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Automated Highway Tollgate Collection System

[I]L.D.Vijay Anand, [II]Hepsiba.D
[I,II]Assistant Professor, Dept. of Electrical Technology, EIE/BMI Programme,
Karunya University, Coimbatore

Abstract
These days there is a huge rush in the toll plazas to pay the toll tax. Therefore in order to reduce the traffic jam, to save time and also to reduce the fuel consumption in vehicles, automatic highway toll collection system has been designed using Radio Frequency Identification (RIFD). The automation of tool plaza is done by using the combination of microcontroller, RFID and Load Cell Technology. The implantation of automation in toll plaza is a step towards improving the monitoring of vehicles travelling in predetermined routes. The RIFD technology is used to identify an approaching vehicle details such as vehicle number, type and other related information. The Load Cell technology is used to calculate the weight in the loaded vehicles, to determine the amount according to the weight. Thus the total amount to be paid is displayed as soon as the vehicle reaches the toll plaza using Microcontroller programming.

Keywords
RFID, Load Cell, Microcontroller

I. Introduction

Automated Toll Collection System (ATCS) is a toll tax collection implementation system that will save time, space and money. Taking the case study of manual toll tax collection, the time required for collection of tax will be reduced, therefore there is no need for any vehicle to stop and thereby enlarging the space and the system can be efficiently implemented on a large scale with low capital. ATCS is an electronic collection system based on RFID i.e., Radio Frequency Identification where every vehicle will have a RFID tag with a unique tag identification number. This identification number will be associated with the complete information such as vehicle number, owner name etc with which the cost to be paid is determined. ATCS enables the electronic collection of toll payments. This system is also capable of determining if the car is registered or not and then informing the authorities of toll payment violations, debits and participating accounts. The outmost advantage of this technology is the opportunity to eliminate congestion in tollbooths, especially during the festive seasons with traffic tends to be heavier than normal. Other than this obvious advantage, applying ATCS could also benefit the toll operator. In case for the vehicles that do not have the tag, their identification will be sent along the description if the vehicle to control centre identifying an illegal entry. In case of loaded vehicles there is a need to measure the weight so that the toll amount to be paid is calculated.

II. Overview of The Project

A. Rfid Transmittor Tag

RFID is an automated data-capture technology that can be used to electronically identify, track and store information contained in the tag. An RFID tag or transponder consists of a chip and an antenna. A chip can store a unique serial number or other information based on the tag's type of memory which can be read only. The antenna which is attached to the
microchip transmits information from the chip to the reader. Typically larger antenna indicates a longer read range.

B. Rfid Reader

In order for an RFID system to function, it needs a reader or scanning device that incapable of reliably reading the tags and communicating the results to a database. A reader uses its own antenna to communicate with the tag. When the reader broadcasts radio wave all tags designated to respond to that frequency and within range will respond. A reader also has the capability to communicate with the tag without a direct line of sight, depending on the radio frequency and the type of tag used. Readers can process multiple items at once.

C. IR Sensor

In this project two IR Proximity sensors are used to detect the exact location and position of the vehicle on the load cell plate. One of the sensors are placed at the beginning of the load cell plate and the other sensor is placed at the end of the load cell plate. This arrangement is used because the load cell plate is not capable of weighing the moving objects.
A typical system for detecting infrared radiation using infrared sensors includes the infrared source such as black body radiators, tungsten lamps and silicon carbide. In case of IR sensors, the sources are infrared lasers and LEDs of specific IR wavelengths. The output from the detector is usually very small and hence pre-amplifiers coupled with circuitry signals are added to further process the received signals. If the IR sensor detects any object the IR rays are reflected back to the sensor. When the vehicle is in the exact position the IR Receiver will give an acknowledgment signal to the controller to actuate the load cell plate which in turn weighs the load of the vehicle. The IR receiver used here has three pins i.e. 5V supply, GND Line, Signal line.

