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A Novel Smart highway automated toll collection system using Raspberry PI& OpenCV

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ABSTRACT.
Automation being the need of today has made tremendous advancement in all most all areas.One of which is Automatic toll collection which is rapidly becoming a globally accepted system. The existing toll collection being manual in nature is time consuming, therebyleads to traffic congestion, pollution and a lot of frustration.It also necessiates for the manual services to be rendered continuously through the day and night.Ever increasing need for efficient, reliable, safe, and cheap toll taxation along with imageprocessing resulted in the development of different kinds of solutions. We have prposed an smart Automatic TollCollection System using Optical Code Recognition and Encryption system in which vehicles arriving at the toll plaza were detected using an IR proximity sensor and a data is updated in the server using a Raspberry Pi. Our propsed sytem.aims at successfully removing unnecessary traffic delays, faster and reliable processing, and also keeping an eye onunauthorized vehicles, etc.

Keywords: Raspberry, Smart, image processing, etc.

I. INTRODUCTİON

Automation being the need of today has made tremendous advancement in all most all areas.One of which is Automatic toll collection which is rapidly becoming a globally accepted tollcollection system. Initial toll collection being manual in nature was time consuming, therebyleading to traffic congestion, pollution and a lot of frustration. Quite obviously, this process makesit necessary for the manual services to be rendered continuously through the day and night. Everincreasing need for efficient, reliable, safe, and cheap toll taxation along with image processinghas resulted in the development of different kinds of novel solutions.

Image processing based Automatic Toll Collection Systemuses Optical Code Recognition and Encryption aiming at successfully removing unnecessarytraffic delays, enabling faster and reliable processing, and keeping an eye on unauthorized vehicles, etc.

In this paper we present a model based on image processing which can be employed for realtime automatic vehicle toll collection system. A High Definition (HD) camera was used to capturean OCR code of an incoming vehicle's windshield. This is followed by the process of featureextraction. Based on the observed feature the vehicle's verification is done and automatic toll deduction process is carried out thereby allowingthe vehicles to pass easily.

II. LİTERATURE REVİEW

The concept of automatic toll collection has been studied since 1992 and is based on the RFIDTags. The research paper titled "Electronic toll collection system usingpassive RFID technology" gives the overview of the toll collection system using RFID.The concept was based on existing toll booths; however human intervention was no longer required.The vehicles will be given a passive tag in the form of a sticker which could be affixed on thewindshield, just like in the existing road tax system. Each time the vehicle passes the toll booth,the tag will be read and information will be transmitted to the main computer. The tax amountwill be either deducted by prepaid or credited by postpaid.

"Automated TollCollection System using RFID" was done with the help of radiofrequency. A vehicle will hold an RFID Tag. Reader will be strategically placed at toll plaza.When the vehicle passes the toll, the tax amount will be deducted from his prepaid balance.

The shortcoming of the existing system the tag can be read only at very short distances, typicallya few feet at most. This greatly limits the device for certain applications. The tag remainsreadable for a very long time, even after the

product to which the tag is attached has been sold and is no longer being tracked We have proposed an automatic toll collection system in which vehicles arriving at the toll plaza were detected using an IR proximity sensor and a pulse is generated which is sent to the Raspberry Pi. The Raspberry Piimports the MySQL database from the server when the Raspberry Pi is connected to Wi-Fi. The database can be updated locallywithout internet connection and it can be updated in the server whenever it's connected tointernet.The microcontrollerprovides a message to computer via an USB TTL module about the presence of the vehicle. Raspberry Pisignals the HD webcam to take a picture. Webcam in turn sends the captured image to thedatabase, where the processing, matching and deduction is performed. The Raspberry Pi in turnalerts the motor driver to open the gate and allow the vehicle to pass. In case if the balance of thevehicle is NIL, it blocks it and asks it to join the manual lane which is joint to it and pay theremanually Thus the processing becomes faster and no traffic congestion takes place savingmoney, time, fuel, etc.

III. SMART HİGHWAY TOLL COLLECTİON SYSTEM

The complete block diagram and the schematic for our work is shown in Fig 1.

3.1 USB web camera

Web camera used was Logitech 720 USB web cam. It was connected to the RaspberryPi via USB port. The USB webcam captures high definition image at the rate of 30 frames persecond and sends it to Raspberry Pi for further processing.

3.2 IR sensor

This sensor was used for detecting motion. Vehicles emit infra-red radiation in the rangeof 9-10 micro meters. It is capable of exactly detecting this particular radiation. Hence the sensor exactly detects vehicle. IR sensor consists of 3 pins (VCC, ground, output). Whenever motionis detected, the output of this IR sensor goes high. The output pin of this sensor is connectedto pin no. 18 of Raspberry Pi and VCC and ground pins are connected accordingly.

3.3 Gsm module

This block consists of a SIM900 GSM module. It was used for sending the messages tothe owner of the vehicle. It was connected to Raspberry Pi via USB connection.

