A
Project Report
On

DESIGN AND DEVELOPMENT OF SMART LUGGAGE CARRIER TROLLEY

submitted to

Sant Gadge Baba Amravati University,
Amravati (M.S.) 444 602

in partial fulfillment of the requirement

for the degree of

BACHELOR OF ENGINEERING
in
MECHANICAL ENGINEERING

by

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Certificate

This is to certify that the project report entitled **"Design and Development of Smart Luggage Carrier Trolley"** is hereby approved as a creditable study carried out and presented by

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Abstract

The smart trolley is a general one that incorporates all vehicle structures fit for working without driver action. Robotized guided vehicles have found colossal present-day applications. Smart trolleys are right now found in a wide scope of adventures, with the principle constraints on their usage basically coming about due to the segments of the items to be transported or spatial thoughts. Various employments of smart trolleys are really feasible, yet the purchase and execution of such systems is for the most part established on money-related examinations. In an ordinary conveyance community, human prosperity administers productivity. The smart trolly is uncommonly versatile in light of remote correspondence. Its ability to talk with various autonomous vehicles gives a predictable action. Persevering coordination between vehicles passes on money-saving viability. The introduction of unmanned vehicles onto a stockroom floor affects security. With the guidance of natural sensors, the smart trolley can recognize inquiries in its accident way. Computerization abstains from vehicle car over-burdens and their potential for disasters. To overcome these problems, we have designed a smart trolley using a joystick. With this system, we detect the obstacle along the way and also it carries weight up to the 20kg.

KEYWORDS= LoRaWAN Technology, Ultrasonic Sensor, automatically movable

Contents

List of Figures

Chapter 1

INTRODUCTION

Currently, the human lifestyle has changed. Day to day life of an ordinary human being has become a lot more hectic. Time has become money. So, people actually do not have much time to spend on shopping, which is an inevitable thing. That is why people prefer shopping in the malls so that they can get all the products at the same place. This saves them from going into different shops to purchase only a limited type of products. Though shopping in malls gives the benefit of saving time to people, they have only weekends to visit shopping malls.

The main purpose of supermarkets is to provide availability of all the products and save the time of the customers but sometimes customers get frustrated while waiting For the trolley . During festival season due to the overcrowding, there is scarcity of trolly , which make a long time for shopping and it is very frustable to.

To overcome these problems, we have designed smart trolly using LoRaWAN With this system, due to this we detect obstacle along the way and also it carries weight upto the 20kg.

1.1 Objective

1. Design the trolley to safely and securely handle loads of up to 20 kg, ensuring that the structure and components can withstand the weight and maintain stability during movement . To Avoid the Obstacle when we use trolly in supermarket

2. Implement a reliable and responsive joystick control system that allows the operator to navigate the trolley smoothly and intuitively. The joystick should offer accurate control in multiple directions, enabling precise positioning and movement.

3. Prioritize the comfort and usability of the trolley for the operator. Consider factors such as handle design, adjustable height, and ergonomic features to minimize fatigue and improve overall user experience.

4. Construct the trolley using durable and reliable materials that can withstand regular use in industrial environments. Ensure that the trolley is easy to maintain, with accessible components for repairs or replacements when necessary

Chapter 2

LITERATURE REVIEW

Archana Nikose et al. [1] proposed a system where the customer is given a card to scan the barcode which generates a unique id. Later the bill details are displayed onthe screen and have to be paid online.

Vishwanadha V et al. [2] proposed a system which is using a raspberry pi based system with a barcode scanner where the customer has to pay the bill through online payment like GooglePay, Paytm etc.

Ashok Sutagundar et al. [3] proposed a system of RFID tags [Radio Frequency Identification] but the shopping information is passed on to the Amazon cloud using the Wi-Fi module and the data is sent to the android application of customersto pay the bill at the counter.

Agarwal Isha Sanjay et al. [4] proposed an IOT based automated trolley where each product is tagged with RFID. The bill is sent to the counter using a wireless system.

Raghav Chadha et al. [5] proposed a system that utilizes RFID with the billing sideusing mobile applications. The billing information is sent to the customer through amobile application using the Wi-Fi module.

Tharindu Athauda et al. [6] has proposed a system which is low-cost, robust, passive UHF RFID based shopping system. It uses a UHF antenna mounted on a shopping trolley and products are tagged with UHF-RFID.

Awati.J.S, S.B.Awati,[7] They Developed microcontroller based design for user who waits in queue so avoid the crowd at the billing counter and headache like pulling trolley. They used LCD display, Max 232, Barcode scanner; RF module, RF transmitter & RF receiver, & Object counter

Megha R mane, Innovation of new technologies such as barcode reader as mentionedin [8], will make shopping process faster. The barcode reader is an optical scannerthat detects items by reading the barcode. Barcode scanner is easy to use, because it doesn't need any kind of training and employees can easily understand its functionality. Shopping system with barcode reader for product identification needsa line of sight between product and items. In the proposed system the barcode reader scan the barcode, decode it and send data to the computer. Here the customers will be able to scan each product themselves. A LCD display is providedwith the trolley. So the display keeps information about price. It continuously updates the total whenever the customer purchase product.

Chapter 3

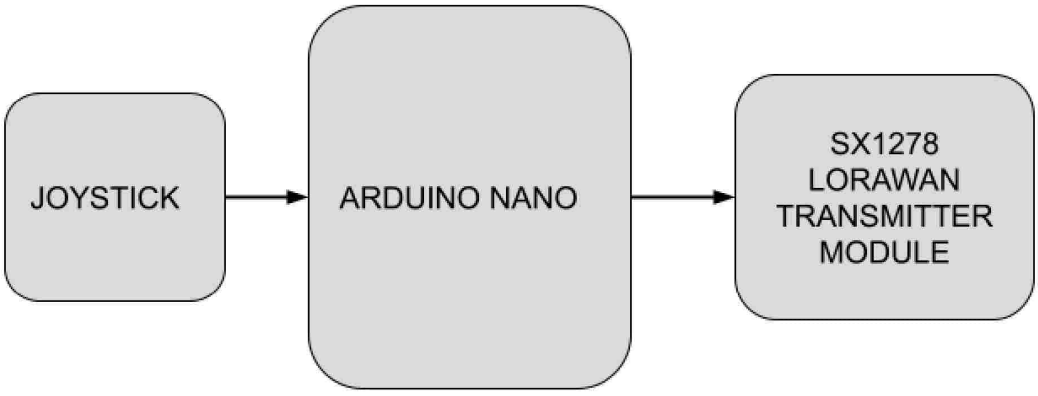
PROJECT DESCRIPTION

3.1 Proposed System

In This Proposed System we make a System that is handled automatically as well as manually type. This System is based on LoRAwan Technology. we used 2 Arduino Nano with the SX1278 lorawan module. Here we used an ultrasonic sensor to detect the obstacle in the trolley's path. It carries a 20 kg weight. This is controlled by a joystick. With the help of a joystick, we can turn Right, left, back, and forward. The structure is a rectangle in size. Trolly made with 4 wheels of hightorque gear motor. The program code using Arduino IDE and Circuit is made of Proteus Software.

