Visvesvaraya Technological University

Jnana Sangama, Belgavi —590018

MINI PROJECT

On

RFID BASED AUTOMATED PETROL PUMP

Associated with the subject

MINI PROJECT

[BEC586]

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CERTIFICATE

Certified that the Mini Project "**RFID BASED AUTOMATED PETROL PUMP"** carried out by **CHARAN G, LIKITH H P, VIVEK D & R HARISH** bearing **USN: 1RI22EC007 1RI22EC029 1RI22EC063 1RI23EC401** respectively, a bonafide students of **R R Institute of Technology** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communications Engineering** of the Visveshvaraya Technological University, Belagavi during the year 2024-25. It is certified that all theory/practicals/corrections/ suggestions indicated for Mini project have been executed under the Mini project Co ordination of **Prof Shyamala P Bhat.** The Mini project report has been approved as it satisfies the academic requirements in respect of MINI PROJECT prescribed for the said degree.

Signature of Project Coordinator	Signature of HOD	Signature of Principal
Prof. Shyamala P Bhat	**Dr. Sunitha H D**	**Dr. Mahendra K V**
Associate Professor	Professor and HOD	Principal
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DECLARATION

We team **CHARAN G, LIKITH H P, VIVEK D, R HARISH** bearing the USN **1RI22EC0007, 1RI22EC029, 1RI22EC063, 1RI23EC401** respectively, student of 5th Semester B.E. Department of Electronics and Communications Engineering, R R Institute of Technology, Bengaluru declare that the Project work entitled "**RFID BASED AUTOMATED PETROL PUMP**", has been duly executed by me under the guidance of **Shyamala P Bhat** , Asst Professor, Department of Electronics and Communications Engineering, R R Institute of Technology, Bengaluru and submitted in partial fulfilment of the requirement for the award of Bachelor of Engineering degree in Department of **Electronics and Communications Engineering** by **Visvesvaraya Technological University, Belgaum** during the year **2024-2025**.

Place: Bengaluru
Date:

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I am grateful to **R R Institute of Technology** for providing me an opportunity to enhance my knowledge through the project.

I express my sincere thanks to **Dr. Mahendra K V**, Principal, RRIT for providing me an opportunity and means to present the project.

I express my heart full thanks to **Dr. Sunitha H D**, Professor and Head, Department of Electronics and Communications Engineering, RRIT for encouragement in my project work, whose cooperation and guidance helped in nurturing this project report.

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Abstract

This project introduces a **Smart Petrol Pump System** utilizing **RFID technology** to automate fuel dispensing and payment processes. The system employs an Arduino microcontroller connected to an **EM-18 RFID reader**, a **4x1 switch panel** for selecting the fuel amount (₹50, ₹100, ₹150, ₹200), and an LCD display for process visualization. The system simplifies fuel purchase transactions by enabling users to pay securely by scanning RFID cards. By eliminating manual intervention, this innovative solution enhances customer convenience, reduces operational errors, and promotes faster and more efficient fuel dispensing.

Introduction

Petrol pumps often experience inefficiencies due to manual payment processing and fuel dispensing. These challenges can lead to delays, inaccuracies, and reduced customer satisfaction. The proposed **Smart Petrol Pump System** addresses these issues by automating payment and fuel dispensing using RFID technology. The integration of Arduino with switches and an LCD display ensures a seamless and user-friendly interface for selecting and processing transactions, reducing human error and increasing operational efficiency.

Scope

The **Smart Petrol Pump System** has broad applicability and scalability, including:

1. Automating payment processes in fuel stations to save time and enhance user experience.
2. Integrating RFID technology for secure, cashless transactions.
3. Supporting customization for varying fuel amounts and pricing.
4. Expanding to accommodate advanced features like digital receipts and mobile app integration.
5. Improving efficiency in urban and rural fuel stations by reducing reliance on manual processes.

Motivation

The increasing demand for efficient and secure transaction systems in petrol stations, coupled with the growing adoption of cashless payments, highlights the need for automated solutions. This project is motivated by the desire to improve the speed and accuracy of fuel dispensing processes, minimize human involvement, and leverage emerging technologies like RFID to revolutionize traditional petrol pump operations.

Problem Statement

Current petrol pump systems face the following challenges:

1. Time-consuming manual payment processes.
2. Increased likelihood of human errors in fuel dispensing and billing.
3. Limited adoption of secure, cashless payment options.
4. Customer dissatisfaction due to delays and inefficiencies.

This project aims to develop a smart petrol pump system that eliminates these inefficiencies by automating payment and fuel dispensing using RFID technology.

Existing and Proposed Systems

Existing System

1. Manual payment collection and fuel dispensing processes.
2. Risk of billing errors and fraudulent transactions.
3. Limited adoption of advanced technologies for customer convenience.

Proposed System

1. An Arduino-based system integrated with RFID readers for secure payments.
2. A switch-based interface for selecting fuel amounts.
3. Real-time process visualization via an LCD display.
4. Automation of fuel dispensing, minimizing manual intervention.

Objectives

1. Develop a secure, cashless payment system using RFID technology.
2. Automate fuel dispensing based on preselected amounts.
3. Enhance the speed and accuracy of petrol pump transactions.
4. Provide a user-friendly interface for customers.
5. Reduce operational errors and manual dependencies.

Methodology

1. **Hardware Integration**
   - Use an Arduino microcontroller to manage system operations.
   - Integrate the EM-18 RFID reader for payment processing.
   - Connect a 4x1 switch for selecting fuel amounts and an LCD display for real-time updates.
2. **Software Development**
   - Program the Arduino to process RFID card data, fuel selection inputs, and payment authorization.

3. **System Flow**
   - The user selects a fuel amount using the switches.
   - The RFID card is scanned for payment.
   - Upon successful payment, the fuel dispensing process begins.
4. **Testing**
   - Conduct extensive tests to ensure accuracy in payment processing and fuel dispensing.

Working

1. The system initializes and displays a welcome message on the LCD screen.
2. The user selects the desired fuel amount using the 4x1 switch.
3. The selected amount is displayed on the LCD for confirmation.
4. The user scans their RFID card using the EM-18 reader.
5. The system verifies the card's validity and deducts the corresponding amount.
6. Upon successful payment, the system activates the fuel dispenser to deliver the selected quantity.
7. The process status (e.g., "Payment Successful," "Fuel Dispensing") is displayed on the LCD.

CHAPTER 2

LITERATURE SURVEY

1. Paper: "RFID-Based Automated Fuel Dispensing System with Secure Payment"

- **Methodology:**
  - RFID-based authentication
  - Microcontroller-controlled fuel dispensing
  - Integrated payment verification system
- **Merits:**
  - Reduced human intervention
  - Accurate fuel measurement
  - Secure payment mechanism
  - Real-time transaction tracking
- **Demerits:**
  - Initial high implementation cost
  - Dependency on RFID infrastructure
  - Potential technological vulnerabilities
  - Limited to specific RFID card users

2. Paper: "IoT-Enabled Smart Fuel Station Management System"

- **Methodology:**
  - Internet of Things (IoT) integration
  - Cloud-based transaction monitoring
  - Multiple payment gateway support
  - Remote fuel inventory management
- **Merits:**
  - Real-time inventory tracking
  - Multiple payment options
  - Reduced human error
  - Enhanced data analytics
- **Demerits:**
  - Complex system architecture
  - High initial setup cost
  - Internet connectivity dependence
  - Cybersecurity challenges

3. Paper: "Automated Fuel Dispensing with Blockchain Payment Verification"

- **Methodology:**
  - Blockchain-based transaction validation
  - Smart contract implementation
  - Decentralized payment processing.

