Power Generation using Load Sensors and Solar Panels in automated Toll Gate System

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Abstract - *In the present day scenario, power is a major need for human life. There is a need to develop non-conventional sources for power generation due to the reason that our conventional sources of power are getting scarcer by the day. This project emphasizes on the idea that the kinetic energy getting wasted while vehicles move can be utilized to generate power by using a special arrangement called —power hump at toll gates. The main aim is to run the toll system using piezoelectric sensor. In turn we are saving the power needed for running the toll gate. Now a day's there is a huge rush in the toll plazas in order to pay the toll tax. Therefore in order to reduce the traffic jam and to save time, & also to reduce the money loss of 300 cores / year. In this project automation in toll tax payment using RFID is designed. Automation of toll plaza is made using the combination of microcontroller, RFID and Piezoelectric sensor. In addition, this paper also had solar panels, which would satisfy our power needs, when there is no vehicular movement. It has been observed that a lot of electrical energy is wasted at toll gates just to operate gates, computer systems and for lighting. Nearly 500 units of electrical energy is required to operate one toll gate in one day. If all the toll gates are considered, a huge amount of electrical energy is needed.*

Key Words: **Power hump, piezoelectric sensor, RFID**

1. INTRODUCTION

Power generation using load sensors and solar panel at automated toll gate system which is based on piezoelectric sensors (load sensors), solar panel, RFID and microcontroller to make the operation more energy efficient, to save time at toll plaza and cash free operation.[1]

A bunch of series connected load sensors is installed on the road near toll gate. When a vehicle approaches the toll gate it exerts pressure on the sensor which in turn generates electricity. Also solar panels are placed at the toll gate for the generation of electricity by using solar energy. The generated electricity is stored in a battery and is utilized for the operation of the toll gate system. [2]

When the vehicle is going to enter into the toll plaza, the first aim is to detect the vehicle. For that RFID system is provided. In this system the tag which is stickled at the front glass of the vehicle is detected by the RFID reader & the data is matched with the data base provided at every toll booth.

Then the desired amount of toll will be deducted from the account. [6]

1.1 OBJECTIVE

- Providing power supply for all circuit with renewable energy system with the help of Solar panel and piezoelectric. Because in some area power supply cannot be provided due to hill area or other area so this renewable energy system will help to provide power supply and this power will be used for toll tax part.

- To transform manual transaction to automated toll collection with the help of RFID technology. There are three portions in toll collection system which is RFID system, balance deduction system in host computer and toll gate control system by reducing the traffic conditions on toll gate.

1.2 METHODOLOGY

- ❖ Electrical energy can be generated at the toll gates by using Load Sensors and Solar Energy to overcome this problem.

- ❖ In recent years, Load sensors (piezoelectric sensors) have been widely used in various applications of mechanical sensors. Load sensors have several beneficial properties, such as: flexible, lightweight, very wide frequency range and no need of power supply as it is self- generating.

- ❖ The multilayer technology allows the component to convert (harvest) mechanical energy and produce electrical energy with low voltage that can be used for direct supply of electronic devices.

- ❖ This project also operates solar panels by constantly facing towards sun at 90 degrees to produce maximum voltage. It can move the solar panel from east to west also from south to north & also to correct for the durational movement of the Sun in the sky. The set of light sensors give the input and it operates stepper motor with gear mechanism.

- ❖ This is based most demanded natural resources where recurring cost of energy is nil. This is an ideal solution urban agriculture area where electricity is not available or may be far from the available spot.

- ❖ The project automated toll system mainly deals with automated toll collection using RFID. Each and every customer will be having RFID card and whenever he/she

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approaches toll system they just have to scratch their card and the corresponding amount will be deducted. So the energy is conserved and are making the process of toll collection simpler.