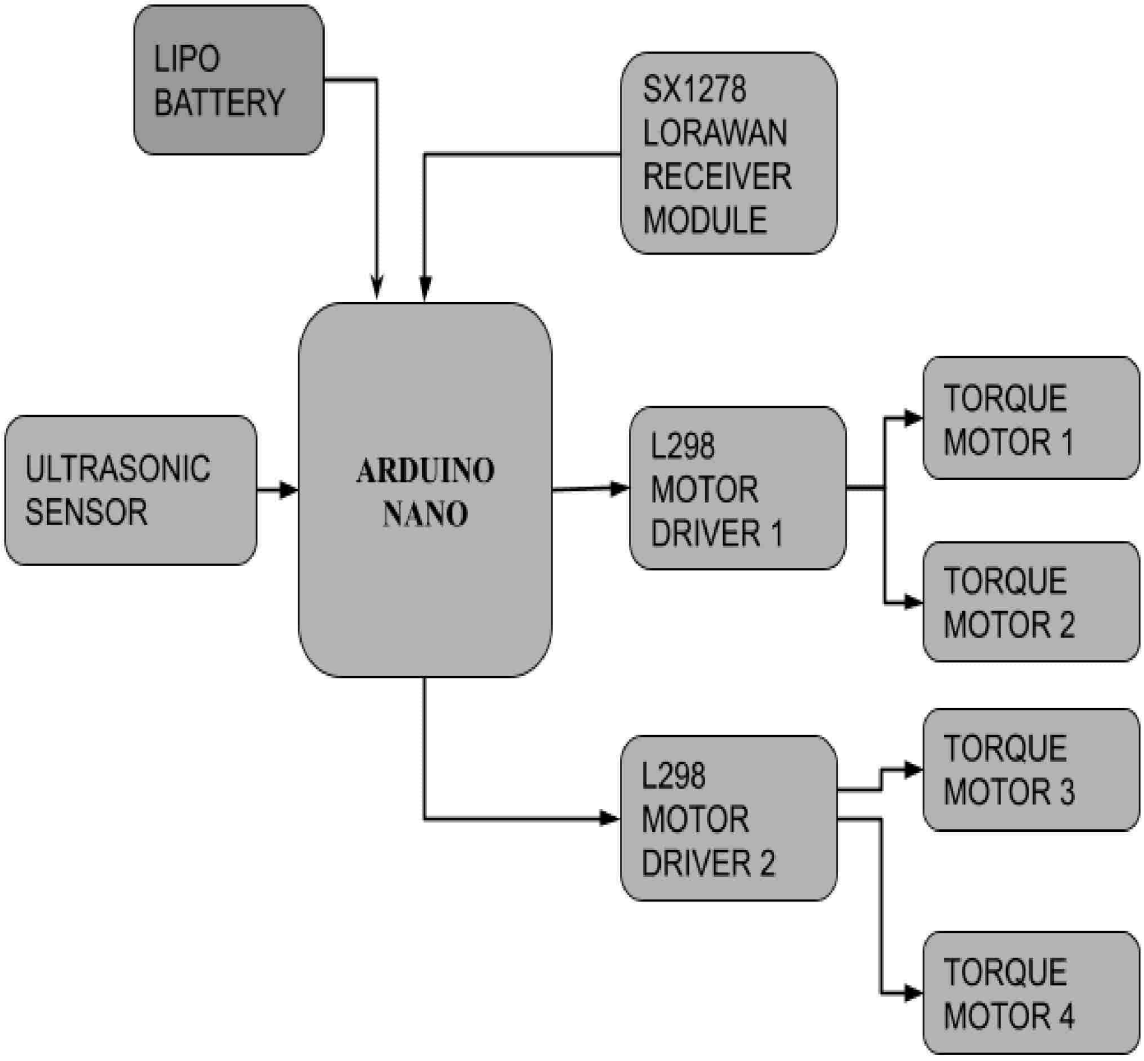
3.2 Block Diagram

3.2.1 Transmitter Side



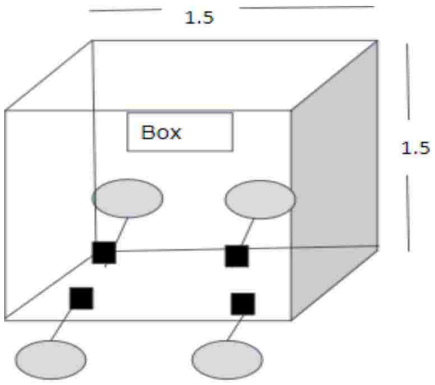
In this project we used Arduino Nano as a microcontroller. As an input device we used a joystick and as an output device the lorawan transmitter module.

3.2.2 Receiver Side

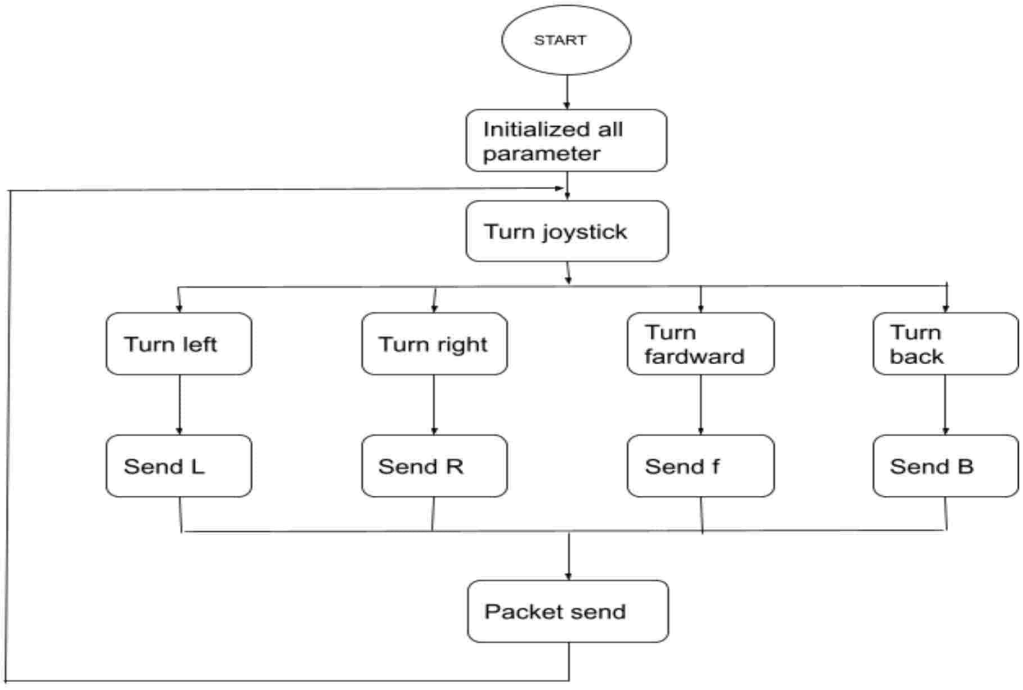


In this project we used Arduino Nano as a microcontroller. Ultrasonic is connectedas an input device to the Arduino Nano. The 2 L298 motor driver is connected to the microcontroller as an output device. The 4 torque motor is attached SX1278 receiver lorawan module is connected as an input device to the arduino nano.