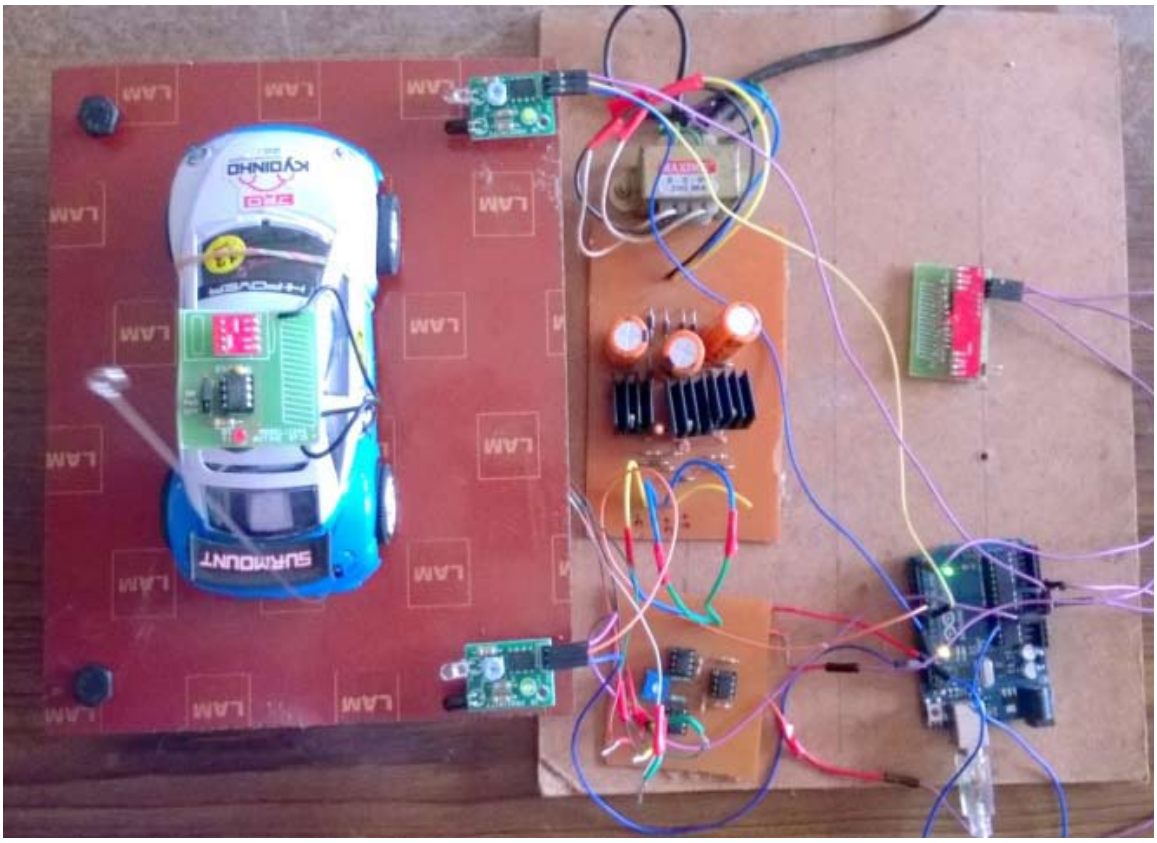

Fig. 1 : Hardware Setup of the Prototype

D. Load Cell

A load cell is a transducer that converts load acting on it into an analogue electrical signal. This conversion is achieved by the physical deformation of strain gauges which are bonded into the load cell beam and wired into a Wheatstone bridge configuration.

E. Instrumental Amplifier

An instrumental amplifier is a type of differential amplifier that has been outfitted with input buffer amplifiers, which eliminate the need for input impedance matching and this make the amplifier particularly suitable for use in measurement and test equipment.

