Raspberry Pi Based Image and Video Capturing of Wireless Access Point in ETC System

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Abstract

This project proposes the Raspberry based toll collection system for toll tax collection. Current toll collection systems in Myanmar make use of manual cash transactions. Exponential growth in traffic is observed in past years. Manual toll *collection systems are major bottlenecks of high speed commutation. This results in problems like longer queues, wastage of time and increased fuel consumption at toll booths. This project implements an electronic toll collection system using Raspberry Pi and passive RFID tags. These electronic booths automatically collect toll from user account corresponding to the RFID tag pasted on windshield of car. The toll is deducted from the user account each time it passes through a toll plaza. An RFID reader with high power and high directional property is placed overhead for detecting the passive tags pasted on windshield. On-site LCD screen displays details about the toll deducted and remaining account balance. Pi camera that is installed with LAMP (Linux, Apache, MySQL and PHP) and captures the cars passing the ETC. On successful transaction barricade is opened. Recharge facility for accounts having insufficient balance is provided on toll booths. This system addresses all issues like time wastage, fuel consumption and collection errors at one go. Electronic system will also bring transparency in toll tax collection and stop corruption and tax evasion issues.*

Key Words: *Raspberry Pi, RFID tag, Electronic Toll Collection, LAMP application, Access Point Architecture*

1. Introduction

Radio frequency identification is a wireless communication system that is used to identify tagged objects, people or animals. The area of applications for RFID is increasing rapidly. Applications include supply chain management, access control to building, security systems, animal identification, public transportation, healthcare, open-air events, air-port baggage, excess parcel logistics and so on.

RFID system consists of readers and a large number of tags. A tag has an identification number (ID) and a reader recognizes an object through consecutive communications with the tag attached to it. The reader sends out a signal which supplies power and instructions to a tag. The tag transmits its ID to the reader consults an external database with received ID to recognize the object. In this paper, RFID system is considered with 125 kHz, FSK modulation scheme.

Toll tax collection systems in Myanmar are based on manual cash transactions. The operator at the toll booth manually collects toll amount according to vehicle type, in form of cash bills. He hands the receipt for same. This modus operandi is time consuming. Due to such systems bottleneck is created in the high speed highways. There are chances of error, time wastage, and longer queues leading to fuel wastage.

The Raspberry Pi based toll collection system works as a centralized server which stores database of users. It has private IP address digitally 192.168.42.1 and shares the fifty android phones or iphones or computers. Raspberry Pi controls hardware i.e. RFID reader and simultaneously it communicates with the pi-camera.

1.1 Literature survey

Electronic toll collection was first implemented in 1986. After that many electronic toll collection systems are implemented with different techniques. Some of them are as follows:

System proposed in [1] uses Wi-Fi for communication with the smartphone of user. This phone contains all necessary data related to the user registration. User is registered at toll booth automatically as he passes through .But in countries with less smartphone penetration, system may not work effectively.

System proposed in [2] uses overhead camera to detect number plate and uses it as the account number of the user. Database is stored in central server. But deterioration of number plates or duplicate numbers may introduce false positives in the system.

System proposed in [3] uses NFC chips for detection of vehicle identity. The NFC chips are designed to work in the close vicinity of reader. If the distance between reader and chip is more than critical limit, system will not detect the vehicle.

Considering the limitations of former systems, RFIDs stand out with many advantages. RFID tags needs no battery as they can work perfectly with the power transmitted by RFID reader. Unlike number plate physical wear and tear has no harm. Distance of tag from reader is no issue as high power radio waves can detect the tag up to sufficient distance. Unlike Wi-Fi it does not require any authentication hence faster than system proposed in [1].

More to this the Raspberry Pi based toll collection system provides a cost effective implementation as components are fairly inexpensive.

2. SYSTEM DESIGN

This system is implemented with following major components:

- Raspberry pi model 3 B
- RFID Reader RC 522
- Pi Camera (5M, Infrared LED)

