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Design RFID tag and implementation of RSSI based automatic toll Connection

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Abstract: Electronic toll collection (ETC) systems are designed to assist in the management of toll operations through technology that aids in streamlining traffic movement. ETC aims to eliminate the delay on toll roads by collecting tolls electronically. ETC determines whether the vehicles passing are enrolled in the program, alerts enforcers for those that are not, and electronically debits the accounts of registered vehicle owners without requiring them to stop. ETC involves four major components: Automated vehicle identification, Automated vehicle classification, Transaction processing, Violation enforcement. The database and report capabilities allow for better management of tolling operations, ensuring maximum revenues. This system detects distance between the vehicles and the reader using RSSI and debits from the account. Received Signal Strength Indicator (RSSI) is a measurement of the power present in a received radio signal. My project consists of an integrated vehicular unit onboard with wireless transceiver and a roadside reader with wireless transceiver and web access to debit from vehicle owner's account. The vehicular unit automatically communicates with the reader when it enters the range and transmits its identification. The reader based on the identification received, deducts money from the vehicle owner's account and sends a message to the owner. Other vehicles are indicated in case of arrival of an emergency vehicle in the range to yield the way to the emergency vehicle.

Keywords: Received Signal Strength Indicator (RSSI), Automated vehicle identification, Automated vehicle classification, Transaction processing, Violation enforcement. wireless transceiver and web access.

I. INTRODUCTION

As per 2013 estimates, the total road length in India is 46, 89,842 km, making the Indian road network in the world after the United States. At 0.66 km of highway per square kilometer of land the density of India's highway network is higher than that of the United States (0.65) and far higher than that of China's (0.16) or Brazil's (0.20). This project, aims in collecting the toll fees from the subscribers at toll collection points on these improved highways. This underlines the need for large scale tolling of the highways. As the volume of traffic increases, the current method of manual toll collection with or without using computer generated receipts, becomes inefficient prone to leakage and difficult to sustain. The method of payment requires vehicles to stop at toll plazas and wait a relatively long time for their turn to come. The Current state of congestion and operational inefficiency at toll plazas prompted to plan and implement an integrated ETC system, which can facilitate convenience for subscribers, and transparency & efficiency for operators. The ETC implementation on India's highway network aims to ease delays and traffic congestion at toll collection points. The ETC system would enable a smoother thoroughfare of traffic at toll plazas by facilitating Automatic Vehicle Identification (AVI) and electronic collection of toll. Considering user convenience, rate of acceptance and ease of implementation, wireless technology is used to implement the same.

II. BLOCK DIAGRAM

The proposed ETC detects distance between the vehicles and the reader using RSSI instead of using GPS. Here the signal strength is used to detect the position of the vehicle and the amount is debited from the closer vehicle owner's account. The proposed system consists of

- An **integrated vehicular unit** onboard with wireless transceiver
- A **roadside reader** with wireless transceiver and web access to debit from vehicle owner's account

The vehicular unit automatically communicates with the reader when it enters the range and transmits its identification. The reader based on the identification received, deducts money from the vehicle owner's account and sends a message to the owner. Other vehicles are indicated in case of arrival of an emergency vehicle in the range to yield the way to the emergency vehicle.

A unit with zigbee module as wireless transceiver is integrated in all the vehicles with different id for each vehicle. The id is used for vehicle classification and amount transaction by using the web server at the reader. The vehicular units synchronizes with the reader and the vehicle at least distance is accessed first and amount is deducted. Also if one of the vehicles is an emergency vehicle, the other vehicle are indicated the yield way to emergency vehicle.

The Electronic toll Collection helps with the following aspects: Increase in toll lane capacity, throughout, and revenue Reduce traffic congestion .Minimize revenue leakage. Enhanced audit controls. Maximize customer satisfaction. Low Cost Path to Regional/National Interoperability. Increase revenue collection decreased cost per transaction .Innovative pricing models to meet toll authority needs

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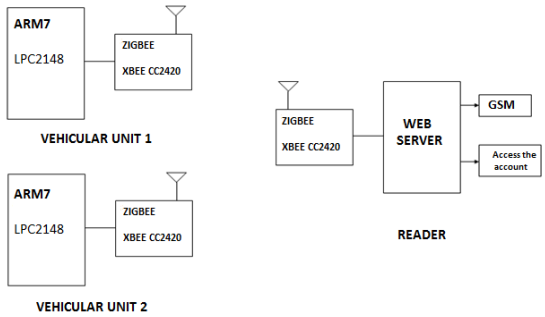