  - Cryptographic security mechanisms
- **Merits:**
  - Transparent transaction records
  - Enhanced security
  - Fraud prevention
  - Immutable payment history
- **Demerits:**
  - High computational requirements
  - Complex implementation
  - Scalability issues
  - Technical complexity for users

4. Paper: "Contactless Payment Solutions in Fuel Distribution Systems"

- **Methodology:**
  - Near Field Communication (NFC)
  - Mobile wallet integration
  - Biometric authentication
  - Real-time transaction processing
- **Merits:**
  - Faster transaction speeds
  - Enhanced user convenience
  - Reduced cash handling
  - Multiple authentication layers
- **Demerits:**
  - Technology dependency
  - Privacy concerns
  - Potential signal interference
  - Device compatibility limitations

5. Paper: "Smart Fuel Dispensing System with Machine Learning Optimization"

- **Methodology:**
  - Predictive maintenance algorithms
  - Machine learning-based fuel pricing
  - Automated inventory management
  - User behavior analysis
- **Merits:**
  - Predictive maintenance
  - Dynamic pricing strategies
  - Improved operational efficiency
  - Data-driven decision making
- **Demerits:**
  - High computational complexity
  - Data privacy challenges
  - Significant initial investment
  - Algorithmic bias potential

6. Paper: "RFID and GSM Integrated Fuel Management System"

- **Methodology:**
  - RFID-based user authentication
  - GSM module for remote monitoring
  - Real-time transaction alerts
  - Centralized data management
- **Merits:**
  - Remote transaction tracking
  - Enhanced security features
  - Instant notifications
  - Comprehensive user management
- **Demerits:**
  - Network dependency
  - Potential communication failures
  - Complex system integration
  - Higher maintenance requirements

7. Paper: "Automated Fuel Dispensing with Solar-Powered IoT Infrastructure"

- **Methodology:**
  - Solar energy integration
  - IoT-based monitoring
  - Energy-efficient design
  - Sustainable fuel distribution
- **Merits:**
  - Reduced operational costs
  - Environmentally friendly
  - Self-sustainable system
  - Low carbon footprint
- **Demerits:**
  - Location-specific effectiveness
  - Initial high infrastructure cost
  - Weather dependency
  - Limited night-time operations

8. Paper: "Multi-Factor Authentication in Fuel Distribution Systems"

- **Methodology:**
  - Biometric verification
  - RFID card authentication
  - Mobile OTP integration
  - Multilayered security protocols
- **Merits:**
  - Enhanced security
  - Reduced fraudulent activities
  - User identity verification

- Flexible authentication methods
- **Demerits:**
  - Complex user experience
  - Higher implementation costs
  - Potential user privacy concerns
  - Technology adoption challenges

9. Paper: "Cloud-Connected Smart Fuel Dispensing Ecosystem"

- **Methodology:**
  - Cloud platform integration
  - Real-time data synchronization
  - Advanced analytics
  - Predictive maintenance algorithms
- **Merits:**
  - Centralized data management
  - Scalable infrastructure
  - Advanced reporting capabilities
  - Continuous system improvements
- **Demerits:**
  - Internet connectivity requirement
  - Data security challenges
  - High computational overhead
  - Potential system vulnerabilities

10. Paper: "Low-Cost RFID-Based Fuel Management for Rural Applications"

- **Methodology:**
  - Cost-effective RFID implementation
  - Simplified user interface
  - Offline transaction capabilities
  - Localized payment solutions
- **Merits:**
  - Affordable technology
  - Easy user adoption
  - Minimal infrastructure requirements
  - Suitable for rural environments
- **Demerits:**
  - Limited advanced features
  - Reduced security complexity
  - Minimal data analytics
  - Lower scalability

Comparative Analysis Summary

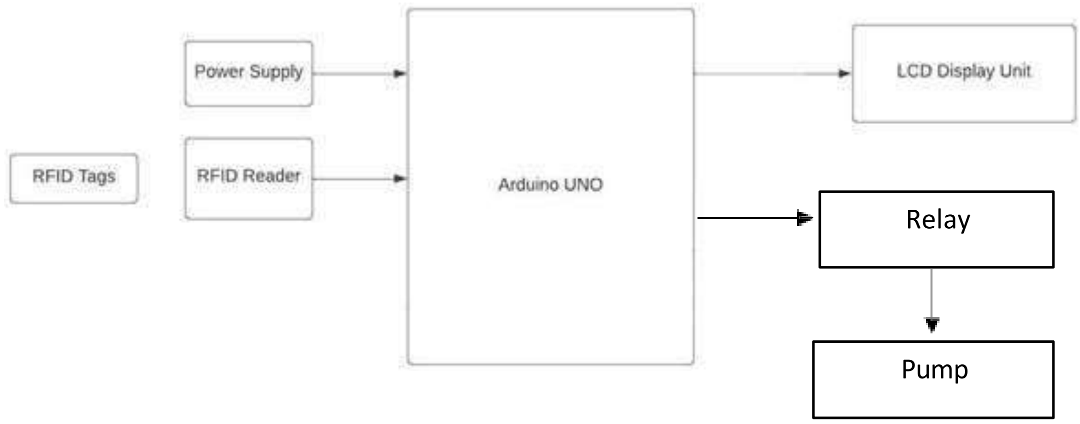
- **Common Themes:**
  1. RFID-based authentication
  2. Microcontroller integration

3. Secure payment mechanisms
4. Real-time monitoring

- **Emerging Trends:**
  1. IoT integration
  2. Machine learning optimization
  3. Blockchain security
  4. Sustainable energy solutions

CHAPTER 3

BLOCK DIAGRAM and Methodology



Working

The Smart Petrol Pump system operates using a combination of components: an Arduino microcontroller, RFID reader, LCD display, switches, and relay to control the pump. The system starts with the user selecting the amount of fuel they wish to purchase. This is achieved using a 4x1 switch panel, where each switch corresponds to a different fuel amount: 50, 100, 150, or 200 units. Upon pressing the desired switch, the amount is displayed on an LCD screen, indicating the fuel amount selected.

Once the user selects the amount, they are prompted to make a payment using an RFID card. The system integrates an EM18 RFID reader, which reads the unique ID stored in the RFID card. The cardholder places the RFID card near the reader, and the system processes the payment, confirming the transaction through the Arduino. Once payment is confirmed, the system activates a relay that is connected to the pump, enabling the fuel to flow.

The LCD display shows the process, providing real-time feedback to the user about the transaction status and pump operation. This seamless interaction eliminates the need for human intervention, reducing errors in payment and dispensing, while offering a smooth, automated fuel purchasing experience.

The relay, which is controlled by the Arduino, acts as a switch between the pump and the rest of the system, ensuring that fuel is dispensed only after successful payment. This automatic control ensures that the user is charged accurately and prevents fuel theft. The entire process is automated, requiring minimal human intervention, which improves efficiency and accuracy.