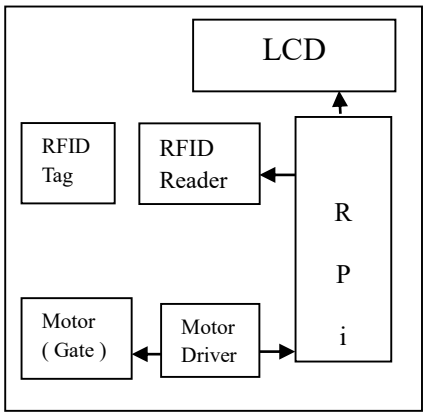

Figure 1. Block Diagram of ETC Bill System

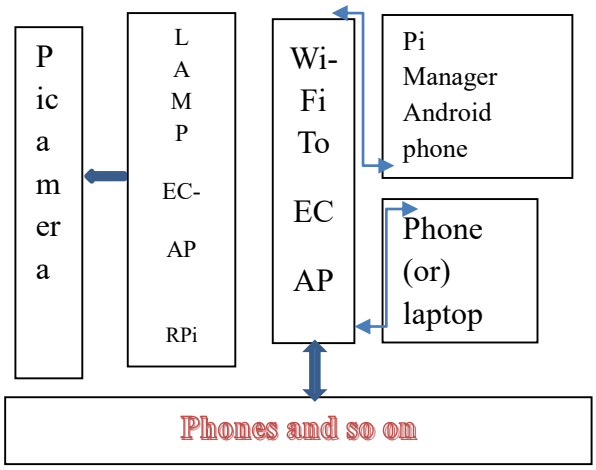

Figure 2. Block Diagram of AP System

3. RFID Reader

A Radio Frequency Identification system consists of an antenna or coil, a transceiver and a transponder programmed with unique information. RFID tag consists of a microchip connected to an antenna, which is constructed of a small coil of wires. Data is stored in the IC and transmitted through the antenna to a reader. Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a RF signal, and other specialized functions.

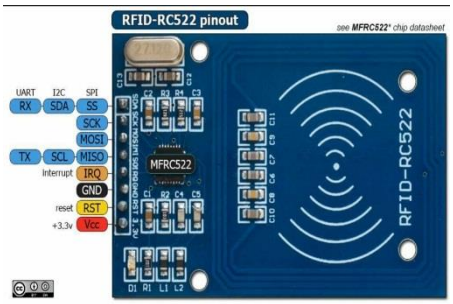

Figure 3. RFID Card Reader

The second is an antenna for receiving and transmitting the signal. A reader is basically a radio frequency RF transmitter and receiver, controlled by a microprocessor. It works on a 5V supply. Typical power consumption is less than 50mA. The reader, using an attached antenna, captures data from tags, then passes the data to Raspberry Pi.

The number contained in RFID tag is of 11 digits in HEX format. This number is sent via either serial interrupt or Wiegand protocol.

3.1 Pi Camera Connecting

The flex cable inserts into the connector situated between the Ethernet and HDMI ports, with the silver connectors facing the HDMI port. The flex cable connector should be opened by pulling the tabs on the top of the connector upwards then towards the Ethernet port. The flex cable should be inserted firmly into the connector, with care taken not to bend the flex at too acute an angle. The top part of the connector should then be pushed towards the HDMI connector and down, while the flex cable is held in place.

Figure 4. Pi camera in Raspberry Pi

3.2 Edimax

The best location to place the Wi-Fi extender is one which is an open space, roughly in the middle between the router and the Wi-Fi ded zone, and where the Wi-Fi extender LED displays the “excellent” signal strength.

The Wi-Fi performance can be affected by environmental factors such as the thickness and proximity of walls, or interference from other devices such as microwaves or wireless telephones, and choose of the location of the extender accordingly.

Supports 150 Mbps 802.11n wireless data rate – the latest wireless standard.

Permits users to have the farthest range with the widest coverage. (Up to 6 times the speed and 3 times the coverage of 802.11b).

The Raspberry Pi 3 is required with 2.4 GHz Wi-Fi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) in addition to the 10/100 Ethernet port.

Another consideration of 802.11n is the significant increased electrical power demand in comparison to the current 802.11b/g or 802.11a products. This is primarily due to multiple transmitters.

Figure 5. Edimax Wi-Fi Dongle

4. System Working

When the vehicle passes through the toll plaza, the RFID tag is detected by the RFID receiver placed overhead. This reader is constantly emitting RF waves at 125 kHz. As soon as the tag comes in field of receiver, the tag number is detected and sent to Raspberry Pi via serial interface. The LCD will display card detection message and number of card.

If sufficient balance is present in corresponding user account then stipulated amount will be deducted. This amount depends upon type of vehicle. The motor driver will open the gate for 30 seconds and the vehicle will pass through the toll booth. In case of insufficient balance in user account the user will have to pay toll manually with some penalty. The user can recharge his account from the toll booth itself. We can know the type of vehicle from initial registration. New user can also be registered at the toll booth.

Currently system uses prepaid mode. This can be changed to postpaid. For the prepaid system online recharge system can be implemented. By using the Pi Camera to get the most stable system of RFID through image and video capturing. These still image and movies of tolled cars can be attained by download of Web-Pi Cam interface via computer or phone.

