be developed to work as a spool proof product which can be implemented in densely populated developing countries.

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