This system also integrates safety features by ensuring that the pump only operates once the correct payment has been made. Additionally, it can be connected to a central system for monitoring and record-keeping, providing detailed transaction logs for further processing.

After the dispensing is complete, the system resets itself for the next transaction, ensuring that each transaction is handled independently. The user receives real-time updates through the LCD display, ensuring transparency throughout the process.

Overall, the working of the Smart Petrol Pump using RFID is simple yet effective. It automates the entire fuel purchase experience, providing convenience, security, and speed to users while maintaining accuracy and reducing manual errors.

CHAPTER 4

Hardware Description

RFID tag

An RFID tag is comprised of a microchip containing identifying information and an antenna that transmits this data wirelessly to a reader. At its most basic, the chip will contain a serialized identifier, or license plate number, that uniquely identifies that item, similar to the way many bar codes are used today. A key difference, however is that [2] RFID tags have a higher data capacity than their bar code counterparts. This increases the options for the type of information that can be encoded on the tag, including the manufacturer, batch or lot number, weight, ownership, destination and history (such as the temperature range to which an item has been exposed). In fact, an unlimited list of other types of information can be stored on RFID tags, depending on application needs. An RFID tag can be placed on individual items, cases or pallets for identification purposes, as well as on fixed assets such as trailers, containers, totes, etc.

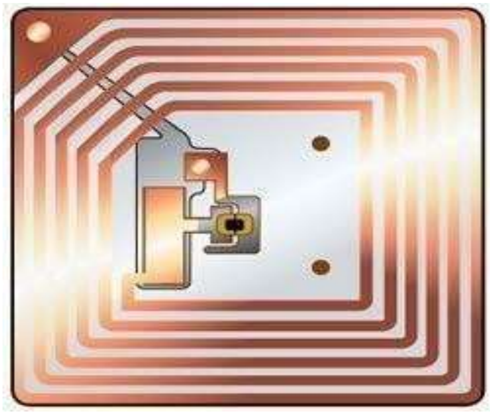


Fig 3.4.1 RFID TAGS

Passive versus Active

"Passive" tags have no battery and "broadcast" their data only when energized by a reader. That means they must be actively polled to send information. "Active" tags are capable of broadcasting their data using their own battery power. In general, this means that the read ranges are much greater for active tags than they are for passive tags perhaps a read range of 100 feet or more, versus 15 feet or less for most passive tags. The extra capability and read ranges of active tags, however, come with a cost; they are several times more expensive than passive tags. Today, active tags are much more likely to be used for high-value items or fixed assets such as trailers, where the cost is minimal compared to item value, and very long read ranges are required. Most traditional supply chain applications, such as the RFID-based tracking and compliance programs emerging in the consumer goods retail chain, will use the less expensive passive tags.

RFID reader

RFID reader is used to read the data's present in the RFID tag. RFID readers or receivers are composed of a radio frequency module, a control unit and an antenna to interrogate electronic tags via radio frequency (RF) communication. Many also include an interface that communicates with an application. Readers can be hand-held or mounted in strategic locations so as to ensure they are able to read the tags as the tags pass through an "interrogation zone."

Fig 3.4.2 RFID reader.

An RFID reader's function is to interrogate RFID tags. The means of interrogation is wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary.[2] A reader contains an RF module, which acts as both a transmitter and receiver of radio frequency signals. The transmitter consists of an oscillator to create the carrier frequency; a modulator to impinge data commands upon this carrier signal and an amplifier to boost the signal enough to awaken the tag. The receiver has a demodulator to extract the returned data and also contains an amplifier to strengthen the signal for processing. A microprocessor forms the control unit, which

employs an operating system and memory to filter and store the data. The data is now ready to be sent to the network.

LCD Display

LCD has the ability to display numbers and characters

Display the product name, price, expire date and total amount .

Complete listings of the products along with their price on LCD display.

Up/down switches are interfaced with the microcontroller which can be used to view all the purchase

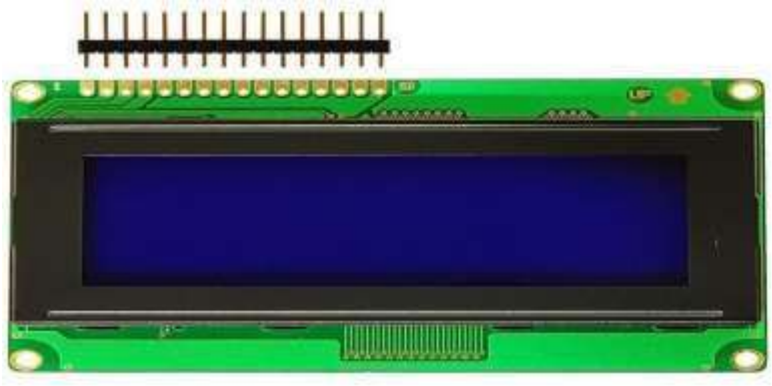


Fig 3.4.3 LCD-20x4

This chip is used when interfacing micro controller with PC to check the Baud rate and changes the voltage level because micro controller is TTL compatible whereas PC is CMOS compatible. The MAX 232 IC contains the necessary drivers and receivers, to adapt the RS- 232 signal voltage levels to TTL logic. RS 232 is used at the time of billing. Cart is connected to the laptop via MAX 232 and after connection is made details about the purchases are transferred to the laptop and lock is opened. The bill is calculated and it is debited from the user RFID credit card and process is complete.

Arduino Uno

Arduino is an open source computer hardware and software that designs single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL). Arduino boards are available commercially in preassembled form or by designing the kits with respect to different application . Figure 4.2 and 4.3 shows the Arduino Uno board and pin diagram respectively.

The different types of Arduino Uno are Arduino Nano,Arduino Pro Mini,Arduino Mega, Arduino Due, and Arduino Leonardo.