3.4 Server

It is used for storing vehicle information. The information stored in the server was doneby MySQLdb and Phpmyadmin.

3.5 RS232 to USB converter

GSM module has only RS232 connection, on the other hand Raspberry Pi has only USB slot. Tomake a connection between GSM module and Raspberry Pi, this converter was used.

3.6Raspberry pı

Raspberry Pi acts as the heart of the system. It is the processor for the entire setup. Ithas 3 USB slots for connecting USB web camera, and GSM module. Raspberry Pi has 40GPIO pins. The 18th pin, VCC and ground pins are connected to IR sensor. The 23th pin andground pins are connected to LED (For Motor)

The Raspberry Pi does the following actions:

1) The Raspberry Pi provides power supply to USB webcam, IR sensor and LED.

2) It initializes the USB webcam to capture the image when IR signal interrupt the
Raspberry Pi.

3) Then the USB webcam captures the image and image processing was done usingOPENCV to obtain the threshold image. Next the threshold image was send to OCR, where the vehicleno was extracted.

4) Now the vehicle no was sent to the server where it can check for the already existingvehicle number in the database registry. If the vehicle no is not available in the databaseregistry then the phpmyadmin asks for new entry or the client can take the manual way.

5) If the vehicle no. is already available in database then it checks for the balance
detail, if the available balance is more than the minimum balance the toll tax is deducedand the balance information is send to the client using GSM module and the gate (LED isON) is opened for the client to cross the toll plaza , else the balance is less the client isdiverted to the manual lane to pay cash and the balance information is updated via GSMmodule.

6) The above process is continuously done and all the toll information is updated to theserver

IV. NUMBER PLATE İDENTİFİCATİON

The image of the vehicle is captured using a high resolution photographic camera. Characterrecognition is generally very sensitive to the skew. The readable characters can becomedistorted due to the obliqueness of the camera. Using a better camera with more definitionand resolution will increase the success ratio of the system. The obtained images were converted to grayscale. Preprocessing was done by employing a bilateral filter which had excellent results in reducing noise and also preserving the high frequency information. Followed by filtering, the image was localized to enhance the region of interest.

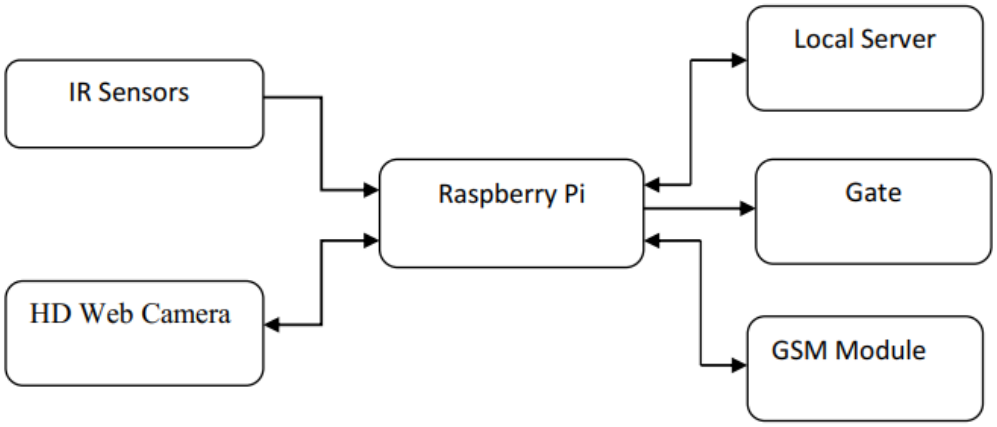

Fig. 1. a) Block Diagram of Smart Highway Toll collection system

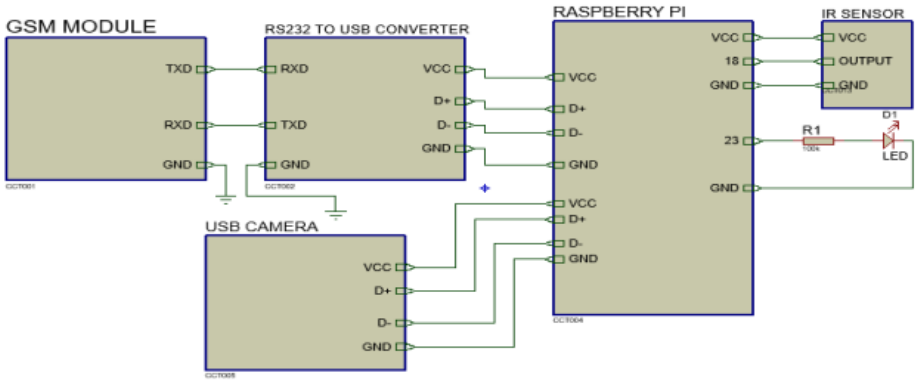

Fig. 1. b) Schematic Diagram of Smart Highway Toll collection system

Localization is basically a process of binarizing the image. Localization was done by an image processing technique called Thresholding. The pixels of theimage are truncated to two regions depending upon the value of threshold. Threshold requirespre-image analysis for identifying the suitable threshold value. Adaptive thresholdingtechnique determines a local optimal threshold value for each image pixel.