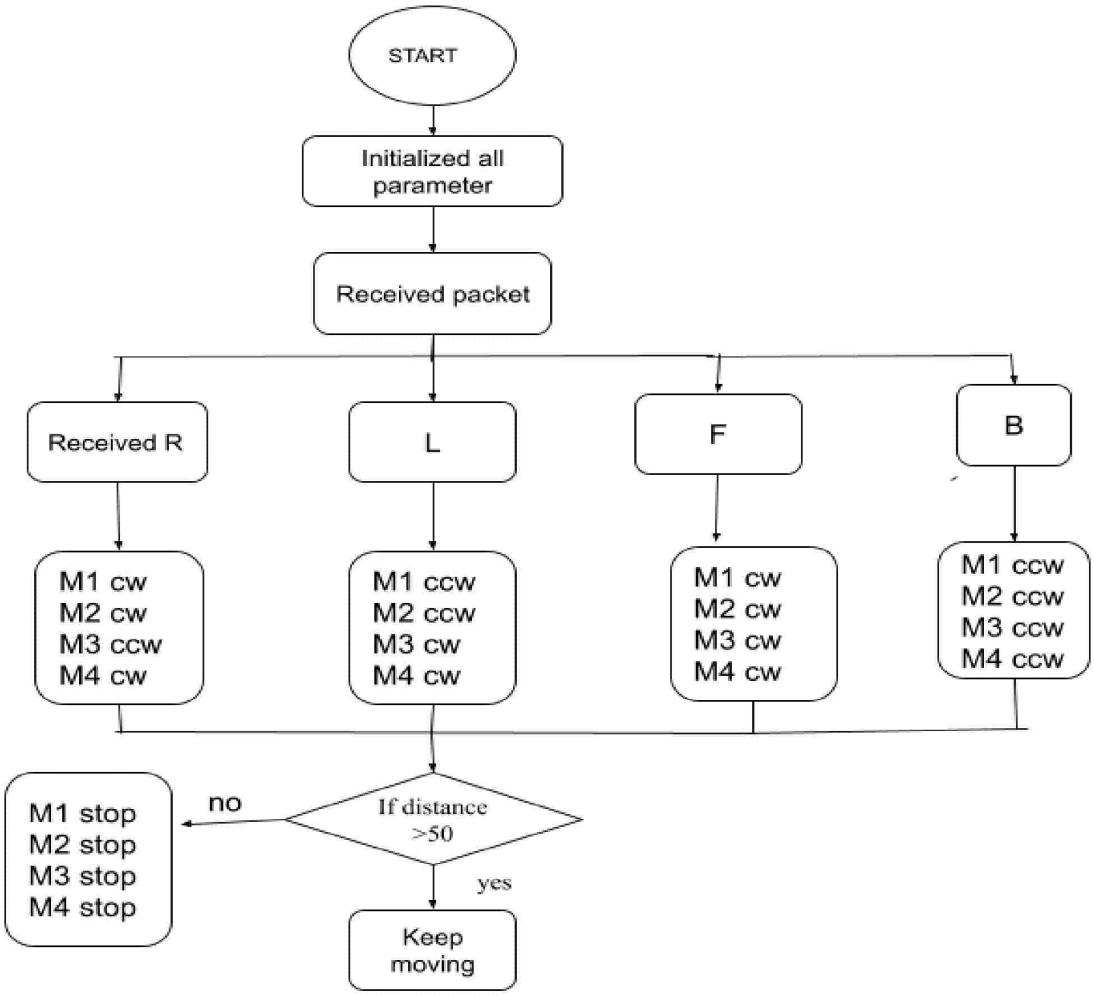
3.3 Design



3.4 Transmitter Flow Chart

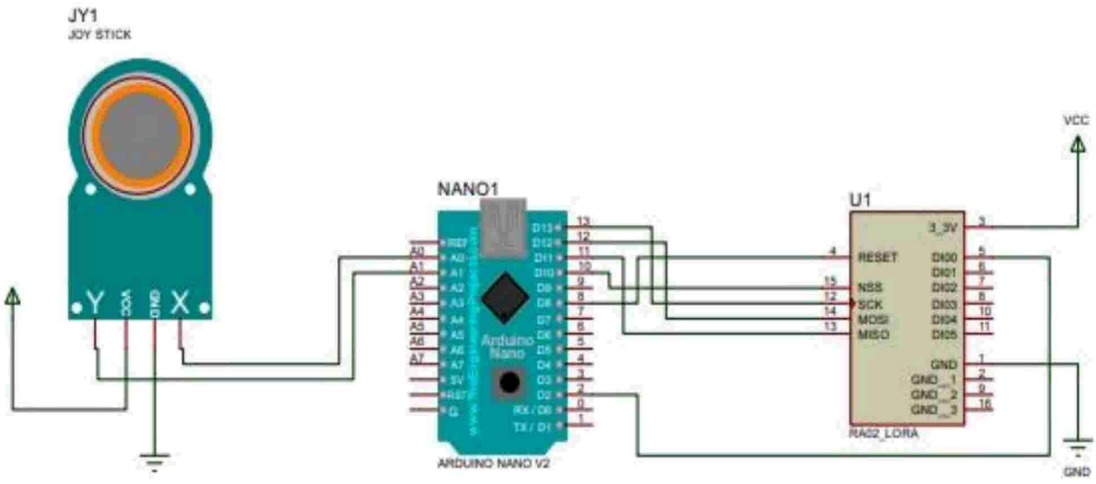


3.5 Receiver Flow Chart

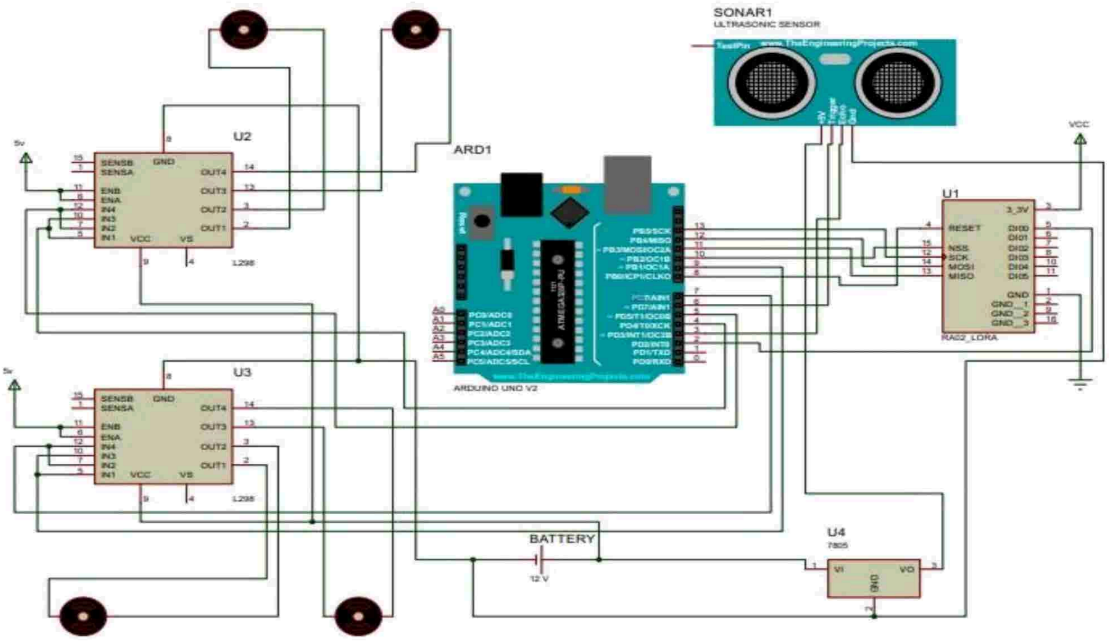


3.6 Circuit

3.6.1 Transmitter Circuit



3.6.2 Receiver Circuit



3.7 Working

The project Title is “Smart trolley using LoRAwan Technology” this is a new invention where the trolley follows automatically using some commands. Here we used different modules like Arduino Nano, SX1278 LoRAwan module, ultrasonic sensor, and Torque motor. This is based on LoRAWan technology. In this project, there are two systems Transmitter and receiver system. In this transmitter circuit byusing a joystick if we turn left send L and Right send R for hardware send F andfor Back send B. this is a packet is sent to the Receiver system and if it Receives R out of 4 motor three M1, M2, and M4 rotate clockwise direction and M3 rotate counter-clockwise direction. If received L then M1 and M2 rotate counter, clockwise and M3, and M4 Rotate clockwise direction. If received F all 4 motors rotate clockwise and if received Back then all four 4 motors rotate counterclockwise direction. After receiving the packet if the distance is greater than 50 then the trolly keeps moving if not then the trolly become stop. So this technology is very useful in this field we make trolly automatically.

