An Intelligent Energy Dispensation Framework for Unified Liquid Fueling and Electric Vehicle Replenishment

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ABSTRACT

The research, IoT (Internet of Things) and RFID (Radio Frequency Identification) Based Multi-Purpose Fuel Dispenser and EV (Electric Vehicle) Charging System for Vehicles, aims to automate conventional petrol pumps and EV charging stations using RFID technology and embedded systems. Traditional fuel stations require manual interaction between vehicle owners and operators, leading to increased waiting time, operational costs, and the possibility of human errors. To overcome these limitations, the proposed system utilizes an RFID-based prepaid authentication mechanism for secure and automated fuel dispensing. In this system, an EM-18 RFID reader interfaced with an Arduino microcontroller through UART (Universal Asynchronous Receiver-Transmitter) communication is used to identify authorized users. After swiping the RFID card, the user is required to enter a password through a 4×4 keypad. Upon successful authentication, the system prompts the user to enter the desired fuel amount or EV charging value. The corresponding relay-controlled AC (Alternating Current) fuel pump or DC (Direct Current) EV charging unit is then activated automatically. The specified amount is deducted from the balance stored in the RFID card. If an incorrect password is entered or the available balance is insufficient, a buzzer alert is generated. A 16×2 LCD (Liquid Crystal Display) display provides real-time information such as authentication status, balance amount, transaction details, and system messages. This system reduces manpower requirements, improves transaction security, minimizes operational costs, and enhances customer convenience through efficient automation.

Key words: IoT, Automated Petrol Pump, EV Charging Station, Arduino, Embedded Systems, Smart Fuel Dispensing, Vehicle Authentication, Relay Control.

1.INTRODUCTION

The dispensing of the fuel to huge number of vehicles at the fuel stations has caused many complications in India. The vehicle driver has to pay for fuel with cash money and may have to pay more than the amount of dispensed fuel due to the lack of small money change available with station operator. RFID Based Automated Petrol Pump is to reduce human work and develop an auto-guided mechanism and to implement the task sequentially by using RFID technology. These systems are highly reliable and less time-consuming devices. The components used in this project are 8051 Microcontroller, RFID tags, Power supply, an LCD display, a Motor driver and an RFID reader. Petroleum products are one of the valuable and rare creations of the nature. The proper use and distribution are an important task to survive these products. A fuel station is a facility which sells fuel and lubricants via fuel dispensers which themselves are used to pump gasoline, Diesel, kerosene, etc. into vehicles and to calculate the financial cost of the product thus dispensed the emergency of radio frequency technology has changed the traditional methods of data collection. Compared to the traditional bar code, magnetic card and IC cards, RFID tags.

When RFID reader, reads the card it asks for the 3-digit password, if we enter wrong password more than twice it raises an alarm. And when the right password is entered is into the system, the system asks for the amount and it also shows the balance amount. On entering the amount, the motor starts and petrol gets filled in the petrol tank from the fuel dispenser. RFID Based Automated Petrol Pump, is to reduce human work and develop an auto-

guided mechanism and to implement the task sequentially by using RFID technology. These systems are highly reliable and less time-consuming devices. The components used in this project are 8051 Microcontroller, RFID tags, Power supply, an LCD display, a Motor driver and an RFID reader.

2. LITERATURE SURVEY

Petroleum products are one of the valuable and rare creations of the nature. The proper use and distribution is an important task to survive these products [1]. A fuel station is a facility which sells fuel and lubricants via fuel dispensers or otherwise called browers which themselves are used to pump gasoline, Diesel, kerosene, etc. into vehicles and to calculate the financial cost of the product thus dispensed [1]. Enterprises engaged in urban and suburban public transport as well as other transport enterprises big fuel consumers, need control of fuel delivery to prevent or at least minimize the misuse of the fuel [2]. The emergency of radio frequency technology has changed the traditional methods of data collection. Compared to the traditional bar code, magnetic card and IC cards, RFID tags have the features of non-contact, reading speed, no wear, long life, user friendly and the security function [7]. The use of RFID for vehicle identification, toll collection, traffic management have already been experimented with extensively [8]. This paper proposes the implementation of RFID technology in controlling fuel dispensing for an Indian city.

Internet of Things (IoT) is the network of joined devices, mechanical and digital machines, automobiles, home appliances and other things inserted with sensors, software, control keys and connectivity which allow these things to attach to a network and gather and exchange data [1, 2]. Smart petrol pump is a petrol pump based on internet of things [3-5], where the rise in the number of cars in Iraq in current years has guided to the congestion and traffic jams in almost all cities of Iraq[6- 9]. The supply of the fuel to this enormous number of automobiles at the fuel stations has produced many difficulties in Iraq. The automobile driver has to pay for fuel with cash money and may have to pay above than the amount of distributed fuel because of the lack of small money change unused with station worker. The role of the software and hardware that base the Arduino program is to reduce problems when working on an electronic project [10, 11]. ATmega2560 is an electronic circuit board that support you make shared objects by evaluating information from the real world, treating these information, and then getting action in the world suitably [12-13]. This paper focus on design RFID based automated petrol pump to reduce human roles and develop an auto- led technique and to do the work serially by using RFID technology. The radio frequency technology has improved the old-style methods of data collection.

