AUTOMATIC TOLL COLLECTION AND VEHICLE MONITORING USING IOT

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Abstract: This paper addresses the problems that one has to face at toll plaza & also introduces system for vehicle identification against which stolen and accident cases are registered in police station using UIN (Unique Identification Number). Whenever a vehicle approaches a toll gate, it is identified as passenger or goods carrying vehicle based on Unique Identification Number (UIN). A goods carrying vehicle is weighed at TCU and if it is overloaded then it will be charged with extra penalty. After that UIN is sent to Central Server Unit (CSU) where the balance gets deducted from account which is registered with UIN system. Once the balance is deducted at CSU it will indicate TCU which is toll collection unit to open the barricade and vehicle is allowed to pass. If the vehicle is stolen then it will indicate TCU to not open the barricade. To overcome the problem of hit & run cases, a mechanism is introduced using piezoelectric sensor at toll gate to spot the RFID of collided vehicles.

***Index Terms*: GPS, Toll Collection, Anti-collision device, RFID, Zigbee, IOT 802.15.4;**

I.INTRODUCTION

Automobile invention is considered as one of the greatest achievements of human's era and this industry has contributed in many ways to the growth of this planet. However, all the vehicles need good roads or highways to run at their full efficiency. These highways are usually built by government to provide public a better connectivity option. But these highway projects are really very costly and it is built by taxpayer's money. Hence one need to pay toll tax on the highway while using it. But this is a well-known fact that due to toll plaza on the highway, there is always a huge traffic jam on highways every now and then, because this entire process requires at least two minutes to five minutes, depending on type of vehicle and weight limit of vehicle. Due to this, we often face a long traffic jams on highways connecting two big cities. Our proposed system can reduce time for this entire process at toll plaza by using various sensors at vehicle and toll gates. This paper shows how smart sensors interface network [1] can help achieve this goal across all toll plazas across the country. In this paper we are introducing an advance system which can not only reduce the time period for the entire process but also make this task very easy and makes toll-collection possible without even stopping the car and all the toll collection process is being cashless, direct from the vehicle owner's bank account.

Apart from the toll collection, our system also focuses on the safety system of the highway. We all know the truth that thousands of people lose their life or meet with life changing accidents due to vehicular collisions on our highways every year. Our system can also track theft vehicle and vehicles which have met with an accident.

Here we are introducing a system for moving vehicles using Global Positioning System (GPS) and a wireless communication module of IEEE 802.15.4 Medium Access Layer (MAC) and Physical (PHY) specification [2] operating on the license free Industrial Scientific-Medical (ISM) band of 2.4 GHz. To the best of the authors' knowledge, this is the first work developing a vehicular anti-collision system on IEEE 802.15.4.

The paper structure is as follows. Section II shows the related work in this area that is being done by other researchers and provide motivation for this paper. Section III explains about the proposed model and section IV gives the performance of image processing, GPS module and the IEEE 802.15.4 communication module. Section V shows the future advancements and future scope for this paper.

II. RELATED WORK

There have been so many works done on smart toll plaza to reduce time in toll collection. Some of them are listed here:

1. E-Toll plaza: The work on E-Toll plaza has been done to reduce the overall time at toll collection point during toll collection. This work has been done by authors [3] in 2nd International conference on information and communication technology.

E-Toll card is basically a prepaid card which needs to be recharged before use. During toll collection, driver needs to present the card and the exact money will be deducted from the card and it will result in reducing overall time taken at toll plaza hence it will reduce the traffic load at toll gates. This system has really a lot of advantages, it reduces time, it increases the transparency and it reduce the traffic load. The only drawback of this system is that, this E-Toll card needs to be recharged every time you cross a toll gate, otherwise the vehicle can't be passed through it.

2. RFID Based automatic toll-collection: An RFID based system has also been surveyed by authors [4] in IEEE international conference, 2016. In this system they have introduced a system in which RFID is being used to identify the vehicle using its radio frequency waves. Each RFID has its own unique wave simulation, this wave can be identified at Toll collection unit and hence the

vehicle can be identified and the amount can be deducted from the vehicle's owner account directly. Advantage of this system is that, in this system the vehicle does not need to stop entirely, it needs to slow down at toll gate and once its RFID is identified it can pass through toll gate. It will save a lot of time on highway and it is more convenient system than any other present system.
There has been more work done on this apart from these surveys, but these three surveys provide the foundation on which our proposed system is based.