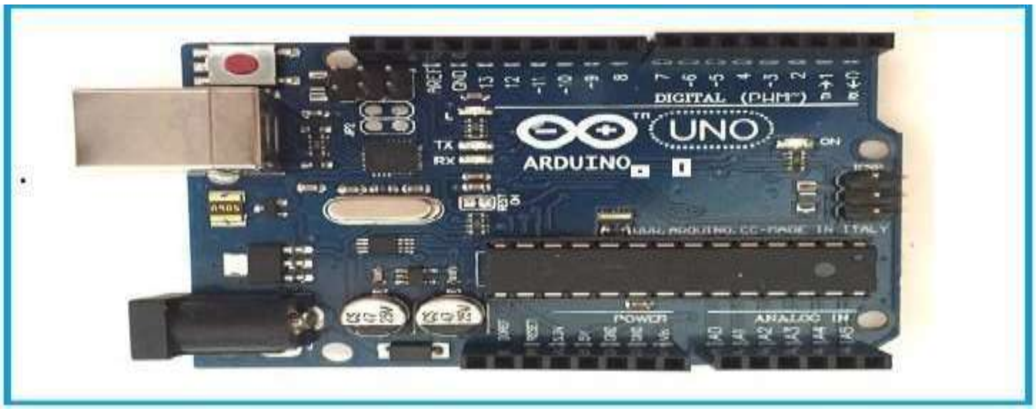


Fig 4.2:Arduino Uno board

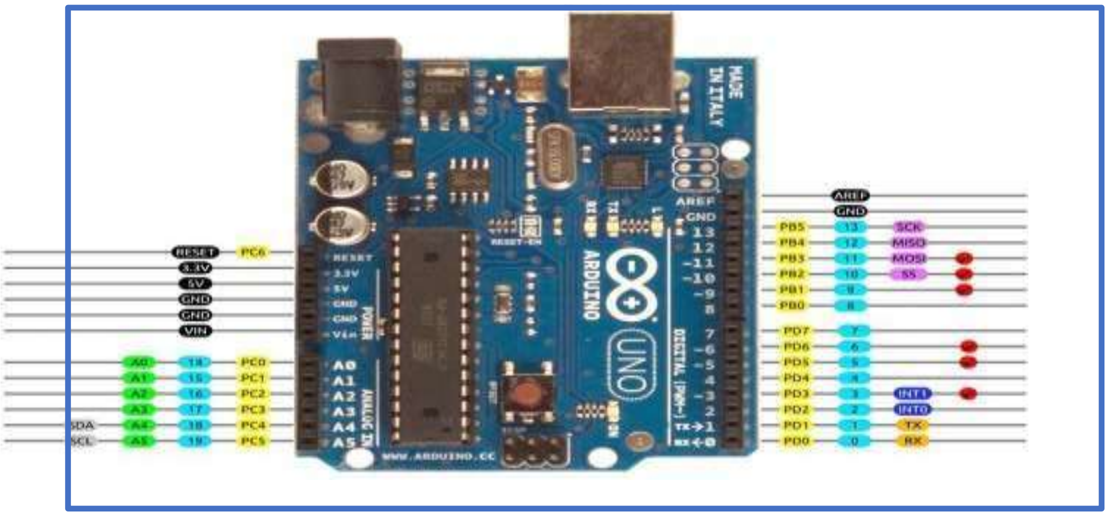


Fig 4.3:Arduino Uno board pin diagram

PIN DESCRIPTION

Table 4.1 explains the pin descriptionArduino Uno board.

Table 4.1: The pin descriptionArduino Uno board.

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

ARDUINO UNO TECHNICAL SPECIFICATION

Table 4.2 explains the Arduino Uno technical specification.

Table 4.2: Arduino Uno technical specification

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

OVERVIEW

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

HOW TO USE AURDINO BOARD

The 14-digital input/output pins can be used as input or output pins by using pin Mode (), digital Read () and digital Write () functions in Arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current and has an internal pull-up resistor of 20-50 K Ohms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

1. **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
2. **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
3. **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analog Write () function.
4. **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
5. **In-built LED Pin 13:** This pin is connected with built-in LED.When pin 13 is high, then LED willON and when 13 pin is low, it represent led is OFF.

There are 14digital pins and 6 analog input pins, each of which provides 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog reference () function.

Analog pin 4 Serial Data Access(SDA) and pin 5 scratch controlling aurduino(SCA) also used for TWI communication using wire library.Arduino Uno has a couple of other pins as explained below:

1. **AREF:** Used to provide reference voltage for analog inputs with analog Reference () function.
2. **Reset Pin:** Making this pin LOW, resets the microcontroller.

COMMUNICATION

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a in file is required.

ARDUINO UNO TO ATMEGA328 PIN MAPPING

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two.

SOFTWARE

Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board.

ARDUINO PROGRAMMING

Once Arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuine Uno and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into the IDE, click on the 'upload' button given on the top bar. Once the upload is finished, it should see the Arduino's built-in LED blinking. Below is the example code for blinking.

```
// the setup function runs once it press reset

or power the board void setup () {

  // initialize digital pin

  LED_BUILTIN as an output. pin

  Mode (LED_BUILTIN,

  OUTPUT);

}
// the loop function runs over and

over again forever void loop () {
  digital Write (LED_BUILTIN, HIGH); // turn the LED on (HIGH is

  the voltage level) delay (1000);                  // wait for a second

  digital Write (LED_BUILTIN, LOW);   // turn the LED off by making

  the voltage LOW delay(1000);                      // wait for a second
```

APPLICATIONS

1. Prototyping of Electronics Products and Systems
2. Multiple DIY Projects.
3. Easy to use for beginner level DIY and makers.
4. Projects requiring Multiple I/O interfaces and communications.

ARDUINO UNO 2D MODEL

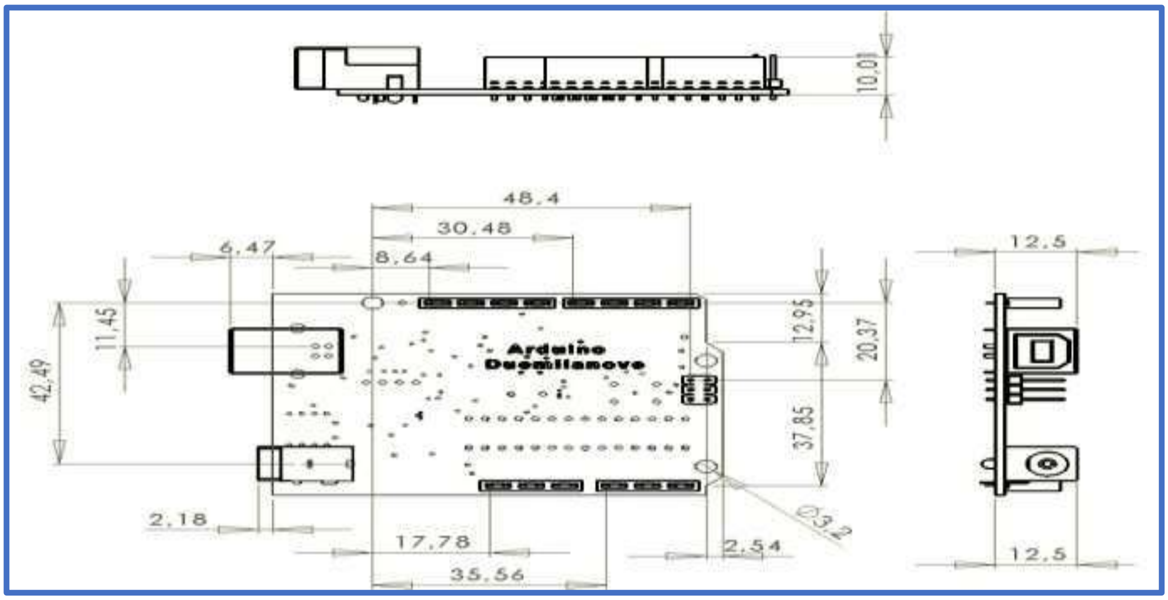
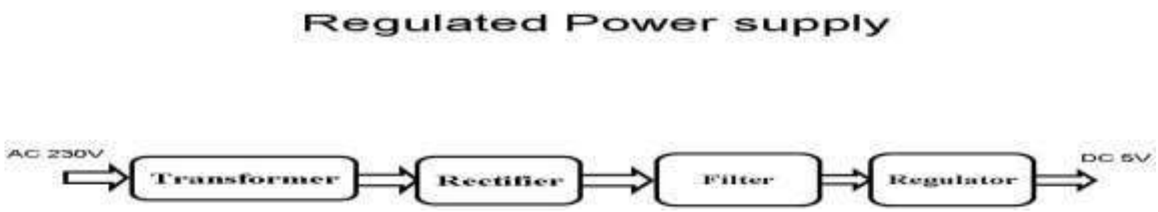


Fig 4.4:Arduino Uno 2D Model

Regulated power supply:



Transformer:

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors without changing its frequency. A varying current in the first or primary winding creates a varying

magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying
magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. This field is made up from lines of force and has the same shape as a bar magnet. If the current is increased, the lines of force move outwards from the coil. If the current is reduced, the lines of force move inwards. If another coil is placed adjacent to the first coil then, as the field moves out or in, the moving lines of force will "cut" the turns of the second coil. As it does this, a voltage is induced in the second coil. With the 50 Hz AC mains supply, this will happen 50 times a second. This is called MUTUAL INDUCTION and forms the basis of the transformer.