CHAPTER 4

DESIGN CALCULATIONS

- Weight of single motor(w) = 0.2kg
- Therefore, total weight of motor(w_t) = 4*0.2 =0.8kg
- Weight of body structure (w_{body}) = 2kg
- Weight of battery = 0.4kg ($w_{battery}$)
- Total weight of trolley (W) = w_t+ w_{body}+ $w_{battery}$

  = 0.8kg+ 3kg+ 1.2kg

  = 5kg
- Weight bearing capacity = up to 15kg
- Load =15kg+5kg=20kg

- Radius of wheel (r) = 0.05m
- Force = Load * g = 20kg* 9.81

  =196.58N
- Force on single wheel = 196.58/4
- = 49.15N
- Assume coefficient of friction between trolley wheels and road to be 0.3
- Force required to push/pull trolley (F) = 49.15* 0.3

  = 14.74N
- Torque available at wheels = F*r

  = 14.74 * 0.05

  = 0.84N-m = 8.57kg-cm

- Now let's say that the trolley must be pulled at max speed of 4kmph (0.1m/s)
- Velocity = r*w

$$1.1 = 0.05*2*3.14*N$$

$$N = 3.1*60$$

$$N = 186\text{rpm}$$

Chapter 5

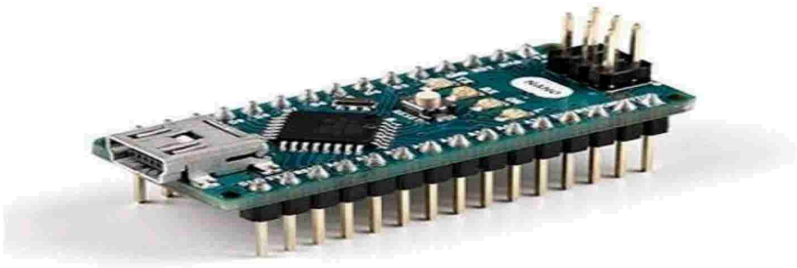
System Requirement

5.1 HARDWARE REQUIREMENT

5.1.1 Arduino Nano

The Arduino Nano is a small Arduino board based on ATmega328P or ATmega628 Microcontroller. The connectivity is the same as the Arduino UNO board. The Nano board is defined as a sustainable, small, consistent, and flexible microcontroller board. It is small in size compared to the UNO board. The ArduinoNano is organized using the Arduino (IDE), which can run on various platforms. Here, IDE stands for Integrated Development Environment. The devices requiredto start our projects using the Arduino Nano board are Arduino IDE and mini USB. The Arduino IDE software must be installed on our respective laptops or desktop. The mini USB transfers the code from the computer to the Arduino Nano board.

The Arduino Nano is shown below:



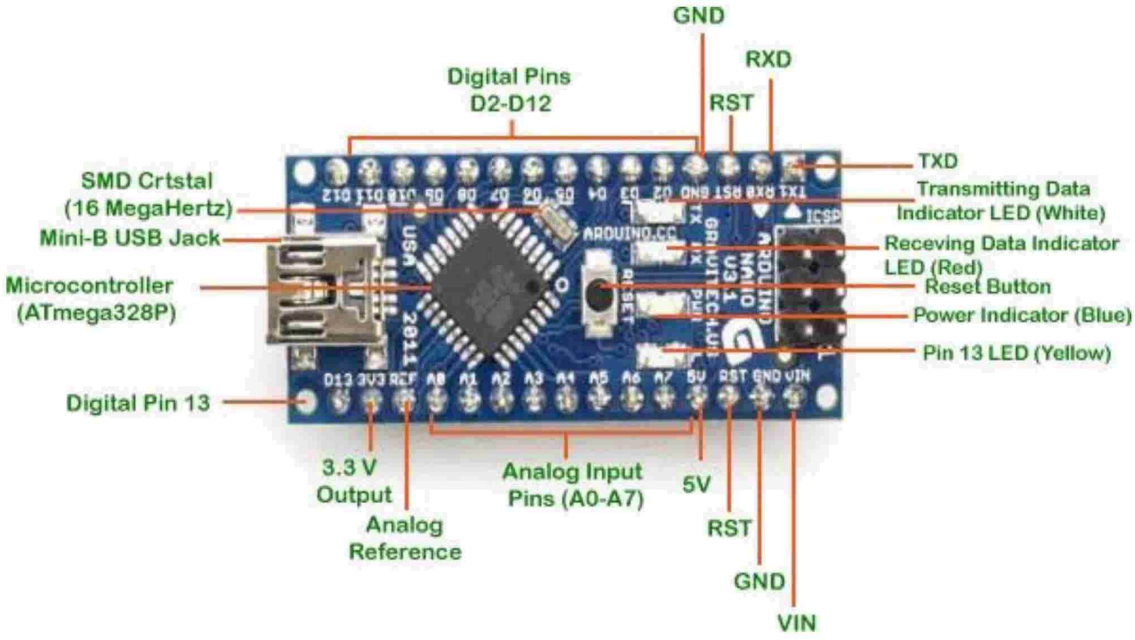
Features :

- ATmega328P Microcontroller is from 8-bit AVR family
- Operating voltage is 5V
- Input voltage (Vin) is 7V to 12V
- Input/Output Pins are 22
- Analog i/p pins are 6 from A0 to A5

- Power consumption is 19 mA
- Flash memory is 32 KB
- Size of the printed circuit board is 18 X 45mm

Arduino Nano Pinout

Arduino nano pin configuration is shown below and each pin functionality isdiscussed below**.**



Atmega328P Microcontroller

The Atmega328P is a high performance and low powered 8-bit microcontroller, which is based on AVR RISC Architecture. Here, AVR stands for Audio Video Recorder and RISC stands for Reduced Instruction Set Computing. It is also considered as the most popular AVR controller. It consumes less power than Atmega328 Microcontroller.

- **RXD and TXD -** TXD and RXD pins are used for serial communication. The TXD is used for transmitting the data, and RXD is used for receiving the data. It also represents the successful flow of data from computer to the board.

- **Mini USB -** The Mini USB is smaller than the standard USB but thick than the micro USB. It allows the board to connect to the computer. It is essential for the programming of the Arduino Nano board.
- **RST -** It is used to add a Reset button to the connection.
- **Power Indicator -** It indicates the status of the battery. It can also show the voltage of the battery on the LCD display connected to the Arduino board.
- **Digital Pins -** There are 14 digital I/O pins. The six pins from the set of digital pins are PWM (Pulse Width Modulation) pins numbered D3, D5, D6, D9, D10, and D11. The digital pins have the value either HIGH or LOW.
- **Analog Pins -**There are eight analog pins numbered from A0 to A7. The function of Analog pins is to read the value of analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.
- **Analog Reference or (AREF) -**The AREF pin acts as a reference voltage to feed the Arduino from an external power supply voltage.
- **Vin -**It is defined as the input voltage, which is applied to the Arduino Board when it is using an external power source.
- **3V3**- The 3V3 pin works as the output regulated voltage of 3.3V.
- **5V-** The 5V pin works as the output regulated voltage of 5V. The power source of 5V for the Arduino Nano board are USB connector, DC power jack, and the Vin. The power can be supplied to the board from either of the above specified sources.