Fig1. Block Diagram for Implementation Of RSSI Based Automatic Toll Connection

A. RSSI implementation techniques:

Received Signal Strength Indicator (RSSI) is a measurement of the power present in a received radio signal. RSSI is a generic radio receiver technology metric, which is usually invisible to the user of the device containing the receiver, but is directly known to users of wireless networking of IEEE 802.11 protocol family. There two ways to detect RSSI based on which distance could be calculated

- Using Feedback mechanism
- Using AT commands

B. Using feedback mechanism:

The reader initializes the communication by sending a signal to the vehicular units through wireless communication using xbee. When the vehicular unit enters the region, it gets synchronized with the reader. Now based on the received signal, the RSSI is detected from the 6th pin of the xbee in the vehicular unit which is converted to its digital value using analog to digital conversion. The RSSI value is displayed in the vehicular unit and transmitted to the reader with the frame ID. The frame ID consists of Vehicle ID based on which the vehicles are classified and amount is debited. The reader calculates the distance and deducts amount from the closer vehicle.

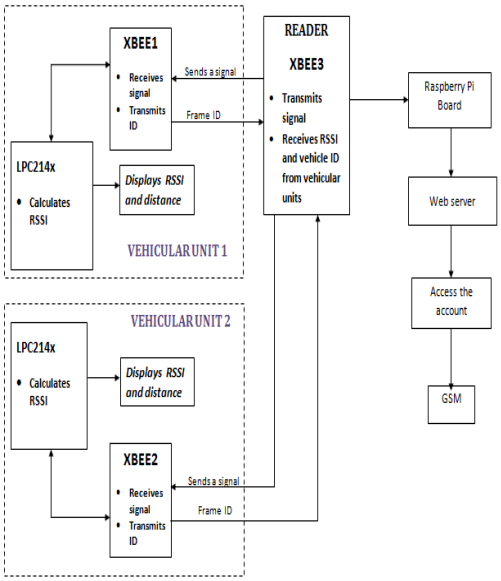

Fig2. Block Diagram for RSSI implementation using Feedback mechanism

C. **Using at commands:**

The xbee's firmware should be upgraded and configured in advance to extract the RSSI value from the xbees using X-CTU software. To configure the xbee, send a "+++" signal to enable AT Command mode. The modules receive a response with "OK" and send a command "ATDB" to the reader. DB parameter is used to read the received signal strength (in dBm) of the last RF packet received. Now based on the received byte from module, the RSSI is calculated. Here the RSSI value is displayed in the vehicular unit and transmitted to the reader with the frame ID. The reader calculates the distance and deducts amount from the closer vehicle. The RSSI implementation using AT commands is more effective when compared to the previous technique.

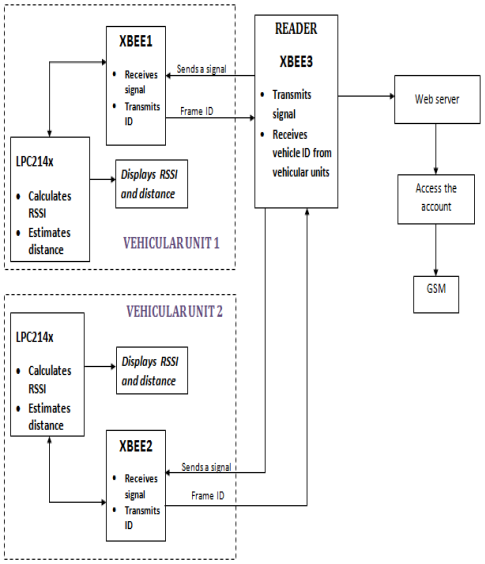

Fig3. Block Diagram for RSSI implementation using AT Commands

D. Formulae for calculation of RSSI:

RSSI Equation:

An equation that works relatively well for RSSI/distance estimation is

$$\mathbf{RSSI} = -(\mathbf{10\ n\ \log_{10} d} + \mathbf{A})$$

Where,

- RSSI is the RSSI value received (dBm)
- n is the path-loss exponent
- d is the distance
- A is the RSSI value at a reference distance

E. At command mode:

✓ **To Enter AT Command Mode:**

Send the 3-character command sequence "+++" and observe guard times before and after the command characters.