3. PROPOSED SYSTEM

The main aim of the project is to design a system which is capable of automatically deducting the amount of petrol dispensed from user card based on RFID technology. Liquid dispensing systems are quite commonly found in our daily life in different places like offices, Bus stands, Railway stations, Petrol pumps. Here we are going to present modern era petrol dispensing system which is meant to be operated with prepaid card using RFID technology. The project mainly aims in designing a prepaid card for petrol bunk system and also petrol dispensing system using RFID technology. In current days the petrol stations are operated manually. These petrol pumps are time consuming and require more man power. To place petrol stations in distant area is very costly to provide excellent facility to the consumers. All these problems are sorted out by the use of unmanned power pump which requires less time to operate and it is effective and can be installed anywhere. The customer self-going to avail the service has to done the payment by electronic clearing system.

AC pump/ DC EV charge station operated by relay which is connected to Arduino digital pin. 4X4 matrix keypad connected to Arduino digital pins. In this project initially we have to swipe RFID card and need to enter password. If password is correct then it asks amount. After entering amount Petrol pump or EV charge machine will ON and fuel will dispense according to amount.

In this proposed petrol pump automation system, we are using RFID card to access petrol at different petrol stations of different petrol companies across the country and here, we are connecting all these petrol stations. Whenever we want to fill the tank from the fuel dispenser, we just have to place the RFID card near the RFID reader. Then the microcontroller reads the data from the RFID reader and performs the action according to the customer requirements. This digital petrol pump system also provides the security for the customers for filling petrol at the Petrol stations by avoiding the involvement of human beings, hence reduces the risk of carrying money every time. This petrol pump system consists of Atmega328 microcontroller, RFID module, LCD display, Ac pump and alarm.

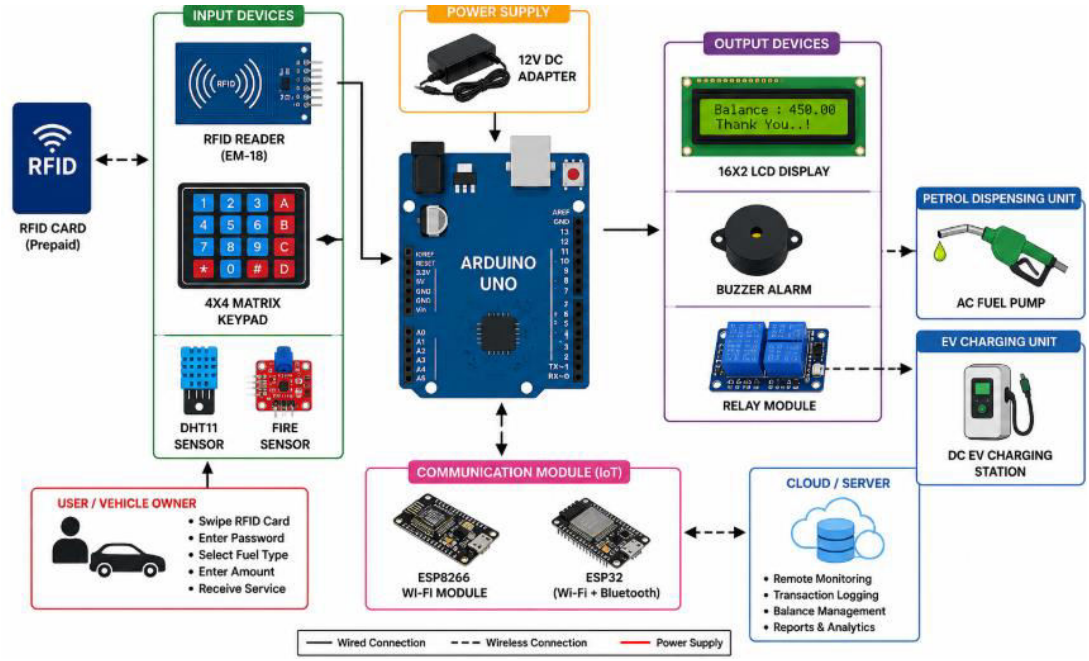

Fig. 1: Proposed system architecture

This is the pin diagram where all the hardware components are been connected components. this ARDUINO microcontroller having 28 pins. In which 14 GPIO pins as digital pins and 6 GPIO pins. 16MHz crystal oscillator connected internally. The stepdown transformer, Bridge rectifier capacitor with 1000f Resisters and led are connected in Regulated power supply which provide the 5v to the arduino and all input/output modules.