The flow starts from the RFID tag that is present in all the vehicle's which is detected by the RF receiver kept at all the toll plazas that identifies the data i.e. Type and number of the vehicle stored in 16digit code form. These data's are given to the controller to match with the data base provided at the toll booth. The IR sensor assembly will detect the exact location of the vehicle eon the load cell plate to actuate the weighing operation. The load cell then weighs the weight accurately and transmits the analogue signal through the instrumentation amplifier which amplifies the output of the load cell so that it is acceptable by the controller. The controller then calculates the amount according to the weights and displays the amount to be paid.

F. Arduino Uno

Arduino is single-board microcontroller intended to make the application of interactive objects or environments more accessible. It has 14digit input/output pins, 6 analogue inputs, a 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything that needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with an AC to DC adapter or battery to get it started. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM.

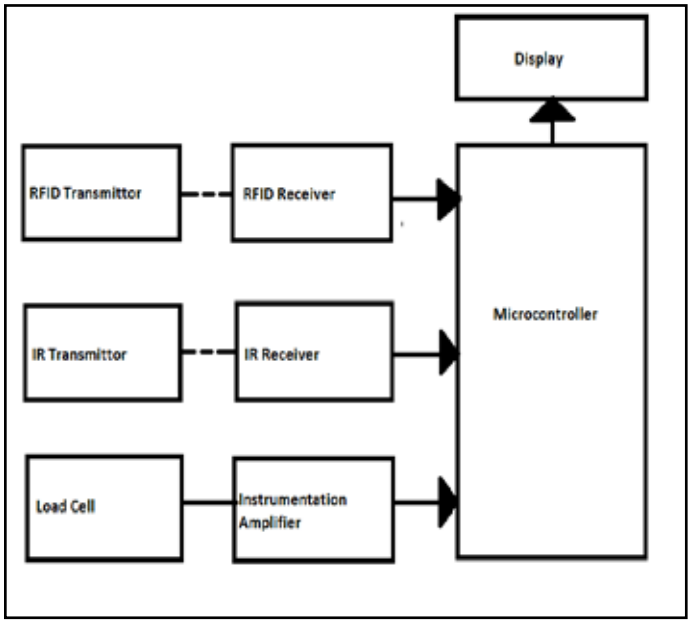

Fig. 2 : Block Diagram of Automated Tollgate Collection System

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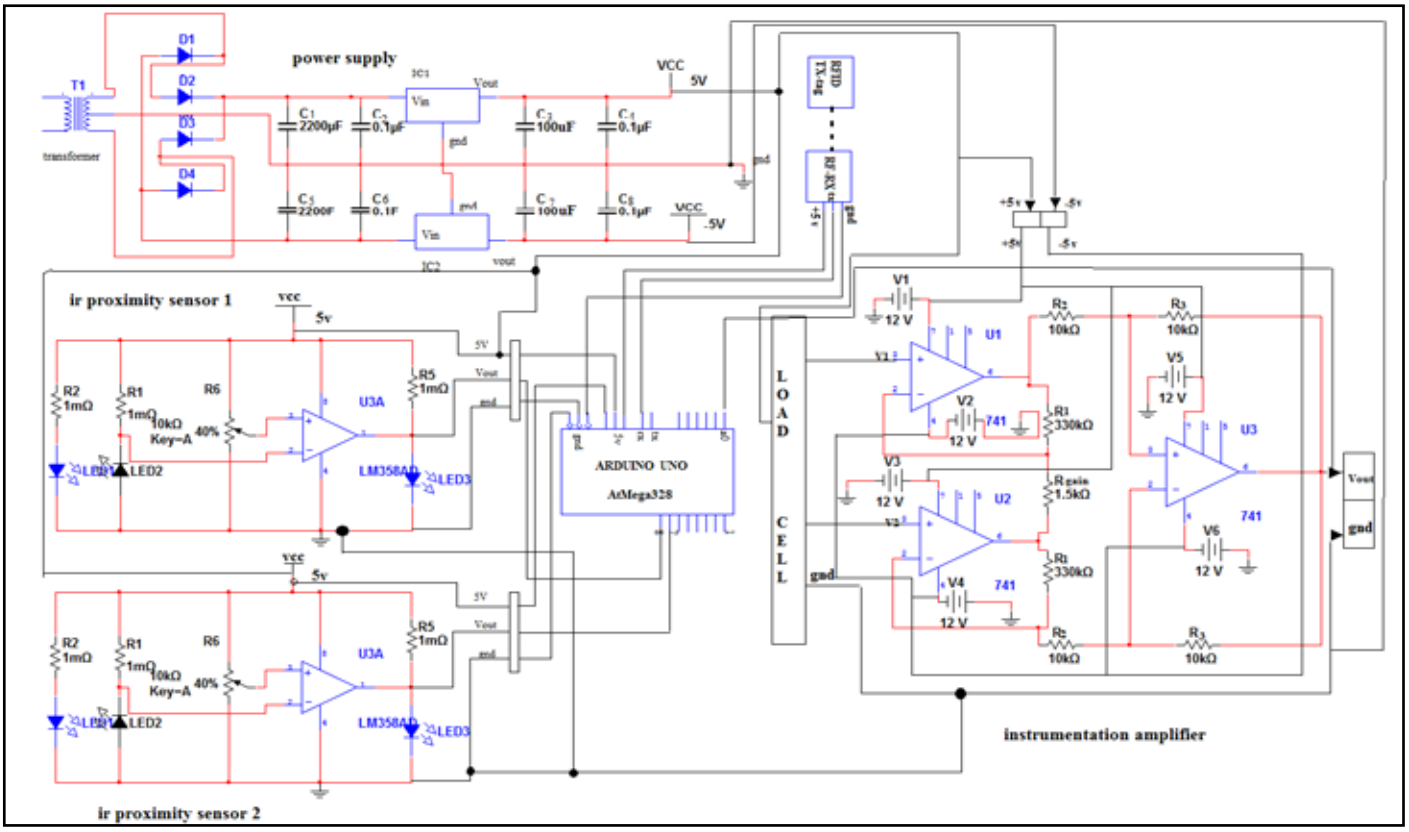

Fig. 3 : Schematic Diagram of of Automated Tollgate Collection System

III. Results And Discussion

Case 1: When the vehicle tag is not identified
Output: WELCOME TO TOLL GATE
NO DATA AVAILABLE

Case 2: When the vehicle is identified and not Correctly placed in the load platform.