Rectifier:

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid-state diodes, vacuum tube diodes, mercury arc valves, and other components. A device that it can perform the opposite function (converting DC to AC) is known as an inverter. When only one diode is used to rectify AC (by blocking the negative or positive portion of the waveform), the difference between the term diode and the term rectifier is merely one of usage, i.e., the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode. Before the development of silicon semiconductor rectifiers, vacuum tube diodes and copper (I) oxide or selenium rectifier stacks were used.

Filter:

The process of converting a pulsating direct current to a pure direct current using filters is called as filtration. Electronic filters are electronic circuits, which perform signal-processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones.

regulators are very robust. These can withstand over-current draw due to short circuits and also over-heating. In both cases, the regulator will cut off before any damage occurs. The only way to destroy a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator almost instantly.

LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance. LCD’s consumes less amount of power compared to CRT and LED and consist of some microwatts for display in comparison to some mill watts for LED’s. LCDs are of low cost and provides excellent contrast.

LCD’s are thinner and lighter when compared to cathode ray tube and LED.

A 20x4 LCD display as shown in the figure 4.5.2 is very basic module and is very commonly used in various devices and circuits. Preferred over seven segments and other multi segment LEDs. A 20x4 LCD means it can display 16 characters per line and there are 2 such lines. This LCD has two registers, namely, Command and Data.

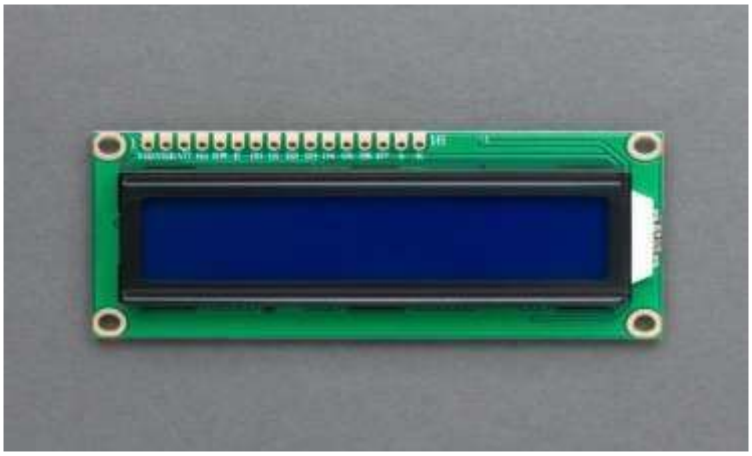


Fig 4.5.2 LCD Display

1. High Resolution: Crystal clear displays typically have high resolutions, such as 4K (3840 x 2160 pixels) or even 8K (7680 x 4320 pixels).

2. High Pixel Density: A high pixel density ensures that images appear sharp and detailed.

3. Wide Color Gamut: Crystal clear displays often support a wide color gamut, which enables the display to show a broader range of colors.

4. High Contrast Ratio: A high contrast ratio ensures that images appear vivid and lifelike.

3.2 DC WATER PUMP

This DC 3-6 V Mini Micro Submersible Water Pump is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.Make sure that the water level is always higher than the motor. The dry run may damage the motor due to heating and it will also produce noise.

Specification

- Operating Voltage : 2.5 ~ 6V.
- Operating Current : 130 ~ 220mA.
- Flow Rate : 80 ~ 120 L/H.
- Maximum Lift : 40 ~ 110 mm.
- Outlet Outside Diameter: 7.5 mm.
- Outlet Inside Diameter: 5 mm.

Fig: 3.4 DC Water pump

CHAPTER 5

Software Requirements

Software Requirements Description

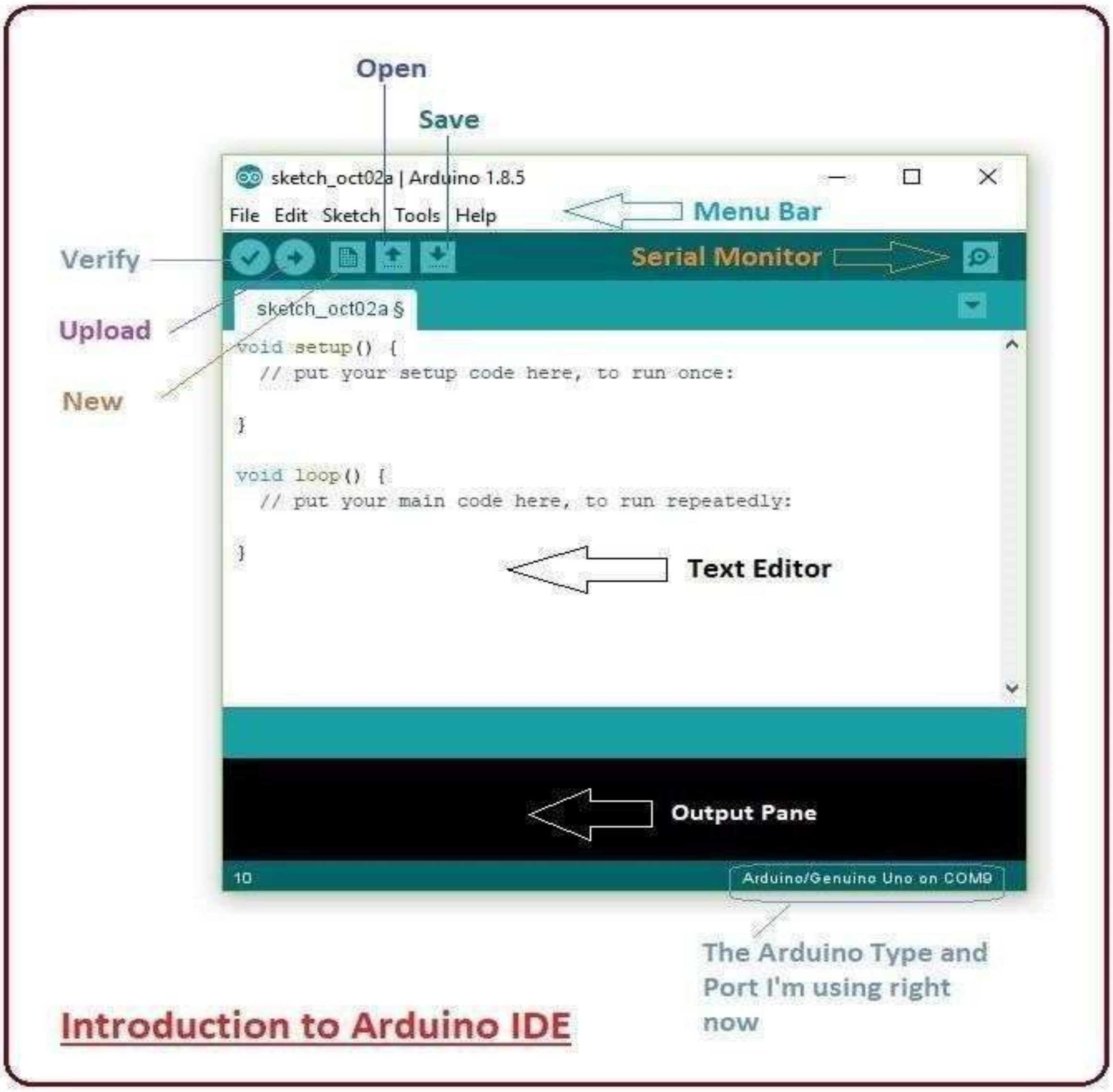
Software Requirements is a field within software engineering that deals with establishing the needs of stakeholders that are to be solved by software. The IEEE Standard Glossary of Software Engin