16*2 LCD Monitor has connected with the Digital pins 2, 3, 4,5,6,7.

RFID has connected to Digital Pins D0,D1 internal Transmitter and receiver pins.

DHT11 connected to A0 pins of the Arduino micro controller.

Keypad connected to digital pin 9,10,11

Fire sensor connected to digital pin 8

Buzzer alarm connected to digital pin 13

4. RESULTS AND DISCUSSION

The proposed IoT and RFID-based Multi-Purpose Fuel Dispenser and EV Charging System was successfully implemented and tested under different operating conditions. The RFID reader accurately identified authorized

users, and the password authentication mechanism provided an additional layer of security. Upon successful verification, the system allowed users to enter the desired fuel quantity or EV charging amount through the keypad, and the corresponding relay-controlled pump or charging unit was activated automatically. The LCD display effectively showed user balance, transaction status, and system messages in real time. Experimental results demonstrated reliable operation with minimal response time and accurate balance deduction from the prepaid RFID card. The buzzer alert function successfully notified users of invalid authentication attempts and insufficient balance conditions. Overall, the system achieved efficient automation of fuel dispensing and EV charging processes, reducing human intervention, improving transaction security, and enhancing user convenience.

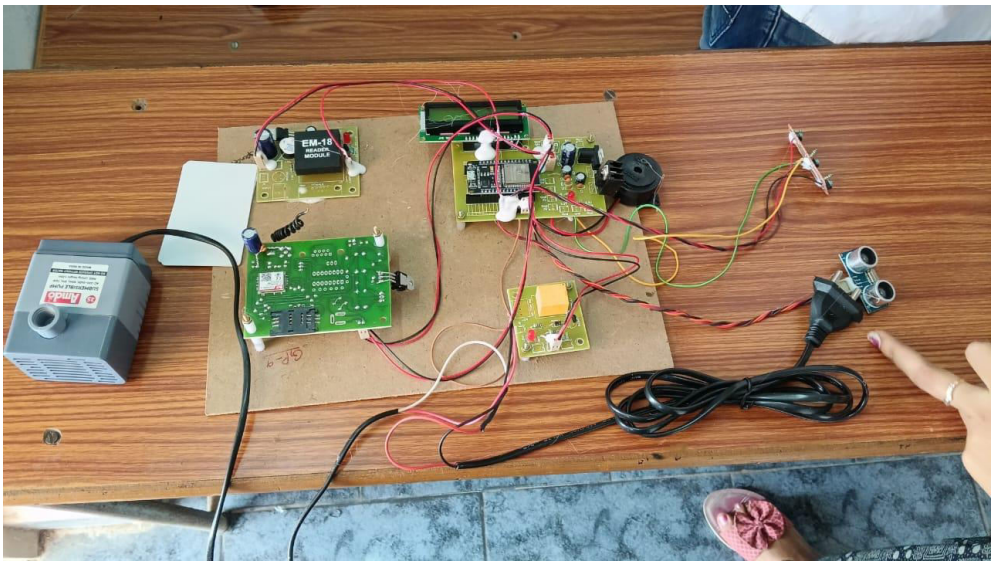

Figure 2: Hardware Prototype of IoT and RFID-Based Multi-Purpose Fuel Dispenser and EV Charging System

The hardware prototype of the proposed IoT and RFID-based Multi-Purpose Fuel Dispenser and EV Charging System is shown in Figure 2. The setup consists of an EM-18 RFID reader, Arduino-based control unit, LCD display, relay module, buzzer, ultrasonic sensor, and power supply circuitry integrated on a single platform. The RFID reader is used for user authentication, while the LCD module displays transaction details and system status messages. The relay circuit controls the fuel dispensing pump and EV charging operation based on the user-selected amount. The interconnected modules demonstrate the successful implementation of an automated, secure, and user-friendly fuel dispensing and EV charging system with minimal human intervention.

5. CONCLUSION

This project is meant for security systems whose access is only for respected authorities. Using a microcontroller, the petrol pump is equipped with a smart card reader/write. At the Petrol Pump, the driver swaps the card and the smart card reader reads the amount in the card and will display it on the LCD. The driver then enters the quantity of petrol that has to be filled using a keypad. The corresponding amount is calculated & deducted from his petro card. The electrical pump is then turned ON according to the entered amount, fills the tank and automatically turns OFF. Our electronic system performed as expected. We were able to implement all the functions specified in our proposal. The biggest hurdle we had to overcome with this project was interfacing the micro controller with the hardware components. We feel that this electronic system is very marketable because it is easy to use, comparatively inexpensive due to low power consumption, and highly reliable. By using this project one can design a secured system. For filling petrol to vehicles at the petrol bunks using Smart Card based Accessing System.

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