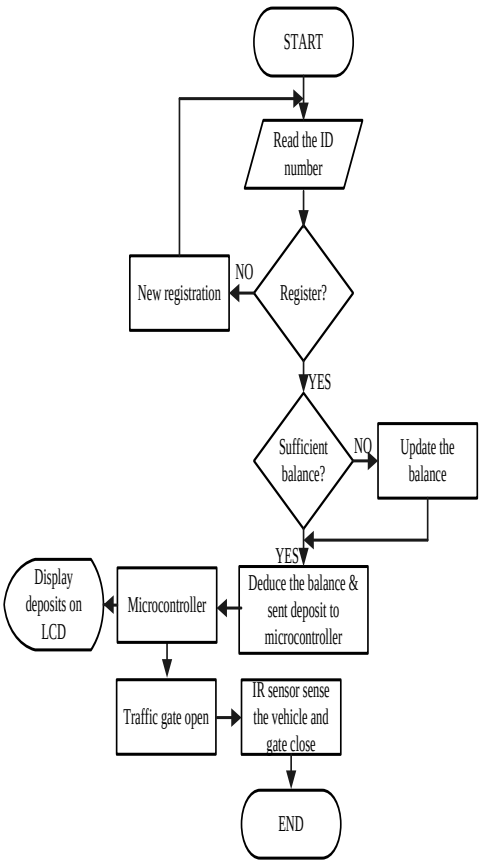

Figure 6. Flow Chart of ETC Bill System

4.1 Configuration Process

In this project, Pi 3 is served as Server type computer to build hotspot server and SSH server. Debian Operating System is used in this project to establish a DHCP(Dynamic Host Configuration Protocol) used on Internet Protocol (IP) network for dynamically distributing network configuration parameters such as IP addresses for interfaces and services. Used Linux command to establish DHCP based wireless network. The IP address of the system is 192.168.42.1 and allows 50 users to access simultaneously.

DHCP is only to setup IP automatically within the given IP range. In this project, we use Apache web server which is based on an open source license and runs on most LINUX-based operating system. Apache acts http web server and port is 80. We need to establish SSH server which uses the secure shell protocol to accept connection from remote computers. SSH is typically used to log in remote machine and execute commands and it can transfer files using the SSH file transfer protocol. SSH server port is 22. After finished establishing SSH server, we can control Pi 3 via smart phone to perform specific tasks for nonstop collection.

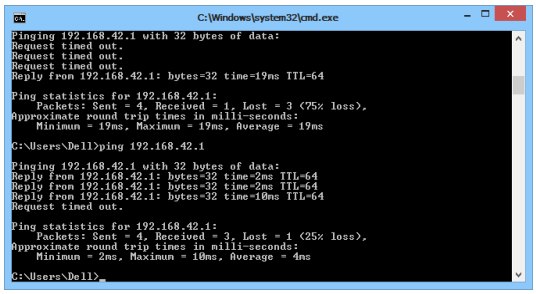

Figure 7. 192.168.42.1 Pinging

5. Photos and Videos Capture

LAMP server is running on a Linux application created with Raspberry Pi Camera interface of Cam Control v6.4.11: mycam@pi developed by Python language. All necessary functions are implemented in this access point server. It gives comprehensive control of the system from access point EC_AP server. And then take in the internet access of http://192.168.42.1/html page. After getting the RPi Cam Control, photos and videos can be shot and downloaded at phones and laptops simultaneously.

Figure 8. Pi Camera and LAMP Rpi

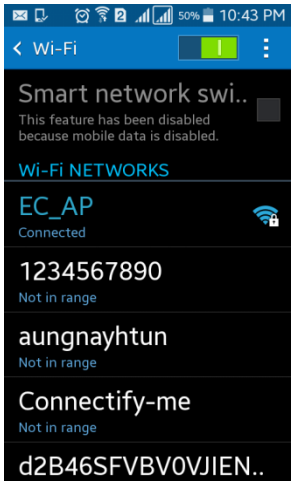

Figure 9. EC_AP Wi_Fi Connection

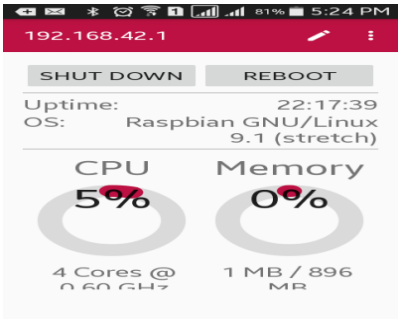

Figure 10. Shutdown of Access Point

Figure 11. Main Contribution of RPi

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8. Conclusion

Issues like long queues are completely eliminated by implementation of the system. This system saves time and fuel. Transparency in toll collection is increased as reports are stored digitally. Need for manpower is reduced on a large scale. User will get proper information of his account on the toll booth UFD(User Fair Display). Skipping of toll will be avoided. This system will ensure faster commutation on highways.

Acknowledgement

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