Applications :

These boards are used to build Arduino Nano projects by reading inputs of a sensor, a button, or a finger and giving an output by turning the motor or LED ON, or and some of the applications are listed below**.**

- Samples of electronic systems & products
- Automation
- Several DIY projects
- Control Systems

- Embedded Systems
- Robotics

5.1.2 Torque Motor

Torque motors are a special class of brushless permanent-magnet synchronous motors. Since the payload is directly connected to the rotor without the use of transmission elements, torque motors are classified as **direct drives.**

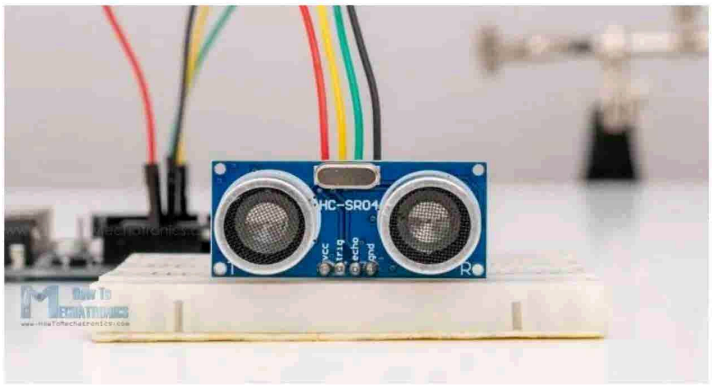
Depending on your perspective, a torque motor is either a rolled-up linear motor or a classic servo drive with a large number of poles. It is the large number of poles that enables conventional torque motors to attain high torque at moderate speeds. Another attractive feature is their compact design which includes a narrow lamination stack and a large hollow shaft or bore.

As with linear motors, torque motors are a type of "frameless" motor. This means that the motor does not include a housing, bearings, or feedback device. These components can be selected by the machine builder and optimized according to the required performance, or purchased as part of an assembly.

Torque motors produce high torque at moderate speeds and even when stationary or "stalled". Contrary to traditional drives, the sizing and selection of a torque motor is purely based on torque, not power. Fundamentally, the peak torque determines the maximum torque that the motor physically produces and the continuous torque defines the amount of torque the motor can continuously supply. The duty cycle of the application will define the dependency on peak or continuous torque.

5.1.3 Ultrasonic Sensor

A transducer that works on the principle similar to the sonar or radar and estimate attributes of the target by interpreting is called an ultrasonic sensors or transceiver. There are different types of sensors that are classified as active and passive ultrasonic sensors that can be differentiated based on the working of sensors.



The high-frequency sound waves generated by active ultrasonic sensors are received back by the ultrasonic sensor for evaluating the echo. Thus, the time interval taken for transmitting and receiving the echo is used for determining the distance to an object. But, passive ultrasonic sensors are just used for detecting ultrasonic noise which is present under specific conditions.

HC-SR04 Ultrasonic Sensor Pinout:

The sensor has 4 pins. VCC and GND go to 5V and GND pins on the Arduino, and the Trig and Echo go to any digital Arduino pin. Using the Trig pin we send the ultrasound wave from the transmitter, and with the Echo pin we listen for the reflected signal.

5.1.4 SX1278- LORAWAN MODULE

The LoRa SX1278 RA02 works with SPI communication protocol so it can be used with any micro microcontroller that supports SPI communication protocol. It is mandatory to use an antenna along with the module else it might damage the module permanently. The module should be powered only with 3.3V, the operating voltage is 3.3V, and the frequency is 433 MHz and transmits and receives packets up to 256 bytes. Here we are not legally allowed to use the

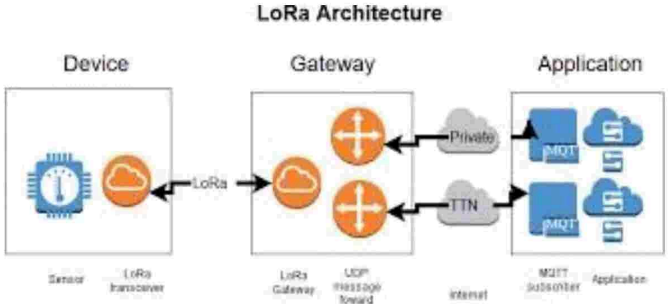
433MHz frequency module for a long time other than for educational purposes**.**

LoraWan Module

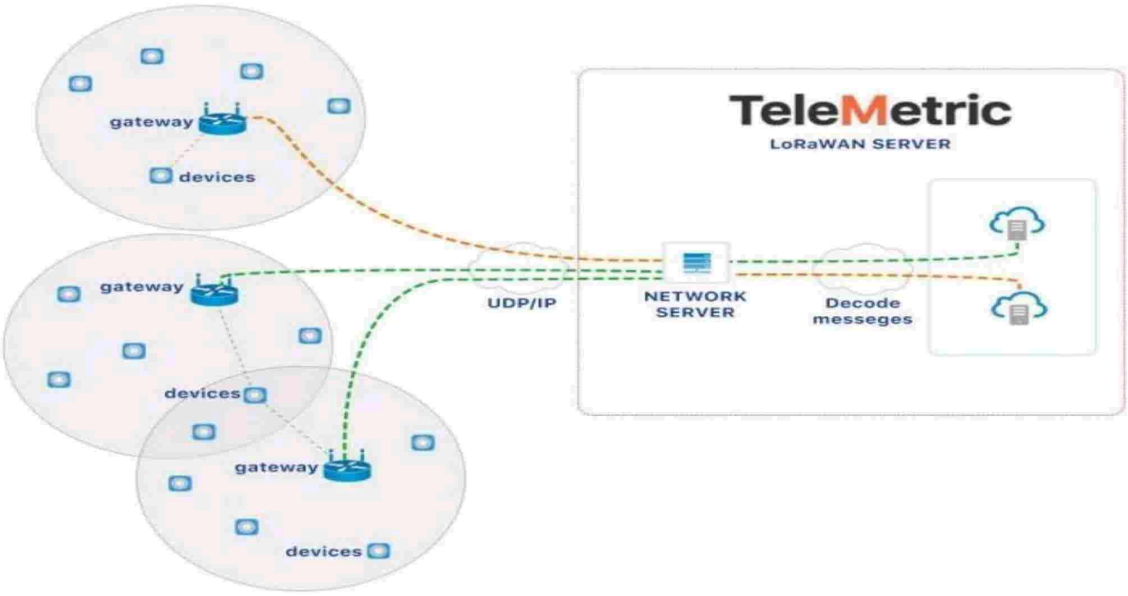
LoRaWAN is a type of LPWAN network, which stands for Low-power Wide-area Network — “energy-efficient long-range network”. LPWAN networks are wireless and have a wide coverage radius, the main advantage of such networks is low power consumption, and the amount of data transfer in such networks is measured in bytes, but this is enough to transmit the necessary telemetry from the end device to the dispatcher server. The lifetime of these end devices is several years on a single battery and depends on the data transfer schedule.

Basically, devices with LPWAN connection are typical microcontrollers with minimal power consumption and a wireless network interface. These devices usually communicate with their gateway (base station), which has an IP address foraccessing the Internet.

LoRaWAN is a technology standard developed and supported by the Lora Alliance, which consists of international telecommunications companies and manufacturers, as well as integrators. The LoRaWAN technology platform can be segmented into:



- **LoRa:** Proprietary technology with LoRaWAN radio modulation that uses wireless connectivity to connect between end devices and gateways.
- **LoRaWAN:** an access control Protocol that uses MAC address identification (MAC-media access control) to transmit and manage messages between the LoRaWAN Network Server and the end device.