- A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document.

Some of the important Software requirements required in our project are:

Arduino IDE

The Arduino integrated development environment (IDE) (figure 4.4.1) is a cross-platform application for Windows, macOS, Linux that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The Arduino IDE supports the languages C and C++ using special rules of code structuring. It is an 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. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board


Open
Save
sketch_oct02a | Arduino 1.8.5
File Edit Sketch Tools Help
Menu Bar
Verify
Serial Monitor
Upload
sketch_oct02a §
New
void setup() {
// put your setup code here, to run once:
}
void loop() {
// put your main code here, to run repeatedly:
}
Text Editor
Output Pane
10
Arduino/Genuino Uno on COM9
The Arduino Type and Port I'm using right now
Introduction to Arduino IDE

The IDE environment is mainly distributed into three sections:

- Menu Bar
- Text Editor
- Output Pane

Embedded C

Embedded C is an extension to C programming language that provides support for developing efficient programs for embedded devices. It is not a part of the C language. C is the most widely used programming language for embedded processors/controllers. Assembly is also used but mainly to implement those portions of the code where very high timing accuracy, code size efficiency, etc. are prime requirements.

Arduino IDE (Integrated development Environment) is fully developed into functionality of full of libraries, as long as programming the Arduino UNO in Embedded C language is possible because Arduino IDE can compile both Arduino code as well as AVR standard code.

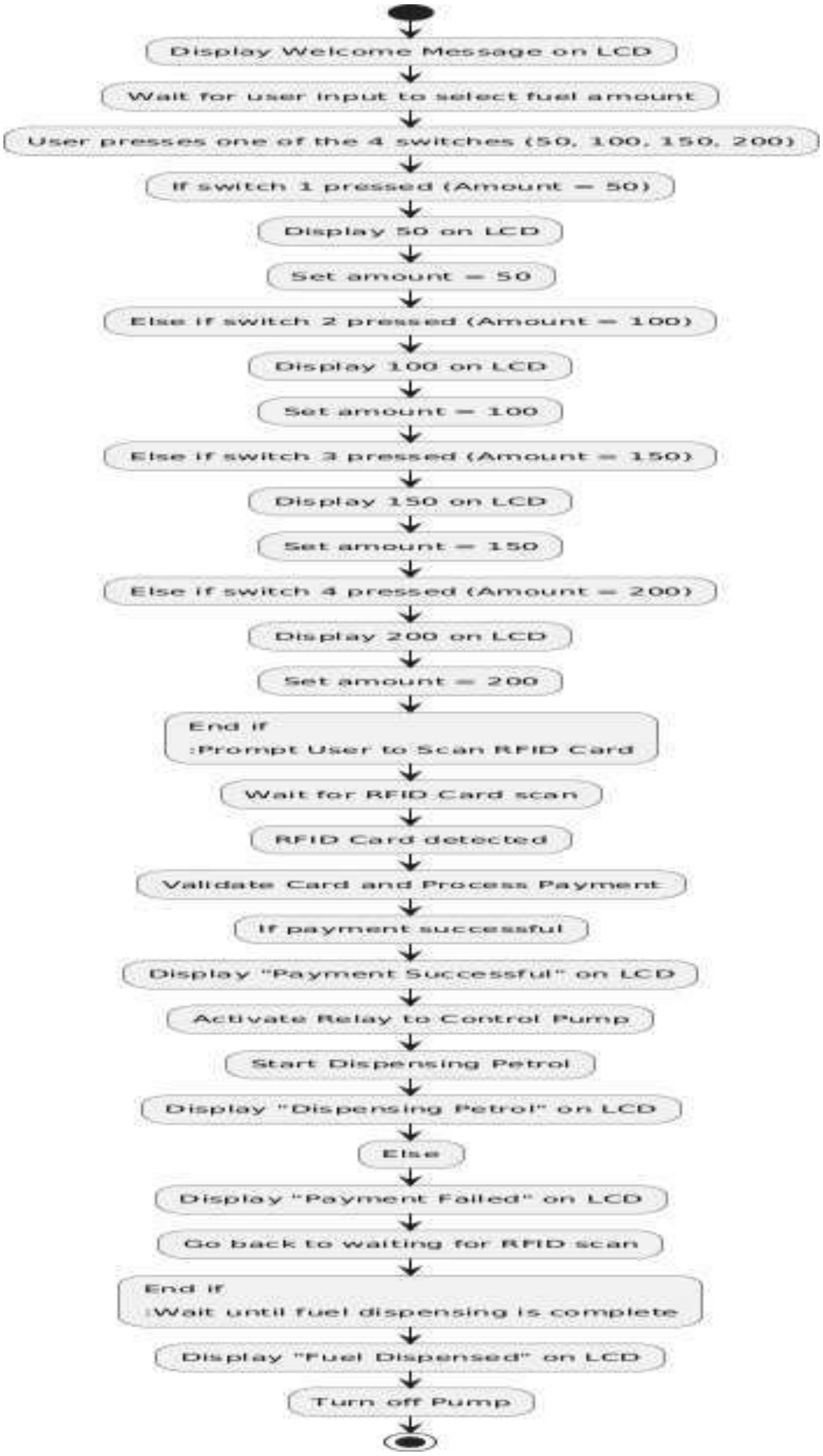
- When designing software for a smaller embedded system with the 8051, it is very common place to develop the entire product using assembly code. With many projects, this is a feasible approach since the amount of code that must be generated is typically less than 8 kilobytes and is relatively simple in nature. If a hardware engineer is tasked with designing both the hardware and the software, he or she will frequently be tempted to write the software in assembly language.
- The trouble with projects done with assembly code can is that they can be difficult to read and maintain, especially if they are not well commented. Additionally, the amount of code reusable from a typical assembly language project is usually very low. Use of a higher-level language like C can directly address these issues. A program written in C is easier to read than an assembly program.

