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ECONOMICAL AUTOMATED TOLL COLLECTION SYSTEM USING IMAGE PROCESSING AND RASPBERRY Pi.

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ABSTRACT

Many developed countries today are having the highway toll system developed and used widely. Radio Frequency Identification is used mostly. In developing countries RFID is not possible for each car because to use it is still a costly solution and so in developing countries image processing technique is used to detect license plate for auto toll system. The problem of high price of host device (e.g. computer) to run the system is not solved yet. This is why implementation of image processed toll system is limited in some places. This project is developed where raspberry pi will be used as host. This is basically a minicomputer which has the ability of image processing and controlling a whole toll system.

KEYWORDS: Raspberry pi B+ model, Image processing technique, Toll system, Electronic toll collection system, intelligent transportation system.

1. INTRODUCTION

The amount of vehicles is increasing rapidly in developing countries. So the question of manual toll system has become a real concern. Hence it is difficult for leading developing countries to implement automated toll system due to its vast vehicle amount and also cost is high to implement it on a large scale.[1] Government has taken steps to digitalize all vehicles license plate number. So, countries with digitalized license plate numbers can use this project

to implement at a negligible cost for automated toll system.[2] Researches are there on developing image processing based toll system like Vehicle Number plate Recognition System for Automatic Toll Tax Collection by Shoaib Rehman[3] but it's based upon software computer dependent image processing system. In this project raspberry pi based image processing system depending automated toll system been proposed. Raspberry Pi can receive picture through Wi-Fi camera and then process the image of license plate. It will connect with database, search the user account and then subtract the toll from user account. As soon as the toll is received the barrier will be moved automatically and after the car has passed the barrier will be placed again automatically.

1.1 Raspberry Pi

The credit-card sized laptop and also capable of the many of the items that consumer desktop laptop like spreadsheets, word-processing and games. In addition it will play high-definition video. The system volume will not require an SD card but instead micro SD cards. It becomes even easier to organize, run and rectify many totally different operating systems on an equivalent hardware.

Unlike previous ARM boards running on linux , raspberry pi board do not need external ARM JTAG wiggler, neither it requires for the user to compile own Image nor Serial / USB connection. With the board which are required to install the operating system. Most Linux distributions for the Pi will live on a 4 GB micro SD card .But larger cards are supported there. Figure 1 shows the Raspberry Pi B+ Kit diagram.

The secret behind the computer is so tiny and powerful that the Broadcom BCM2835, a System-on-Chip that contains ARM l176JZFS with floating purpose, running at 700MHz, and a Video core four GPU. It means that if user plugs Raspberry Pi into HDTV, people can watch Blue Ray quality video, using H.264 at speed of 40MBits/s. The new Model B+ also has a 10/100 Ethernet port so the user can surf the web (or serve web pages) from wherever they are using the Pi.

As it is seen in the picture below, the Raspberry Pi is having a 40-Pin GPIO header, 4 x USB ports, 1x LAN port, 1x CSI and 1x Touch Screen interface, 1x hdmi port, 1x integrated audio and video output port. The board runs on single +5v power supply for that there is a micro USB female connector provided.

Fig. 1: Raspberry pi model B+

2. PROPOSED SYSTEM

System consists of raspberry pi model B+ with an 8 GB SD Card. Below is the system block diagram.