III. PROPOSED SYSTEM

In our proposed system we can monitor each vehicle by using image processing and unique RFID tags which will be preinstalled on all the vehicles. It will be a one-time process where all the vehicle owners have to install the device on their vehicle and link their information with the bank so that toll can be deducted automatically from their respective banks. This system comprises of two main sections:
1. Toll section
2. Vehicle section

1. Toll Section

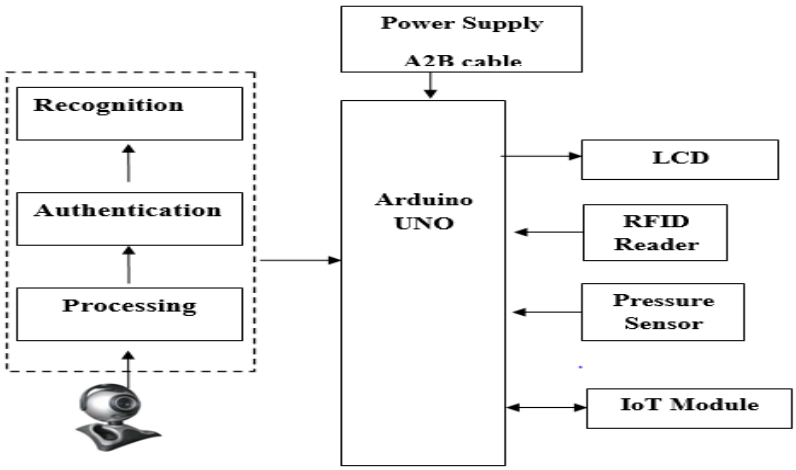

FIG 1. Flow diagram of Vehicle Section

2. Vehicle Section

Vehicle section consists of RFID scanner, a Zigbee module, always-on GPS and IOT module. Once the device is installed on the vehicle, it can track vehicle's all information like its speed, its fuel tank status and weight limit and it can also alert the driver to take specific action based on certain situation. This device is also equipped with an always-on GPS sensor which accuracy is about 7 meters and thus it can locate the device with almost 100% accuracy. All the vehicles' data is updated on the cloud servers in every 10 seconds.
Using piezoelectric sensor which is installed on toll section, we can also tell if the vehicle has met with an accident and we can track those vehicles on highway and stop them on the toll plaza to take appropriate action. If the vehicle is stolen and a vehicle theft complaint is registered it can be track using the same RFID signals because it emits a specific pattern wave which generates a string and that string can be identified easily at toll gates. If the vehicle is overloaded, then the sensor can send the signals to the toll plaza when the vehicle reaches in the range of toll plaza and overloaded vehicles can be stopped and charged according to their load. In essence, our system can detect stolen vehicle, and track vehicle's exact location.
To locate vehicle with almost 100% accuracy, we use the GPRMC [5] format, which is also known for its minimum recommended range for an antenna [6]. The string length of GPRMC is approximately 80 ASCII characters long and this string gets updated on the server every second.

Working Principle: In the proposed method, the image processing unit is used to identify the vehicle number and the pressure sensor is used to identify the weight of each vehicle. The money is deducted from the vehicle owner's account by using RFID. The data is updated to the cloud. If the vehicle is a theft vehicle, the barricade does not open.
Here RFID and Camera will work together. The camera on the toll plaza will continuously capture frames of approaching vehicle and later using image processing vehicle's approaching speed can be traced. This will be done by using image processing algorithms. Here in this part we are using image enhancement and frame comparison to identify vehicle speed.
The image processing system block diagram is shown below:

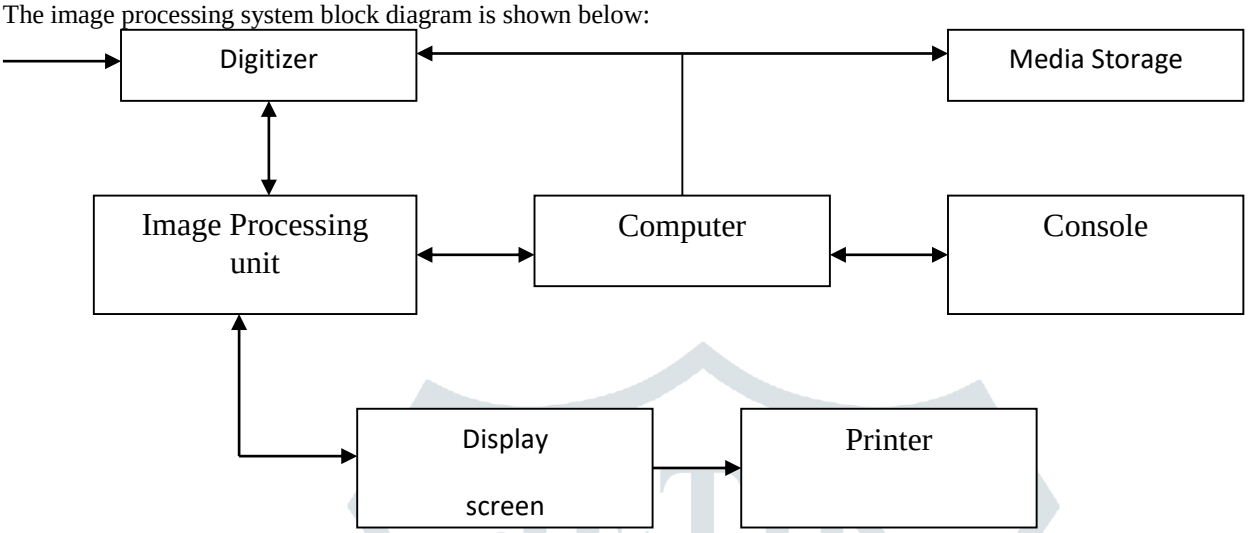

FIG 2. Image processing system sequence

Image processor: The main function of an image processor is image acquisition, storing image, preprocessing the image then segmenting the frames and finally interpretation of the image and it displays the resulting image after the analysis. Diagram shown below gives the sequential steps involved in image processor:

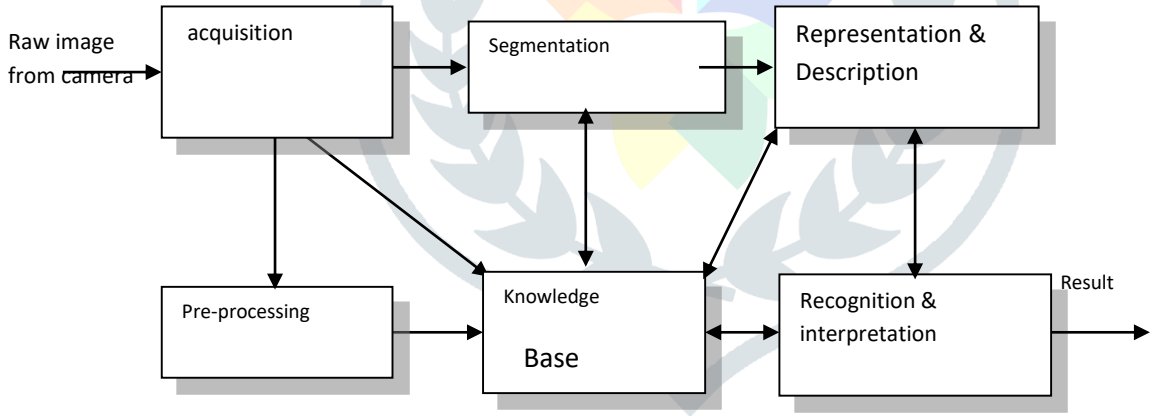

FIG 3. BLOCK DIAGRAM OF FUNDAMENTAL SEQUENCE INVOLVED IN AN IMAGE PROCESSING SYSTEM

As shown in the diagram, first step of image processor is to take the raw image from image sensor as input then by the help of a digitizer convert the image into digital form. Second step is pre-processing of the image. Here in this step the image will get enhanced and this improved quality image will be sent for processing. The main objective of image pre-processing is enhancing the image, remove noise from the image, isolating background from the subject etc. After pre-processing the image is sent for the segmentation where image is divided into different parts and objects. Each object shows a raw pixel based on the color region. Image representation is the step where raw pixel image data is converted into useful subsequent data. Knowledge base guides the entire operation that is being carried by the image processor. Normally the image processor takes images at the rate of 25 to 30 frames per second. This frame rate helps in calculating speed of approaching vehicle.
When vehicle approaches toll gate, active RFID sensor on the vehicle emits a wave which is then verified at the receiver RFID and then certain amount is deducted from the bank account of owner. RFID is connected with the IOT module and this module updates all the information on the cloud server, like at what time vehicle crossed which toll or at what time it was crossed a specific location etc.

Code snippets of vehicle number plate identification using image processing:

```
preview(vid);
        % Resize the image
        I=imresize(I,[512,512]);
        figure,imshow(I);
        title('INPUT IMAGE');
        I = im2double(rgb2gray(I));
        figure,imshow(BW);
        fin_txt = ocr(BW);
        yy = fin_txt.Text;

          if aaa == 1
          msgbox('Enter the car 1');
            ccf = 1;
        elseif bb == 1
           msgbox('Enter the car
   end
```

Since the algorithm only accepts binary input hence it converts all the images into black and white image where 0 stands for black and 1 for white color.

FIG 4. Real image from camera

FIG 5. Converted black and white image

If vehicle number is matched with database then it will pass the signal to toll gate and toll will deduct the amount otherwise it will show document missing and it will not allow the vehicle to pass.

Code snippets of vehicle location tracking:

```
void ggg();
void gps(); //predefined function in Arduino //lib
char str[70];
void iot(String stringdata);
String gpsstr="";
String lat="No Range     ";
String lon="No Range     ";
```

Loop iteration starts:

```
void loop() {
  gps();
  delay(1000);
}
```

IV. RESULTS

As we have mentioned that this device monitors vehicle's exact location with accuracy of upto 7 meters [7], it gives coordinates of that particular location along with time and dates which makes it more useful for vehicle's tracking purpose. The figure below shows the console of cloud server which gives the information about vehicle type its and time along with latitude and longitude value. This information can be used to track exact location of the vehicle.

LogID	DATA	DATE__TIME
1	hi	25/3/2019__16:33:8
2	SIXWHEEL_VEHICLE	25/3/2019__16:36:31
3	SIXWHEEL_VEHICLE	25/3/2019__16:36:33
4	SIXWHEEL_VEHICLE	25/3/2019__16:36:35
5	SIXWHEEL_VEHICLE	25/3/2019__16:36:37
6	ONE_DOC_MISSING	25/3/2019__16:37:19
7	SIXWHEEL_VEHICLE	25/3/2019__16:38:6
8	SIXWHEEL_VEHICLE	25/3/2019__16:38:8
9	SIXWHEEL_VEHICLE	25/3/2019__16:38:10
10	SIXWHEEL_VEHICLE	25/3/2019__16:40:8
11	ALL_DOCUMENT_OK	25/3/2019__16:40:12
12	latitude:_	25/3/2019__17:6:27
13	longitude:_	25/3/2019__17:6:29
14	1302.1613_	25/3/2019__17:6:31
15	1302.1767_	25/3/2019__17:6:34
16	08013.8884_	25/3/2019__17:6:33
17	08013.8366_	25/3/2019__17:6:36

FIG 6. Cloud server console

V. CONCLUSION & FUTURE SCOPE

In recent years IoT has gained a large attention from consumer electronic industry to automobile industry to researchers. Now it has become a trend and this trend will continue in future as well. In immediate future we are going to witness many amazing applications of IoT in our home, office and in our businesses. IoT can change the entire industry because now a days everyone needs automation. One major player in this industry is IBM [8] and Bluemix Foundation [9]. These companies are working on smart vehicle system. Apart from this, this system can be enhanced for security by the help of GPS, Zigbee and RFID. This system will help boost the research in IoT enabled automation.

In near future IoT enabled vehicles are going to lead the commercial activities because it's easier to monitor those vehicles using a centralized server.

VI. REFERENCES

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