2. BLOCK DIAGRAM AND DESCRIPTION
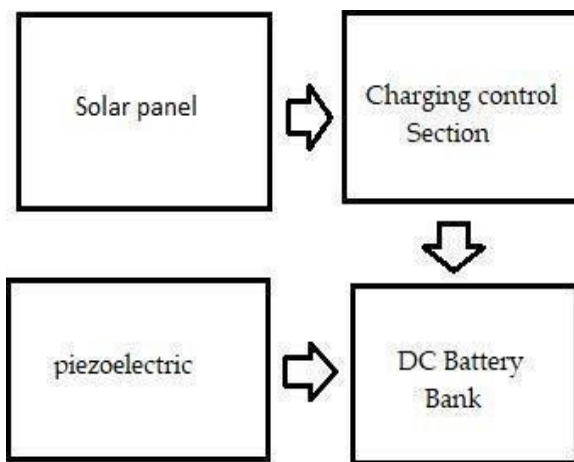
Block Diagram

➢ **Power Section**

Fig -1: Power Section

Description

The solar panels absorbs the sunlight with photo voltaic cells, generating direct current energy and then converting it to usable alternating current. The load sensors or piezoelectric sensors that converts load or force acting on it into an electronic signal. When load or force is applied to the sensor it changes its resistance. The change in resistance leads to an change in output voltage when a input voltage is applied. The obtained energy is stored in DC battery bank to run the toll gate system.
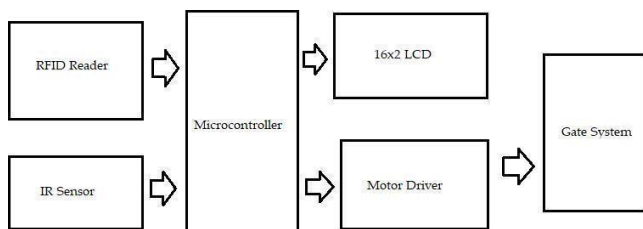
➢ **Toll-Tax Collection**

Fig -2: Toll Tax Collection

Description

First the infrared sensors will detect the presence of the vehicle which in turn activates the RFID circuit to read the RFID enable smart card of the vehicle. Transaction will begin,

depending upon the balance available, toll will be detected directly or the vehicle will be directed towards another lane to pay tax manually. The microcontroller further updates the details in the centralized database and also will show on LCD display. And microcontroller will pass to motor driver after successful payment is done. Motor drive will operate the gate motor and gate will open and close.

3. HARDWARE AND SOFTWARE REQUIREMENTS

Hardware Requirements:

Arduino Uno

Fig -3: Arduino Uno

Above Figure represents Atmega 328P Microcontroller where it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

- MicrocontrollerATmega328
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6 DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB of which 0.5 KB used by boot loader
- SRAM 2 KB
- EEPROM 1KB
- Clock speed 16MHz

MFRC522 RFID Module

Mifare RC522 is the high integrated RFID card reader which works on non-contact 13.56 MHz communication, is designed by NXP as low power consumption, low cost and compact read and write chip, is the best choice in the development of smart meters and portable hand- held devices.

MF RC522 use the advanced modulation system, fully integrated at 13.56MHz with all kinds of positive non-contact communication protocols. Support 14443A compatible answer signal. DSP deal with ISO14443A frames and error

correction. Furthermore, it also supports rapid CRYPTO1 encryption to validate Mifare series products. MFRC522 support Mifare series higher speed non- contact communication, duplex communication speed up to 424 kb/s.

Fig -4: RFID

RFID Technology

The RFID reader is one kind of wireless module used for transferring the data to identify and track tags which are connected to objects. The RFID tag mainly includes the stored information. Some of the RFID tags are run by electromagnetic induction from magnetic fields formed nearby the reader. RFID reader comprises an RF module that works as a transmitter as well as a receiver of RF (radio frequency) signal.

Liquid crystal displays (LCDs)

Fig -5: LCD Display

In the above Figure, Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.
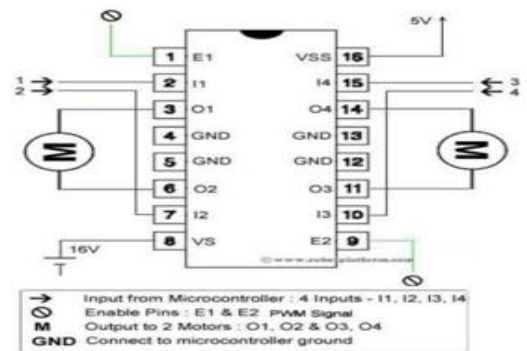
DC Motor Driver