- Since a C program possesses greater structure, it is easier to understand and maintain. Because of its modularity, a C program can better lend itself to reuse of code from project to project. The division of code into functions will force better structure of the software and lead to functions that can be taken from one project and used in another, thus reducing overall development time. A high order language such as C allows a developer to write code, which resembles a human's thought process more closely than does the equivalent assembly code. [25]The developer can focus more time on designing the algorithms of the system rather than having to concentrate on their individual implementation. This will greatly reduce development time and lower debugging time since the code is more understandable.

- By using a language like C, the programmer does not have to be intimately familiar with the architecture of the processor. This means that someone new to a given processor can get a project up and running quicker, since the internals and organization of the target processor do not have to be learned. Additionally, code developed in C will be more portable to other systems than code developed in assembly. Many target processors have C compilers available, which support ANSI C.
- All of this is not to say that assembly language does not have its place. In fact, many embedded systems (particularly real time systems) have a combination of C and assembly code. For time critical operations, assembly code is frequently the only way to go. One of the great things about the C language is that it allows you to perform low-level manipulations of the hardware if need be, yet provides you the functionality and abstraction of a higher order language.

CHAPTER 6

DESIGN



- **Initial Process:**

    - The system starts by displaying a welcome message on the LCD and waits for the user to select the fuel amount using one of the four switches (50, 100, 150, 200).

- **Amount Selection:**

    - Based on the user's input, the appropriate fuel amount is displayed on the LCD and stored in a variable (`amount`).

- **RFID Scan and Payment:**

    - The system prompts the user to scan their RFID card. Upon detection, the system processes the payment.
    - If payment is successful, a confirmation message is displayed, and the system activates the relay to start dispensing fuel.
    - If payment fails, the system asks the user to try scanning their RFID card again.

- **Fuel Dispensing:**

    - Once payment is successful, the system displays that petrol is being dispensed.
    - After dispensing the fuel, the pump is turned off, and the final message is shown on the LCD.

CHAPTER 7

Advantages and Applications

Advantages

The primary advantage of the Smart Petrol Pump using RFID is the automation of the entire fuel purchasing process. Traditional systems require manual intervention for payment and fuel dispensing, which can lead to errors, delays, and increased operational costs. With the RFID system, users can pay and pump fuel without the need for human involvement, streamlining the entire process.

One key advantage is the speed and convenience it provides. Users can simply scan their RFID card, make a payment, and begin fueling almost instantly. The system significantly reduces wait times, especially in busy stations, ensuring a faster and smoother experience for customers.

The RFID system enhances security by eliminating the risk of fuel theft or fraud. The payment process is automated, and the system verifies payment before allowing fuel to be dispensed. This ensures that customers are charged accurately and that no unauthorized fuel dispensing occurs.

Additionally, the system is more accurate than traditional methods. Since the process is automated, there is less room for human error in recording attendance, dispensing fuel, or processing payments. This leads to better customer satisfaction and operational efficiency.

The integration of an LCD display provides real-time feedback, which not only keeps the user informed but also helps to ensure transparency in the process. Users can see the selected amount, the payment status, and the current operation, which improves trust in the system.

Moreover, the system is highly scalable. It can be easily expanded to handle multiple pumps or integrated with existing payment systems. This flexibility makes it suitable for various petrol stations, from small local setups to large, multi-pump stations.

Another advantage is the reduction in administrative costs. Since the system is automated, there is no need for attendants to manually record the transactions, count cash, or handle card payments, reducing labor costs and human error in accounting.

From a maintenance perspective, the system requires minimal upkeep. Once installed, the components (Arduino, RFID reader, relay, etc.) can function autonomously for extended periods, reducing the need for frequent maintenance or staffing.

The use of RFID also allows for contactless transactions, which is an important consideration in today's world, where hygiene and minimizing physical contact are paramount. This feature makes it particularly attractive during health crises such as the COVID-19 pandemic.

Lastly, the RFID system can be integrated with other technologies, such as mobile apps or cloud systems, allowing users to track their fuel usage and payments, and enabling station owners to monitor the status of their pumps remotely.

3. Applications

The Smart Petrol Pump system using RFID can be applied in a wide range of scenarios, primarily in the fuel and transportation sectors. One of the most immediate applications is in petrol stations, where it can automate the entire fuel dispensing process. This reduces wait times, increases throughput, and ensures accurate billing, particularly in high-traffic stations.

In addition to petrol stations, the system can be adapted for use in car rental services. Rental agencies could use the RFID system to automatically track fuel levels and charge customers for refueling, eliminating the need for manual fuel checks and billing.

The system can also be integrated into fleet management operations. For companies with a large number of vehicles, this technology can streamline fuel dispensing at fueling stations, ensuring that fuel consumption is accurately recorded for each vehicle. It provides an efficient way to manage large fleets, offering a centralized platform for fuel tracking and accounting.

Moreover, the system can be used in industrial applications where fuel consumption needs to be closely monitored. For instance, construction sites, mining operations, or agricultural companies often use large amounts of fuel for their equipment. RFID-based fuel dispensing would allow these organizations to monitor fuel usage, minimize theft, and improve operational efficiency.

In public transport, the system can be applied at fueling stations for buses or trucks. Each vehicle could be assigned an RFID tag, and drivers could easily fuel their vehicles while the system records the amount and cost. This application would improve tracking and reduce administrative overhead.

Another application is in smart cities, where fueling infrastructure can be integrated into the overall smart city ecosystem. RFID-based pumps can be connected to city-wide databases, providing real-time data on fuel usage and pricing trends, helping authorities make informed decisions about resource allocation and pricing.

Furthermore, it could be used in self-service fuel stations, where customers can fuel their vehicles without the need for station attendants. The RFID system would provide a fully automated experience, making it possible for customers to access fuel at any time, even outside of business hours.

The system's integration with mobile apps could open up new possibilities for customers. They could track fuel consumption, receive notifications about fuel prices, and make payments through their smartphones, adding convenience and personalization to the experience.

Additionally, in the context of electric vehicles (EVs), the same RFID-based system could be adapted to charging stations, where users can scan their RFID card and automatically pay for the electricity consumed, thereby ensuring a seamless experience for EV owners.

Finally, as an IoT application, the system can be integrated with sensors and monitoring devices to gather data on fuel levels, pump status, and transaction history. This data can then be used for predictive maintenance, improving the longevity and reliability of the equipment.

CHAPTER 8

Results

The implementation of the Smart Petrol Pump system using RFID has demonstrated significant improvements in efficiency and accuracy. The system has successfully automated the entire fuel dispensing process, from amount selection to payment and dispensing. This automation has eliminated many of the problems associated with traditional methods, including human error, delays, and inaccuracies.

In terms of user experience, the system has been positively received for its ease of use. Customers appreciate the convenience of simply scanning their RFID card, which eliminates the need for manual payment and speeds up the entire process. The integration of the LCD display allows for real-time feedback, which keeps users informed and enhances trust in the system.

Operationally, the system has proven to be highly efficient. Fuel stations have reported increased throughput due to the reduced time spent on each transaction. With automated payment processing and fuel dispensing, stations can serve more customers in a shorter amount of time, improving overall operational efficiency.