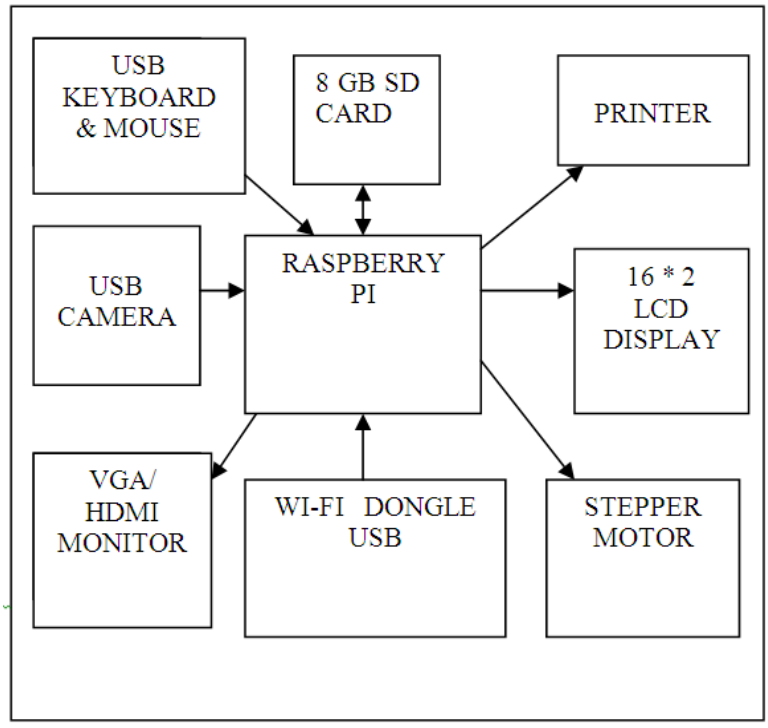

Fig. 2: Block diagram of the system.

There are two types of unit in this system. First is automated toll unit and second is manual toll collection unit. Both these units are connected internally through RF transceiver. But in this system we are implementing a single unit which is automated toll unit. If automated unit

face any obstacles like an unrecognized or not registered vehicle number, insufficient balance etc then the vehicle should to pay toll through manual system.

Automated toll processing unit consists of camera which will capture the license plate number. In processing there are Raspberry Pi, and we can use NRF24L01 transceiver for connecting to manual toll system & Wi-Fi USB dongle. In output section for token printing thermal printer, seven segment display & stepper motor are connected. Raspberry Pi receives the image from USB camera with Wi-Fi network. And by using optical character reading algorithm it identifies the license plate number. The raspberry pi is connected with internet, so it transmits the number to server for matching and subtraction of toll from users account. After successful toll transaction the stepper motor rotates 90 degree clockwise and opens the barrier. LCD display will back count of 20 seconds. Within 20 seconds vehicle needs to pass the barrier and after 20s stepper motor rotates again 90 degree anti clockwise and barrier is closed. Printer prints the toll token and the system becomes ready for the next vehicle toll.
If there is any problem occurs the vehicle is indicated to go to manual terminal so that user can make manual toll payment. Manual system also use of Raspberry Pi, as input here keyboard and mouse is used. In this operator will enter the license plate number manually. The toll amount will be entered manually and then printer prints the token.

Even if, raspberry pi supports a variety of different programming languages, for this system python is used. Python is the officially supported language for raspberry pi. There are number of different libraries available for raspberry pi to be used with python. Python is a perfect mix of easy to use as well as powerful programming features such as video/ audio processing, internet and email connectivity also available. Raspberry pi is having the Python 2.7 is installed by default and for all experiments, in this python 2.74 used with additional libraries. With Raspberry Pi, linux operating system, any required software can be directly installed from internet through lxterminal. In this the RPI.GPIO library used for python on raspberry pi for interfacing with device optocouplers and read the inputs. For the internet part, python's built in HTTPLIB is used which can effectively send GET requests also. Python code can be run directly from command prompt or an IDE called IDLE can also used to run python codes.

2.1 Software requirement of the system

Programming Raspberry pi can be done by various ways. It is a complete Linux based computer hence it can run all those programming languages which a Linux computer is able to run. It runs various programming languages starting from the most basic C programming

to advanced coding like Java or even Qt for GUI development. For embedded programming, there is need to install supporting libraries according to the programming language which is being used.

Operating system of the raspberry pi's which is raspbian preloaded with the GCC compiler suite. This GCC compiler does not need to be installed separately and hence raspberry pi directly run C programs without installing anything more. In the short time that the Raspberry Pi has been around. A considerable number of programming languages been adapted for the Raspberry Pi either by the creator of the language, who wanted to support the Pi by porting their creation, or by enthusiastic users who wanted to see their language of choice available on their platform of choice can be possible.