Fig -6: DC Motor Driver

Above Figure is the pin diagram of L293D which is a dual H-Bridge motor driver, so with one IC two DC motors can be interfaced which can be controlled in both clockwise and counter clockwise direction speed of each dc motor can be controlled by giving PWM to enable pin. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

Piezoelectric sensor

A piezoelectric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical signal. As seen in Figure 3.5, the unit cell contains a small positively charges particle in the centre. When a stress is applied this particle becomes shifted in one direction which creates a charge distribution, and subsequent electric field. These materials come in several different forms. The most common is crystals, but they are also found as plastics and ceramics.
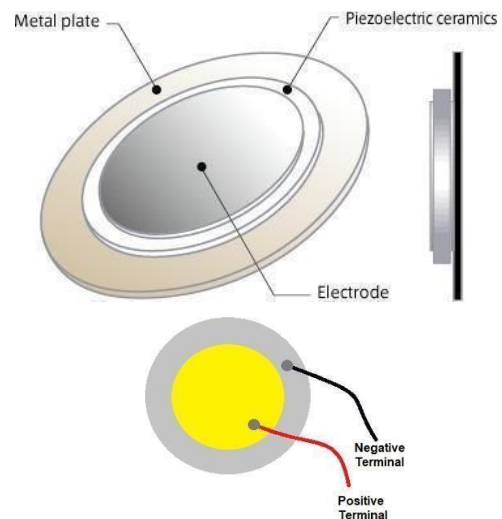

Fig:-7-Piezoelectric powder level sensors and piezoelectric sensors pin out

IR LEDs

IR LED is shown in figure 3.6 which emits infrared light, means it emits light in the range of Infrared frequency. Infrared light cannot be seen through our eyes; they are invisible to human eyes. The wavelength of Infrared (700nm – 1mm) is just beyond the normal visible light. Everything which produces heat emits infrared like our human body. Infrared have the same properties as visible light, like it can be focused, reflected and polarized like visible light.

Other than emitting invisible infrared light, IR LED looks like a normal LED and also operates like a normal LED, means it consumes 20mA current and 3vots power. IR LEDs have light emitting angle of approx. 20-60 degree and range of approx. few centimeters to several feet's, it depends upon the type of IR transmitter and the manufacturer. Some transmitters have the range in meters.

Fig-8: IR Led

Wind blades

There is an air turbine of large blades attached on the top of a supporting tower of sufficient height. When wind strikes on the turbine blades, the turbine rotates due to the design and alignment of rotor blades. The shaft of the turbine is coupled with an electric generator. The output of the generator is collected through electric power cables.
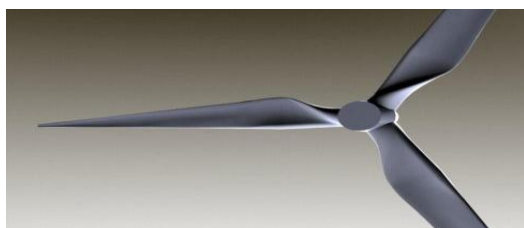

Fig: - 9: Wind blades

Solar Panel Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. A photovoltaic (PV) module is a packaged which connects assembly of typically 6×10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 watts.

Fig-10: Solar panel

Software Requirements

Arduino IDE

Arduino IDE is open source software that is mainly used for writing and compiling the code into the Arduino Module. It is official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. Compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

Embedded C

Embedded C is perhaps the most popular languages among Embedded Programmers for programming Embedded Systems. There are many popular programming languages like Assembly, BASIC, C++ etc. that are often used for developing Embedded Systems but Embedded C remains popular due to its efficiency, less development time and portability.