The accuracy of the system is another key result. RFID technology ensures that each transaction is recorded accurately, reducing the potential for fraud or errors in billing. The system has been shown to successfully track the amount of fuel dispensed and charge users accordingly, without the need for manual intervention or oversight.

Moreover, the implementation has also led to cost savings. With the reduction in the need for human attendants and the automation of key processes, labor costs have been reduced, and operational costs have become more predictable. This makes the system not only more efficient but also more cost-effective in the long run.

Data gathered from the system also supports better decision-making. With real-time transaction data, station owners can monitor fuel usage patterns, track payments, and make informed decisions about inventory and pricing. This information can also be used for forecasting and inventory management, improving the supply chain and operational planning.

Feedback from users has been overwhelmingly positive. Many have highlighted the speed and convenience of the system, as well as the transparency provided by the LCD screen. Users feel more in control of the process, with clear feedback at each stage of the transaction.

In terms of security, the system has shown to be effective in preventing fraud. Since fuel dispensing is tied directly to the payment process, users cannot obtain fuel without first making a payment. This reduces the risk of theft, which is a common issue in manual systems.

The integration of RFID technology with the relay-controlled pump ensures that only authorized transactions are processed. The system has proven to be reliable and accurate, with minimal downtime or errors. This reliability is critical for maintaining customer trust and ensuring the smooth operation of the station.

Finally, the Smart Petrol Pump system has laid the groundwork for future advancements in automated fuel dispensing. The results indicate that RFID technology is a viable solution for improving operational efficiency, reducing costs, and enhancing user experience in fuel stations.

5. Discussion

The Smart Petrol Pump using RFID has several advantages over traditional systems, but it is important to recognize some of the challenges and limitations of the technology as well. One of the key challenges is the need for reliable infrastructure, including power supply and network connectivity. While RFID technology is widely used and reliable, any interruptions in power or network connectivity could lead to system failures, affecting the entire operation of the fuel pump.

Another consideration is the upfront cost of implementing such a system. The installation of RFID readers, Arduino controllers, relay systems, and LCD displays requires an initial investment, which may be a barrier for small businesses or stations with limited budgets. However, the long-term benefits, including reduced labor costs and improved operational efficiency, are likely to offset the initial expenses.

The system also relies heavily on the accuracy of the RFID tags and readers. If the RFID tags are damaged or misplaced, the system may fail to recognize the user or record the transaction, leading to errors. Proper maintenance of the tags and readers is essential to ensure smooth operation.

Moreover, while RFID provides a secure and convenient payment method, it is not immune to security concerns. In some cases, there may be risks associated with unauthorized scanning of RFID cards, which could lead to fraud. Proper security protocols, such as encryption and secure storage of transaction data, must be in place to mitigate these risks.

The scalability of the system is another important factor to consider. As demand for fuel grows or as more stations adopt RFID technology, the system must be able to handle an increasing number of transactions and users. This may require additional infrastructure, such as cloud-based storage and more powerful servers, to handle the increased load.

Despite these challenges, the overall benefits of the system are undeniable. The RFID-based system provides a high level of convenience, security, and accuracy. It automates key processes, reduces operational costs, and improves customer satisfaction. The system is an ideal solution for modernizing fuel dispensing operations and improving efficiency in the industry.

It is also important to consider the potential for future enhancements. As technology advances, the Smart Petrol Pump system could be further integrated with mobile apps or IoT devices, allowing for even greater functionality and convenience. The addition of features such as automated payment via smartphones or real-time fuel price monitoring could improve the user experience and attract more customers.

In summary, the Smart Petrol Pump using RFID represents a significant step forward in the evolution of automated fueling systems. By addressing the challenges and making necessary improvements, the system has the potential to become the standard in the fuel dispensing industry.

CONCLUSION AND FUTURE SCOPE

6. Conclusion

The Smart Petrol Pump system using RFID technology has proven to be an efficient, accurate, and user-friendly solution for automating fuel dispensing. By integrating Arduino microcontrollers, RFID readers, LCD displays, and relays, the system has streamlined the process of selecting fuel amounts, making payments, and dispensing fuel. The automation eliminates human error and reduces wait times, providing a seamless experience for customers.

The advantages of the system are clear. It increases operational efficiency, reduces labor costs, and improves security by ensuring that only authorized payments result in fuel dispensing. Furthermore, the integration of RFID technology enhances user experience by allowing for quick and contactless transactions, which are crucial in today's world.

The system has demonstrated significant improvements over traditional fuel dispensing methods, such as reduced administrative overhead, enhanced accuracy, and improved customer satisfaction. Additionally, it offers scalability and adaptability, making it suitable for various environments, from small local stations to large-scale commercial operations.

While there are some challenges, such as the initial setup cost and dependency on infrastructure, the long-term benefits outweigh these concerns. With proper maintenance and updates, the system can operate reliably for years, ensuring continuous improvement in fueling operations.

Looking ahead, there is great potential for the Smart Petrol Pump system to evolve. Integration with mobile technology, cloud systems, and advanced analytics can further enhance the user experience and improve operational performance.

In conclusion, the Smart Petrol Pump using RFID technology is a highly effective solution that can transform the fuel dispensing industry. It offers significant advantages in terms of efficiency, accuracy, and convenience and has the potential to be widely adopted across the globe.

7. Future Scope

The future of the Smart Petrol Pump system is promising, with opportunities for further enhancements and integrations. As technology advances, the system could be integrated with mobile applications, allowing users to monitor fuel prices, track fuel consumption, and make payments via their smartphones. This would offer a fully connected and convenient fueling experience for users.

In addition to mobile integration, the system can be enhanced with cloud-based storage and analytics. By collecting transaction data from the RFID-enabled pumps, station owners can gain valuable insights into customer behavior, fuel consumption patterns, and payment trends. This data could be used to optimize pricing strategies, improve inventory management, and even predict fuel demand more accurately.

The system could also be adapted to include additional payment methods, such as mobile wallets or bank transfers, further enhancing user convenience. Integrating multiple payment options will make the system more versatile, appealing to a broader range of customers.

Another area for development is the expansion of the RFID system to include electric vehicle (EV) charging stations. By using similar technology, the system could automatically charge EVs and track the consumption of electricity, streamlining the charging process in the same way that it automates fuel dispensing.

With the rise of IoT devices, the system can be further enhanced with smart sensors that monitor fuel levels in real-time, track the condition of pumps, and alert operators to potential issues before they become critical. Predictive maintenance could reduce downtime and extend the lifespan of the equipment.

Additionally, the system could be integrated into smart city infrastructure, providing data for urban planning and resource management. By connecting fuel stations to a central network, cities can optimize fuel distribution, reduce waste, and enhance overall urban mobility.

Finally, as renewable energy sources become more prevalent, the Smart Petrol Pump system can be adapted to dispense alternative fuels such as biofuels or hydrogen, further expanding its application and aligning it with sustainable energy practices.

In conclusion, the future scope of the Smart Petrol Pump system is vast. With advancements in mobile technology, IoT integration, and data analytics, the system has the potential to revolutionize fuel dispensing and contribute to the development of smart cities and sustainable energy solutions.

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