The Raspberry Pi Foundation recommends Python as a language for learners which are easy to understand. Any language which will compile for ARMv6 can be used with the Raspberry Pi, though; so not limited to using Python. C, C++, Java, Scratch, and Ruby all can be installed by default on the Raspberry Pi.

Python

Python is considered to be the simplest among all programming languages. That is the reason why many people prefer using python on raspberry pi. First python was being preferred by the raspberry pi foundation itself, later on, it becomes practiced. So that many people who wanted to write device drivers, firmware and sample codes for GPIO interfaces to raspberry pi, began to write all these things in python only. This leads to a wave of programming and material being done in python. The gitbuh.com contains different user contributed libraries to make working with raspberry pi using python a delight.

Python is a itself high-level, interpreted, interactive and object-oriented programming and scripting language. Python is designed to be a highly readable programming language. It uses English keywords frequently; instead other languages prefer to use punctuation. Python was developed firstly by Guido van Rossum in the late eighties and early nineties at the named institute "National Research Institute for Mathematics and Computer Science" in the Netherlands.

2.2 Algorithm of the proposed system

Fig. 3 shows algorithm for the proposed system. The important factor of this project is image processing. In this project to process the image of a number plate, matlab is used [4]. In this project template matching algorithm is used for purpose of database matching. This is the flow chart. First step is that the license plate number is captured through webcam and it crops an approximate area of license plate as the car stand motionless in front of the camera and the number plate extraction is done. To recognize the character on the number plate the software OCR that is optical character reading algorithm is used. By using the characters the licence number is identified and then the user account is opened thus the toll amount is deducted from the current user account.

3. RESULTS AND CONCLUSION

Along with the Python as main programming language, there is a need to use some additional libraries. These additional libraries are nothing but RPI GPIO library which gives access to raspberry PI's GPIO's and the HTTPLIB. These libraries can access the working internet connection of raspberry pi through programming. In the final program, need to handle most of the error exceptions which can occur due to the internet connectivity or GPIO errors. If the exceptions are not handled properly, then it can hang/stop the python program which is not desired in any condition.

The system when installed on a demo machine runs smooth for more than 24 HOURS continuously. The raspberry pi system is fully hardware optimized so that even if it runs 24x7 there is no problem. There can be only some issues if there is no internet connectivity, the program is kept lightweight and handled the internet connectivity exception, so that the program does not hang or automatically stop after such exception, rather it skips the exception and tries to POST the data again on the internet. Whenever there is connectivity, the data posting starts again. In this way, at the output the system which will sort the toll according to vehicles category. Thus it will deduct the toll amount from the user account. There are though some significant feature changes observed with different hardware configurations of raspberry pi.

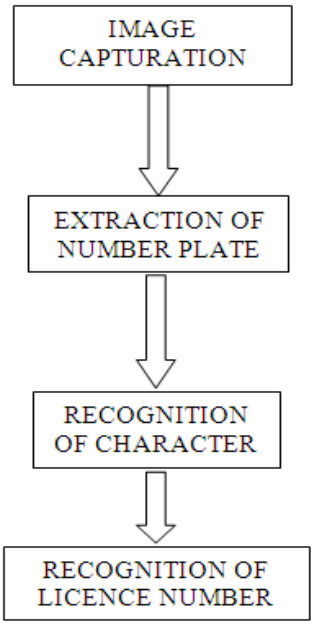

Fig. 3: Algorithm of proposed system.

3.1 Future Scope

The future of this system is very wide. Internet of Things is just opening its arms; there are endless fields where the same system can be applicable without any significant modifications. With the addition of a simple web camera, periodically, images can be taken and sent on the internet. E-mail sending is also possible easily on raspberry pi using the smtplib function present already. By combining all these features, this can be a complete production monitoring system or can be used as a building automation and control system. The applications are truly limitless. Wherever, data monitoring remote sending and remote controlling is required it can be used over there. The same system is applicable directly with little modifications. Thus, such a system can be implemented using a low cost computer like Raspberry Pi which can function like a mini computer.

The said system can run for 24 hours a day 7 days a week continuously for satisfying the most demanding application toll system. The latest advancements of technology and new boards coming every day, it apparent that all embedded applications and systems will be implemented as IoT application.

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