The diagram shows four key elements of the network:

Devices: End IoT devices that send and receive messages in the LoRA wireless network.Gateways: the Gateway works as a relay and its task is to send all messages from the end devices and transmit them to the network server and back. Network server: manages and maintains the LoRA network**.**

Application server: All devices send a message with payload to the client's final application. The diagram shows that the network topology is a Star (Star — base

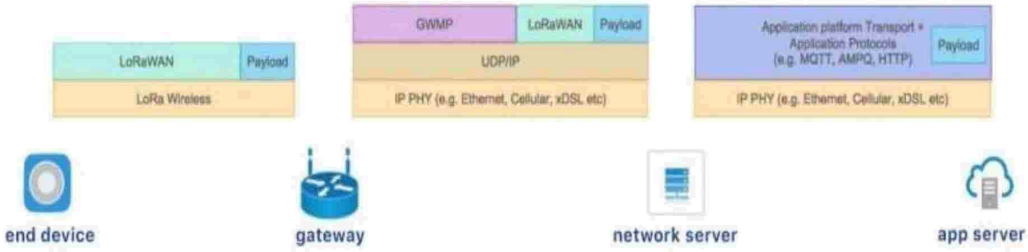
topology of a computer network in which all computers/network devices connectedto the Central node, forming a physical network segment.) with a network server connecting multiple gateways, which in turn connect to devices over the LoRA wireless network.

Communication is bidirectional, but the predominant type of communication is accepting data from end devices.

The diagram shows two LoRaWAN messages sent using two wireless devices, marked orange and green.

In the upper coverage area of the LoRA wireless network, the device sends LoRaWAN messages using the LoRA wireless network. This message is received by the gateway and sent to the network server. In the lower coverage areas, the device sends a similar LoRaWAN message that is received by two gateways, these two messages are forwarded to the network server.

We have shown two devices connected to two different application servers, i.e. in LoRaWAN, the application defines how the devices are connected to a specific backend server and all the devices are connected to a specific application.



Gateways send LoRaWAN messages over the wireless interface using the gateway Message Protocol defined in accordance with the LoRaWAN Gateway to Server interface specification. LoRaWAN messages and attached data are sent in JSON encoded format using UDP/IP

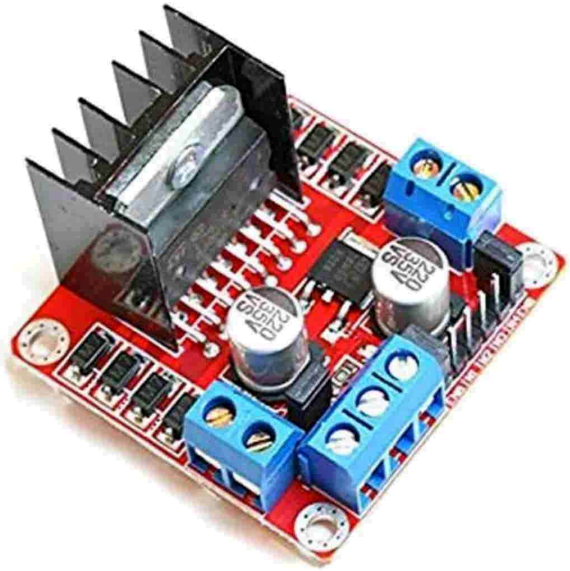
The LoRaWAN specification does not define or describe how the network server will interact with the application server (dispatcher). Typically, applications use Iso standards such as MQTT, AMPQ, HTTP, and others to exchange messages between the network server and the server.

LoRa Devices

End devices exchange LoRaWAN messages with gateways on different frequency channels and data rates, which are defined by The Alliance's LoRa regional parameters document. Currently, more than 100 countries use these LoRaWAN specifications, the main ones are presented below.

5.1.5 L298N Motor Driver Module

This L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors. This module comprises an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.



Features and Specifications:

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V

- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor

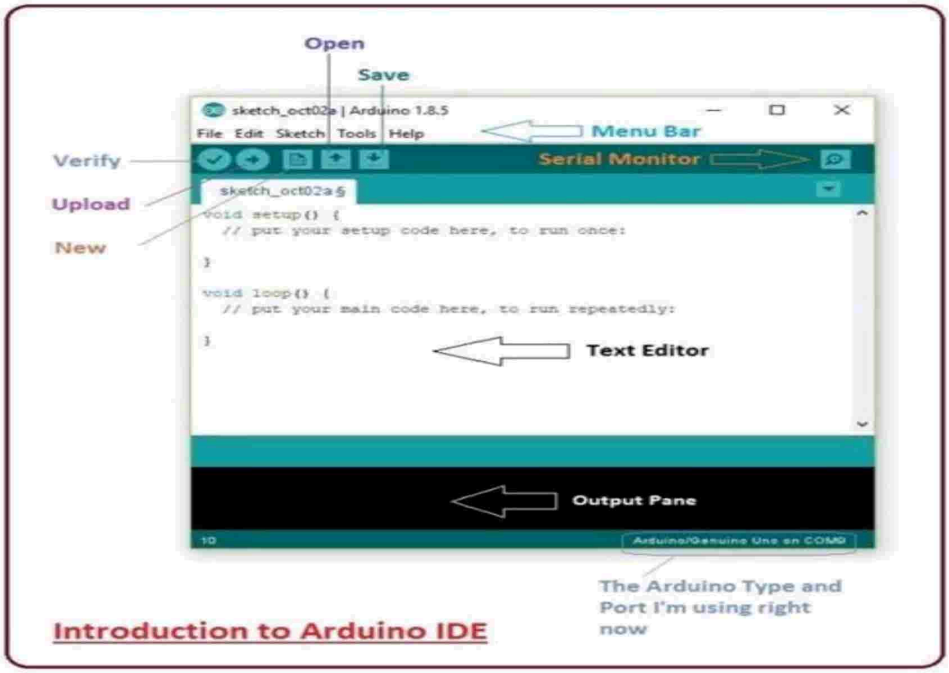
Applications :

- Drive DC motors.
- Drive stepping motors
- In Robotics

5.2 Software Requirement

5.2.1 Arduino IDE

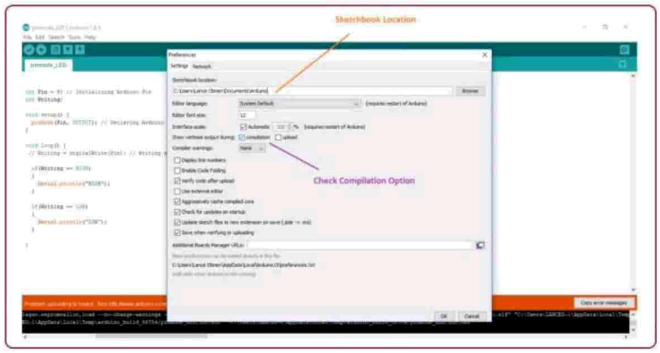
An official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in almost all Arduino modules/boards. Arduino IDE is open-source software and is easily available to download.



- **Arduino IDE** is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules.
- 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.
- It is available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing and compiling the code.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- 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 IDE environment mainly contains two basic parts: Editor and Compiler where the former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.
- This environment supports both C and C++ languages.

File	
New	This is used to open new text editor window to write your code
Open	Used for opening the existing written code
Open Recent	The option reserved for opening recently closed program
Sketchbook	It stores the list of codes you have written for your project
Examples	Default examples already stored in the IDE software
Close	Used for closing the main screen window of recent tab. If two tabs are open, it will ask you again as you aim to close the second tab
Save	It is used for saving the recent program
Save as	It will allow you to save the recent program in your desired folder
Page setup	Page setup is used for modifying the page with portrait and landscape options. Some default page options are already given from which you can select the page you intend to work on
Print	It is used for printing purpose and will send the command to the printer
Preferences	It is page with number of preferences you aim to setup for your text editor page
Quit	It will quit the whole software all at once

- As you go to the preference section and check the compilation section, the Output Pane will show the code compilation as you click the upload button.