Finally, the threshold image was sent to the OCR interface. The Optical Character Recognition (OCR) Engine, returns the ASCII of the license number.Tesseract OCR engine has a Python wrapper, which make character recognition quick andeasy.

Fig. 2.a) Original captured Image b) Image after Thresholding

PY 01 BE 1627

Fig 3 Text output from OCR

V. CREATİNG THE DATABASE İN SERVER

Initially the connection with the localhost server has to be made The toll table that contains serial No., name, license plate no,vehicle type, prepaid amount, and remaining balance has been created.The toll database was uploaded in the server. The vehicle information is also included in the toll database.

VI. CREATİNG GUI IN RASPBERRY PI

Python has a huge number of GUI frameworks (or toolkits) available for it, from TkInter(traditionally bundled with Python, using Tk) to a number of other cross-platform solutions,as well as bindings to platform-specific (also known as "native") technologies. Tkinter provides various controls, such as buttons, labels and text boxes used in a GUIapplication. These controls are commonly called widgets.

Steps in creating the GUI using TkInter
1. Introducing Root Window
Tkinter uses the term 'root window" for a graphical window which accommodates all thewidgets. The first step in Tkinter GUI designing is to create a root window.

2. Adding Widgets
Widget refers to components that we add to the root window. This includes components like buttons, label, text area, menu, check button, entry, canvas,sliders and other elements that are added to the root window.

3. Adding Image

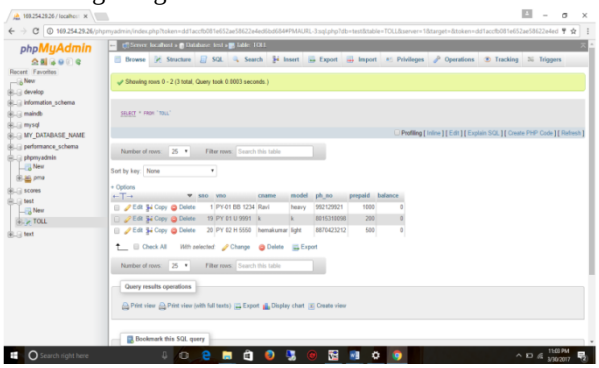

Fig 4 Database in server using phpmyadmi

VII.RESULTS & CONCLUSION

The Figure 5 image indicates that the registered vehicle has entered the toll plaza and themessage displayed "Authenciation ok" indicating that the toll tax amount was deduced andsimultaneously the toll information was updated into the server and message was sent to the client

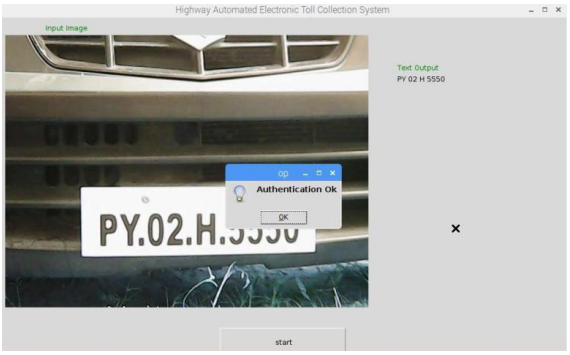

Fig 5 Output Image of System after Authentication

Figure 6 indicates a new entry to me made into the server. Figure 7 indicates the balance information of the client is sent to theregistered mobile number via GSM module.

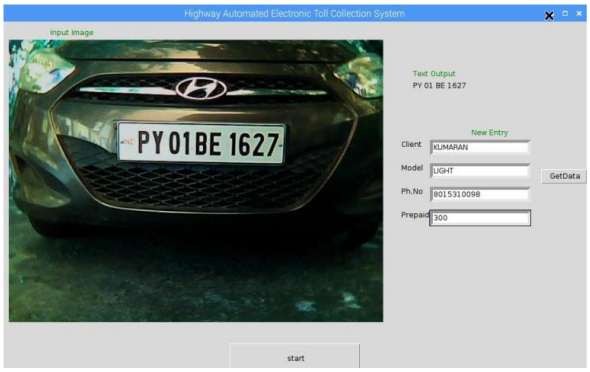

Fig 6 Output Image of System for new entry

This system mainly reviewed the research and development of the tax collection at the toll gate on highway with the help of Raspberry PI. The image was captured using an USB based web camera and was proccessed to extract features from the image for recognition of Optical Characters.

Fig 7 Toll Message

The text output of OCR was added to the SERVER database using phpmyadmin. Everytime a vehicle approaches based Image detection and OCR recognition the toll was calculated automatically by compating with the database. Such a toll collection system will be immensely useful to avaoid traffic conjection and improve smooth vehicle travel.

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