Output: WELCOME TO TOLL GATE
KARUNYA
ITEM NO- 1700
NOT IN CORRECT POSITION

Case 3: When the vehicle is identified and the load is less than 400gms (normal amount)
Output: WELCOME TO TOLL GATE
KARUNYA
ITEM NO-1700
CORRECT POSITION
WEIGHT=100
COST= 100

Case 4: When the vehicle is identified and the load is greater than 400gms (normal+ toll amount)
Output: WELCOME TO TOLL GATE
KARUNYA
ITEM NO-1700
CORRECT POSITION
WEIGHT=500
COST=105

Different scenarios were considered for getting the results. Such as, when vehicle tag is not identified, identified but not correctly placed in load platform, identified & the load is less than 400 gms/greater than 400 gms. For each load changes, the toll fee varies. All these cases were programmed and downloaded in the microcontroller.

It is inferred from the above results that Automated Highway Tollgate Collection System has been designed for the basic functions. The ideas which are implemented in the prototype will be implemented in the real car in the near future.

IV. Conclusion

Automating the toll plazas gives the best solution for reducing the money loss caused due to fuel consumption and also can minimize the congestion in traffic indirectly resulting in reduction of time in toll plazas.

V. Future Scope

The smart mechanism can be implemented for the payment of toll amount. Here the automatic debit card system can also be implemented i.e. the RFID card can be treated as smart card. Since the RFID tag contains all the information about the vehicle, the toll amount is automatically debited from the vehicle owner's account.

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