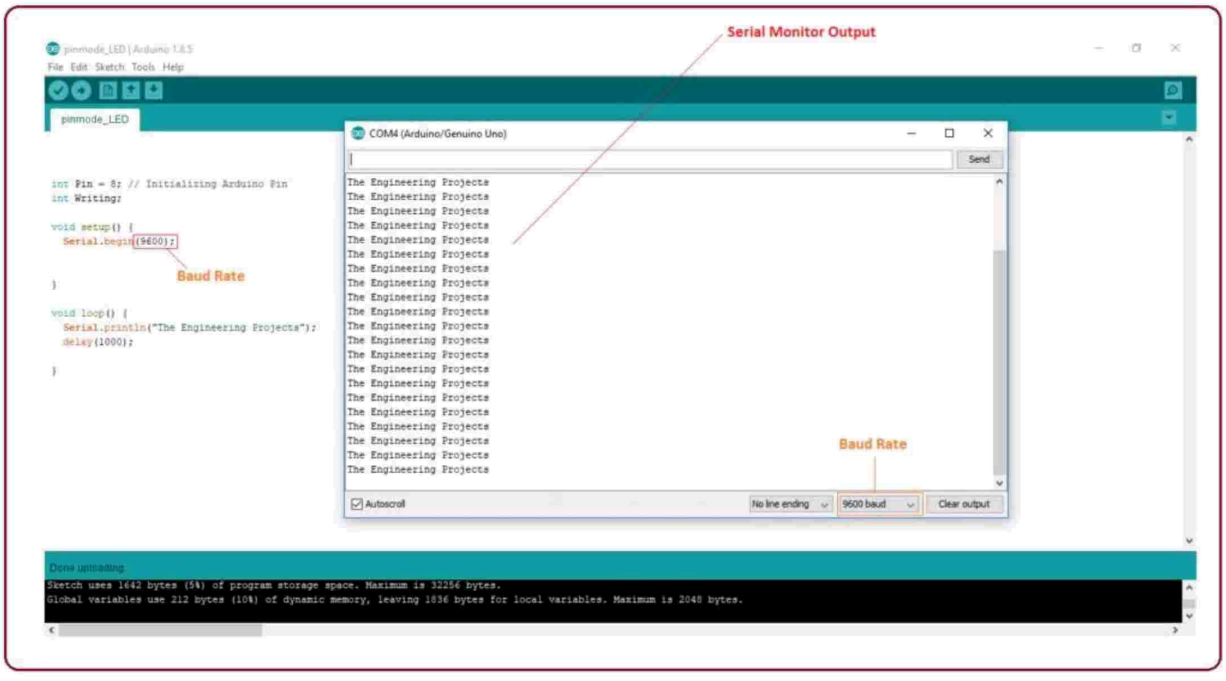
- And at the end of the compilation, it will show you the hex file it has generated for the recent sketch that will send to the Arduino Board for the specific task you aim to achieve.

- Edit – Used for copying and pasting the code with further modification for font
- Sketch – For compiling and programming
- Tools – Mainly used for testing projects. The Programmer section in this panel is used for burning a bootloader to the new microcontroller.
- Help – In case you are feeling skeptical about software, complete help is available from getting started to troubleshooting.

The **Six Buttons** appearing under the Menu tab are connected with the runningprogram as follows.

- The arrow key will upload and transfer the required code to the Arduino board.
- The dotted paper is used for creating a new file.
- The upward arrow is reserved for opening an existing Arduino project.
- The downward arrow is used to save the current running code.
- The button appearing on the top right corner is a Serial Monitor – A separate pop-up window that acts as an independent terminal and plays a vital role in sending and receiving the Serial Data. You can also go to the Tools panel and select Serial Monitor, or pressing Ctrl+Shift+M all at once will open it instantly. The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating. Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor.

- You need to select the baud rate of the Arduino Board you are using right now. For my Arduino Uno Baud Rate is 9600, as you write the following code and click the Serial Monitor, the output will show as the image below.



5.2.2 Proteus

It is a software suite containing schematic, simulation as well as PCB designing.

- ISIS is the software used to draw schematics and simulate the circuits in real time. The simulation allows human access during run time, thus providing real time simulation.
- ARES is used for PCB designing. It has the feature of viewing output in 3D view of the designed PCB along with components.
- The designer can also develop 2D drawings for the product.

Features :

ISIS has a wide range of components in its library. It has sources, signal generators, measurement and analysis tools like oscilloscope, voltmeter, ammeter etc., probes for real-time monitoring of the parameters of the circuit, switches, displays, loads like motors and lamps, discrete components like resistors, capacitors, inductors, transformers, digital and analog Integrated circuits, semiconductor switches, relays, microcontrollers, processors, sensors etc.

ARES offers PCB designing up to 14 inner layers, with surface mount and throughhole packages. It is embedded with the footprints of different categories of components like ICs, transistors, headers, connectors and other discrete components. It offers Auto routing and manual routing options to the PCB Designer. The schematic drawn in ISIS can be directly transferred to ARES.

Chapter 6
FABRICATION

6.1 Frame Construction

6.1.1 Gather Materials and Tools:

Collect all the required materials based on the selected design, such as metal or sturdy plastic tubes, sheets, brackets, and fasteners.
Ensure you have the necessary tools for construction, including a measuring tape, saw, drill, screwdriver, wrench, and any specialized tools specific to the chosen materials.

6.1.2 Design and Measurement:

Refer to the design specifications and drawings to determine the dimensions and layout of the trolley frame.
Measure and mark the lengths and angles required for the frame components, taking into account the overall dimensions and the desired load-bearing capacity.

6.1.3 Cutting and Shaping:

Use the appropriate cutting tools, such as a saw or tube cutter, to cut the frame components to the measured lengths.
If needed, shape the components using bending tools or heat sources, ensuring they match the desired angles and contours specified in the design.

6.1.4 Assembly:

Begin the assembly by connecting the main frame components, such as the longitudinal and transverse beams.

Utilize brackets, fasteners, or welding techniques (if applicable) to securely join the frame components together.

Double-check the alignment and squareness of the frame during the assembly process to maintain stability and structural integrity.

6.1.5 Finishing Touches:

Smooth any rough edges or sharp corners on the frame using sandpaper or a file to ensure safety and aesthetics.

Apply a protective coating or paint to prevent corrosion, especially if using metal components.

6.2 Wheel Assembly Process

6.2.1 Wheel or Track Mounting Points:

Identify the predetermined positions on the trolley frame where the wheels or tracks will be attached. These locations may be specified in the design or based on the desired weight distribution and stability.

6.2.2 Marking and Drilling:

Use a measuring tape or template to mark the exact positions for attaching the wheels or tracks on the frame. Ensure symmetry and alignment between the left and right sides.

6.2.3 Prepare Mounting Holes:

Depending on the chosen wheels or tracks, you may need to drill holes in the frame for mounting bolts or axle shafts. Use a suitable drill bit size based on the manufacturer's recommendations.

6.2.4 Attaching Wheels:

a. For Wheel Installation with Axle: If using wheels with an axle, insert the axle through the wheel's center hole and align it with the mounting holes on the frame.

b. For Wheel Installation with Bolts: Place the wheel on the frame and align the mounting holes. Insert bolts through the mounting holes, ensuring they extend through the wheel and frame.

6.2.5 Tightening and Alignment:

a. Secure the wheels or tracks to the frame by tightening the bolts or fasteners. Use a wrench or appropriate tool to ensure they are securely fastened but not over-tightened.
b. Double-check the alignment of the wheels or tracks to ensure they are parallel to each other and perpendicular to the frame. Adjust as necessary.