Default AT Command Mode Sequence (for transition to Command Mode):

• No characters sent for one second
• Input three plus characters ("+++") within one second
• No characters sent for one second

✓ **To Send AT Commands:**

✓ **To Exit AT Command Mode:**

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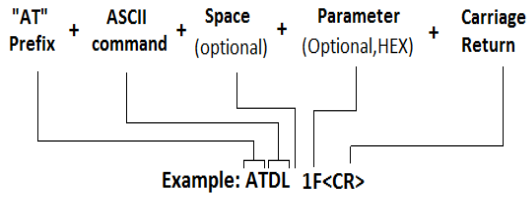
- Send the ATCN (Exit Command Mode) command (followed by a carriage return). Or
- If no valid AT Commands are received within the time specified by CT (Command Mode Timeout) Command, the RF module automatically returns to Idle Mode



III. SOFTWARE TOOLS

A. X-CTU:

The Xbee needs to be updated or the firmware needs to be changed on the radios occasionally. For example, to switch a ZigBee radio from router to coordinator or switch between API and AT modes, we need to upload the appropriate firmware to the radio using X-CTU.X-CTU is a Windows-based application provided by Digi. This program is designed to interact with the firmware files found on Digi's RF products and to provide a simple-to-use graphical user interface to them. X-CTU is designed to function with all Windows-based computers running Microsoft Windows. When launched, you will see four tabs across the top of the program. Each of these tabs has a different function. The four tabs are:

PC Settings: Allows a customer to select the desired COM port and configure that port to fit the radios settings.

Range Test: Allows a customer to perform a range test between two radios. It gives the ideas about how the signal strength is and how the successful rate for sending / receiving data is present.

Terminal: Allows access to the computers COM port with a terminal emulation program. This tab also allows the ability to access the radio's firmware using AT commands

Modem Configuration: Allows the ability to program the radios' firmware settings via a graphical user interface. This tab also allows customers the ability to change firmware versions.

B. Keil c cross compiler:

Keil is a German based Software development company. It provides several development tools like IDE (Integrated Development environment), Project Manager, Simulator, Debugger, C Cross Compiler, Cross Assembler, and Locator/Linker

IV. SIMULATION AND RESULTS

The reader xbee gets synchronized with the vehicular Unit xbee when it enters the region**.** Thus the RSSI value of the xbee is detected and distance is calculated. Both the RSSI value and distance is displayed in the LCD display at the vehicular unit.

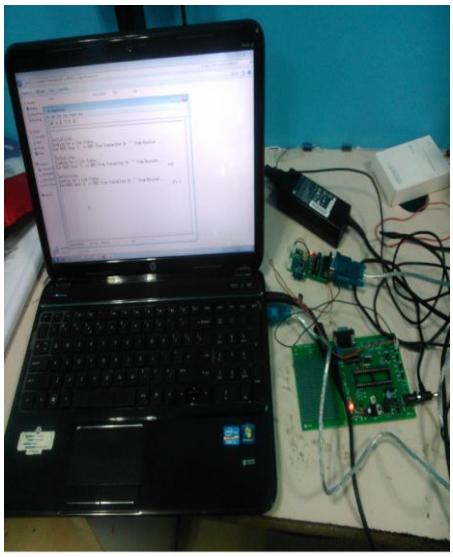


Fig 4 Snapshot of the Reader

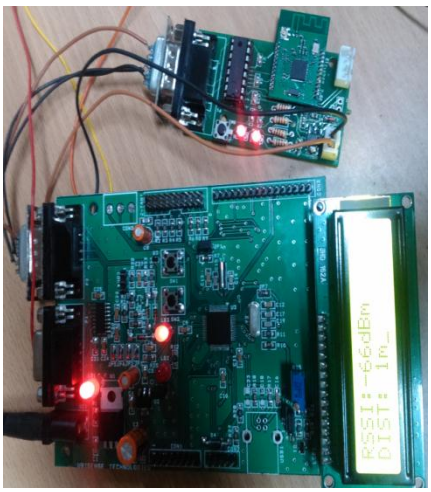


Fig 5 Snapshot of the Vehicular Unit

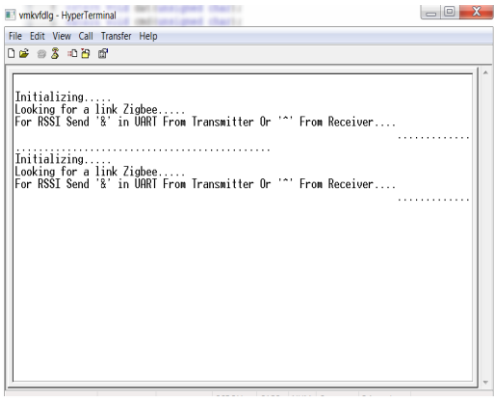


Fig6 Snapshot of the Reader during Initialization

V. CONCLUSION

The RSSI value between vehicular unit and the reader is detected based on which distance is calculated. The calculated RSSI is verified based on which amount can be deducted from the vehicle depending upon the distance calculated. Once the vehicle is selected, the ID assigned for the vehicle can be used to detect the type of vehicle and to access the vehicle owner's account.

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