4. FLOWCHARTS
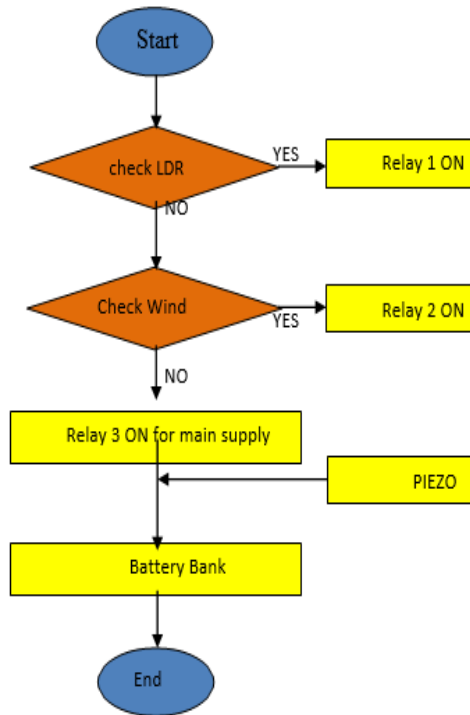
Flow chart for power generation

Fig: - 11: Flowchart for Power Generation

- According to the flow chart firstly it will check for LDR if solar energy is available, if solar energy is available then relay one is on ,which means that battery is charging through solar energy
- If solar energy is not available then it will check for wind energy, If wind energy is available then relay two is on, Which means that battery is charging through wind energy.
- If solar energy and wind energy both are not available then relay three is on, which means that battery is charging through direct power supply.
- Energy produced from piezo electric sensor is directly given to battery bank.

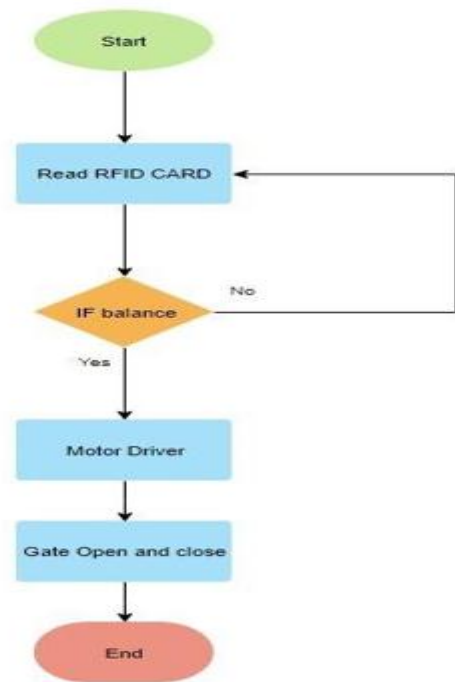### Flow chart for automated toll gate system

Fig: - 12: Flowchart for Automated toll gate system

- RFID based toll collection system is used as a technology for fast and efficient collection of toll at the toll booths.
- This is possible for the vehicles passing through the toll plaza need not stop to pay toll and the payment automatically is deducted from the account of the driver.
- The electronic toll lanes are setup with RFID reader that will send out signals continuously.
- These signals are used to identify the vehicles that travel through them. To use the electronic toll facility the drivers need to setup an electronic transponder.
- These transponders (tags) have to carry with the vehicle. The tags have all the information regarding the users account.
- The RFID reader continuously send radio frequency pulses which returns only when hits a tag. These pulses are returned back from the tag and are received by the RFID reader.
- These reflected pulses from the tags contain information about the account, balance etc. from there the balance will get cut and gate will open.

5. APPLICATIONS AND ADVANTAGES

ADVANTAGES

- ❖ RFID technology can dramatically decrease vehicle queuing at automobile toll plazas, speed throughput, and

significantly improve the quality of life for commuters and communities.

❖ Electronic toll collection transactions to occur under normal highway driving conditions. Open road tolling eliminates plaza barriers and creates a new toll road design that mitigates congestion.

❖ High occupancy vehicle tolling is an extension of electronic toll collection. It is also a concept that is rapidly gaining favour with transportation agencies and planners as it allows them to make better use of the often underutilized high occupancy vehicle (HOV) or carpool lanes.

❖ With high occupancy tolling, single occupant vehicles (SOVs) can drive on HOV lanes for a fee.

❖ Open road tolling gives toll authorities the flexibility to set variable pricing for toll services. Pricing types include premiums or discounts based on the time of day and congestion level. Variable pricing models can be pre-established, or modified in real time, responding to existing traffic situations. Variable pricing allows the transportation authority to maximize the use of HOV lanes.

APPLICATIONS

❖ Enables very specific detection of vehicles.

❖ Simultaneous multiple detection of vehicles are possible using RFID.