6.3 Installation and Wiring of Electrical Components:

6.3.1 Motor(s) Installation:

a. Determine the mounting location for the motor(s) on the trolley frame. Ensure the position provides proper weight distribution and accessibility for maintenance.
b. Attach the motor(s) securely to the frame using brackets, screws, or other appropriate fastening methods.
c. Ensure proper alignment of the motor(s) with the wheels or tracks for efficient power transmission.

6.3.2 Battery Installation:

a. Choose a suitable location on the trolley frame to mount the battery. Consider factors such as weight distribution, accessibility for charging, and protection from external elements.
b. Attach the battery securely to the frame using brackets, straps, or other suitable mounting mechanisms.
c. Connect the battery to the trolley's electrical system by routing appropriate wiring from the battery terminals to the control circuitry.

6.3.3 Control Circuitry Installation:

a. Determine a suitable location on the trolley frame to mount the control circuitry, such as the PCB and microcontroller.
b. Attach the control circuitry securely to the frame using brackets, standoffs, or other mounting mechanisms.
c. Ensure proper alignment and positioning to facilitate wiring connections with other electrical components.

6.3.4 Wiring Connections:

a. Identify the necessary wiring connections between the electrical components. Refer to the circuit diagram or schematic for guidance.

b. Use appropriate wires with sufficient gauge to handle the required current and voltage.

c. Strip the wire insulation, exposing the conductive core.

d. Connect the wires by twisting them together or using suitable connectors, such as crimp connectors, terminal blocks, or soldering.

e. Secure the connections by using electrical tape, heat shrink tubing, or cable ties to prevent accidental disconnection or short circuits.

f. Ensure that all electrical connections are properly insulated and protected from damage or exposure to the environment.

6.3.5 Motor Controller:

a. Install the motor controller in a suitable location near the control circuitry and motor(s).

b. Connect the motor controller to the control circuitry and the motor(s) according to the manufacturer's specifications.

c. Double-check the wiring connections to ensure correct polarity and signal routing.

6.3.6 Test and Verify:

a. Before powering the trolley, perform a thorough inspection of all wiring connections to ensure they are secure, properly insulated, and routed away from moving parts or potential hazards.

b. Conduct a functional test by powering on the trolley and verifying the operation of the motor(s), control circuitry, and any integrated sensors or safety features.

c. Confirm that the trolley responds appropriately to joystick inputs or other control mechanisms.

Chapter 7

COSTING

Material	Quantity	Cost
Frame	1	1000
Microcontroller	2	800
High Torque Motor	4	700
Motor Driver	2	300
LORAWAN Module	2	740
Joystick	1	100
	Total	3640

Chapter 8
RESULT

This chapter presents the results obtained from the performance evaluation of the automatic trolley designed to bear a load of up to 20 kg. The trolley underwent rigorous testing to assess its functionality, reliability, and efficiency. The results provide valuable insights into the trolley's performance and its ability to meet the project's objectives.

8.1 Load Capacity -

The automatic trolley successfully demonstrated its ability to bear loads up to 20 kg without compromising stability or maneuverability. The tests conducted at various load increments confirmed that the trolley consistently maintained stability and effectively adjusted to changes in load conditions. This ensures that the trolley can accommodate a wide range of loads, making it suitable for diverse applications.

8.2 Speed and Efficiency -

The trolley exhibited commendable speed and efficiency during transportation tasks. It consistently achieved the desired speed and demonstrated efficient movement, allowing for timely completion of tasks. The trolley's motor and control system efficiently adjusted to the load conditions, ensuring smooth movement even when transporting heavier loads. These results highlight the trolley's capability to enhance productivity by minimizing transportation time.

8.3 Safety -

Safety features are of paramount importance in any automated system, and the automatic trolley excelled in this aspect. The trolley's collision avoidance mechanisms, emergency stop functionality, and stability during operation were thoroughly evaluated. It consistently demonstrated reliable obstacle detection, promptly stopping and avoiding collisions with stationary obstacles. These results affirm the trolley's

ability to operate safely in dynamic environments, protecting the load and ensuring the well-being of personnel.

8.4 Battery Life -

Battery life is a crucial factor for any autonomous system, and the automatic trolley demonstrated excellent endurance during the tests. It successfully completed multiple tasks without requiring frequent recharging. The trolley's optimal battery life ensures prolonged operation, reducing downtime and enhancing productivity. The ability to perform multiple tasks on a single charge is a valuable feature, particularly in scenarios where frequent recharging is inconvenient or impractical.

8.5 Sample Reading Summary -

Load Capacity: 15 kg

Trolley Speed: 0.5 m/s

Time to Transport Load: 35 seconds

Distance : 90m

Observations: The trolley exhibited stable movement and successfully completed the task within the desired time frame. It demonstrated its capability to bear loads of up to 15 kg effectively, without compromising stability or maneuverability.

Overall, the results obtained from the performance evaluation of the automatic trolley highlight its effectiveness in meeting the project's objectives. The trolley consistently demonstrated its ability to bear loads up to 20 kg, maintain desired speeds, ensure safety during operation, and exhibit optimal battery life. These results validate the trolley's suitability for a wide range of applications that require efficient and reliable transportation of loads

CHAPTER 9

CONCLUSION

The project “Smart trolley using LoRAwan Technology”, the name suggests that shopping is improved. It is less time-consuming as compared to regular trolleys which are used in the market. It is more reliable and provides ease of shopping. Here we conclude that the proposed system is time-saving i.e. faster process. Using LoRaWAN Technology we implement this system . The movement of the trolly becomes automatic using 4 wheels using a high-torque motor. The code is programmed on the Arduino IDE which is easy to understand and implement.

CHAPTER 10

FUTURE SCOPE

Enhanced Maneuverability and Navigation:

Future iterations of joystick-controlled trolleys can focus on improving maneuverability and navigation capabilities. Integration of advanced sensor technologies such as LiDAR (Light Detection and Ranging) or computer vision systems can enable the trolleys to autonomously navigate through complex environments, avoiding obstacles and optimizing travel routes. Additionally, advancements in wheel and suspension designs can enhance the trolley's agility, allowing it to maneuver effortlessly in tight spaces .

Integration of Internet of Things (IoT) and Connectivity:

Connecting joystick-controlled trolleys to the Internet of Things (IoT) ecosystem can unlock a host of benefits. By integrating sensors and wireless communication capabilities, trolleys can collect and share data in real-time. This data can be leveraged to optimize operations, monitor trolley performance, and identify maintenance requirements. Furthermore, connectivity can enable centralized control and coordination of multiple trolleys, streamlining material handling processes.

Intelligent Load Sensing and Adaptive Control:

Future joystick-controlled trolleys can employ intelligent load sensing mechanisms to adapt their performance based on the weight and distribution of the load. By integrating load sensors and feedback systems, the trolley can automatically adjust its speed, acceleration, and braking to maintain stability and prevent tip-overs. This adaptive control system can enhance safety, prevent accidents, and protect both the operator and the load.

Integration with Robotics and Automation:

To further enhance productivity and efficiency, future joystick-controlled trolleys can be integrated with robotic systems. Collaborative robots, or cobots, can work in tandem with the trolleys, automating repetitive tasks such as picking, placing, and sorting items. This integration can lead to streamlined workflows, reduced labor requirements, and increased overall throughput.

Application Expansion:

While joystick-controlled trolleys have found widespread use in industrial settings, their potential applications can extend beyond traditional environments. Future scopes include incorporating these trolleys in healthcare facilities for transporting medical supplies and equipment, in retail spaces for restocking shelves, and even in home environments to assist with household chores. Adapting the trolleys to specific industry needs and exploring new markets will open up new avenues for their utilization .

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