❖ Proximity of loop antenna and tag provides potential for increased reliability.

❖ Saves time and money.

❖ Minimizes work stress.

❖ Pollution free power generation.

❖ Simple construction, mature technology and easy maintenance.

❖ No consumption of any fossil fuel which is non-renewable source of energy.

6. RESULTS

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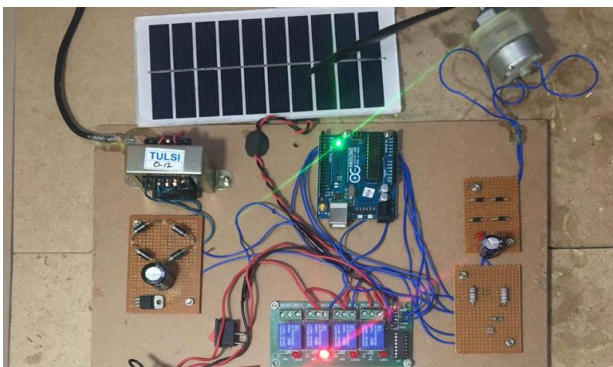
• Firstly we will check the solar power, if its available relay 1 will be ON and if it's not available the voltage sensor will check for the wind energy.

• And if wind is available relay 2 will be ON remaining will be off.

• And if both solar power and wind energy is not available then by default relay 3 will be ON that means main will charge the battery.

➤
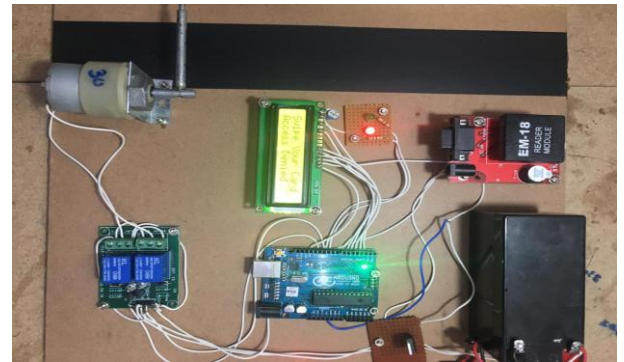
• Here we will be showing about the toll tax system, on LCD screen it will show Swipe your card.

• We will consider two RFID cards one with given correct information and the other one with incorrect information.

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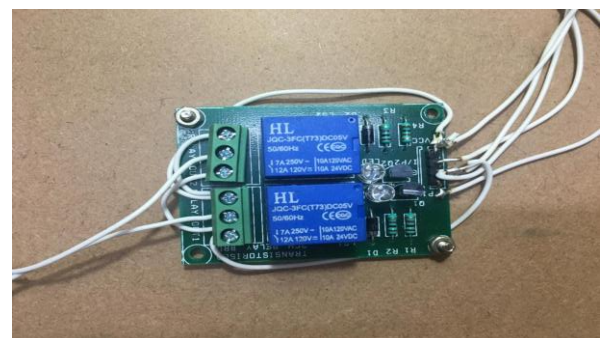
• Here the open/close of gate depends on relay drivers, one relay will be on for the clockwise motor and the other relay for the anticlockwise motor.

• We can change the time duration of open/close of gate in code.

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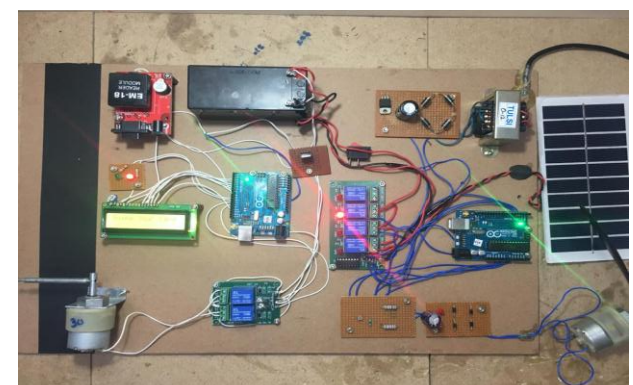
- After swiping the correct RFID card the amount will be detected and the gate will open
- If we swipe the incorrect RFID card the gate will not open.

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