Sustainable Speed Management Strategy for Risk Reduction in Auto Rickshaw –Based on Public Transport in Bangladesh.

A Thesis

Submitted By

Md Kawsar Ahmed	**EEE-2103024029**
Md Shamsul Haque	**EEE-2103024128**
Md Aslam Hossain	**EEE-2103024022**
Md Sihab Sardar	**EEE-2103024035**
Md Anwar Hossain	**EEE-1901016081**



Supervisor
MIRZA RABIUL HASAN

Lecturer In (EEE)
Department of Electrical & Electronic Engineering

Sonargaon University (SU)

Department of Electrical & Electronic Engineering **(EEE)**
Sonargaon University (SU)
147/A, Panthapath, Dhaka-1215

Date of Submission: 9 May 2025

Sustainable Speed Management Strategy for Risk Reduction in Auto Rickshaw –Based on Public Transport in Bangladesh.

A Thesis

Submitted By

…….

Mohammad kawsar Ahmed

ID: EEE-2103024029

……..

Md Shamsul Haque

ID: EEE-2103024128

…….

Md Aslam Hossain

ID: EEE-2103024022

……..

Md Sihab Sardar

ID: EEE-2103024035

……..

Md Anwar Hossain

ID: EEE-1901016081

Supervisor

…….

MIRZA RABIUL HASAN

Lecturer In (EEE)

Department of Electrical & Electronic Engineering

Sonargaon University (SU)

Submitted to the

DEPARTMENT OF ELECTRICAL ENGINEERING

SONARGAON UNIVERSITY (SU)

ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. This thesis is accomplished under the supervision of Mirza Rabiul Hasan. Department of Electrical & Electronics Engineering, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

The authors are also grateful to Rais Uddin Mollah, Head of the Department and Md. Ashikur Rahman, course Coordinator and all respect teachers of the Electrical & Electronics Engineering Department for their co-operation and significant help for completing the thesis work successfully

ABSTARCT

This abstract likely discusses strategies for reducing traffic risks in Bangladesh, specifically focusing on auto-rickshaws (CNGs) as a prominent mode of public transport. The abstract likely outlines how to manage speed, potentially through infrastructure improvements, stricter regulations, and enhanced awareness campaigns, to mitigate risks and promote safer transportation in Dhaka and other urban areas.

High speed and traffic congestion in Dhaka contribute to accidents and safety concerns, particularly involving auto-rickshaws, which are a popular mode of transport.

Implement a sustainable speed management strategy that addresses infrastructure shortcomings, enforces regulations, and raises public awareness about safe driving practices.

Possible strategies:

This might include:

- **Infrastructure improvements:** better road markings, traffic signals, and potentially separated auto-rickshaw lanes in congested areas.
- **Regulations:** Enforce speed limits, stricter licensing for auto-rickshaw drivers, and penalties for violations.
- **Awareness campaigns:** Educate drivers and passengers on safe driving practices, the importance of speed limits, and the consequences of accidents.

Sustainability:

The strategy aims to be long-term, environmentally friendly, and socially responsible, ensuring a safer and more efficient transportation system for all citizens.

In summary, the abstract likely proposes a multi-faceted approach to tackle traffic-related risks in Dhaka, with a particular focus on managing the speed of auto-rickshaws to improve safety and sustainability in Bangladesh's urban public transport system.

TABLE OF CONTENTS

			Page No.
Acknowledgement			i
Abstract			1
Table of Contents			2-3
List of Figures			4
Chapter No.		Chapter Name	Page No
CHAPTER 01		INTRODUCTION	
	1.1	Background of the Project	5
	1.2	Objectives of the Project	5
	1.3	Problem Statement	6
CHAPTER 02		LITERATURE REVIEW	
	2.1	Related Research/ Works	7
	2.2	Hassle of Auto Rickshaw over Speed in Bangladesh	8
	2.3	Problems Faced by People Due to Auto Rickshaw Speed Issues in Bangladesh	8
	2.4	Recent Worst News for Auto Rickshaw Over Speed	8
CHAPTER 03		SOLUTION	
	3.1	There Are Two Types Solutions	9
	3.2	Mechanical Solutions in Motor Speed Control for Auto Rickshaws	9
	3.3	Gear Ratio Optimization	10
	3.4	Throttle Limiter	10
	3.5	How a Throttle Limiter Works	10-11

CHAPTER 04		ELECTRICAL SOLUTIONS FOR MOTOR SPEED CONTROL IN AUTO RICKSHAWS	
	4.1	Electrical Solutions for Motor Speed Control in Auto Rickshaws	11
	4.2	Controller Electronic Motor (EMC)	11
	4.3	Pulse Width Modulation (PWM)	12
	4.4	Pulse Width Modulation (PWM)	13
	4.5	Objective	13
	4.6	Pulse Width Modulation (PWM) and Its Formula	13
	4.6	Use PWM	13
	4.7	Speed Control Program with Arduino	14
CHAPTER 05		WORKING PRINCIPLE OF THIS PROJECT	
	5.1	Components	15
	5.2	BLDC Motor	16
	5.3	Controller	18-19
	5.4	Battery	20
	5.5	Accelerator	21
	5.6	Arduino	22-23
	5.7	Relay Module	24-25
	5.8	Display	
CHAPTER 06		BLOCK DIAGRAM BLDC MOTOR	
	6.1	Block Diagram	27
	6.2	Advantages of The Project	28
	6.3	Advantages of The Project	29
	6.4	Future scope	30
	6.5	Practical View of This project	31
		References	32
		CONCLUSION	33

LIST OF FIGURES

Figure No.	Figures Name	Page No.
2.4	Recent Worst News for Auto Rickshaw Over Speed	8
3.1	There Are Two Types Solutions	9
3.2	Gear Ratio Optimization	9
3.3	Throttle Limiter	10
4.2	Controller Electronic Motor (EMC)	11
4.3	Pulse Width Modulation (PWM)	12
5.2	DC Motor	13
	5.2.1 BLDC Motor Components and Construction	16
	5.2.2 Working Principle of BLDC Motor	16
5.3	Controller	18
5.4	Battery	20
5.5	**A**ccelerator	21
5.6	Arduino	22
6.7	Relay Module	24
5.8	Display	26
6.1	Block Diagram	27
6.5	Practical View of This project	31

CHAPTER 01

INTRODUCTION

1.1 Background of the Project

In Bangladesh, auto rickshaws serve as a vital mode of public transport, particularly in urban and semi-urban areas due to their affordability, flexibility, and accessibility. However, the rapid growth of auto rickshaw usage has led to increased safety concerns, especially regarding speed-related accidents and traffic violations. Speeding is one of the major contributing factors to road traffic injuries and fatalities involving these vehicles. Despite existing traffic regulations, enforcement remains weak, and there is a lack of structured speed management tailored to the unique challenges posed by auto rickshaws

This project aims to develop a sustainable speed management strategy that focuses on reducing traffic risks associated with auto rickshaw transport while maintaining its socio-economic benefits. The strategy integrates infrastructure planning, policy formulation, behavioral interventions, and technology-based solutions to promote safer driving practices. By focusing on sustainability, the project also seeks to ensure long-term impact through community involvement, environmental considerations, and alignment with national road safety goal

This project aims to develop a sustainable speed management strategy that focuses on reducing traffic risks associated with auto rickshaw transport while maintaining its socio-economic benefits. The strategy integrates infrastructure planning, policy formulation, behavioral interventions, and technology-based solutions to promote safer driving practices. By focusing on sustainability, the project also seeks to ensure long-term impact through community involvement, environmental considerations, and alignment with national road safety goal.

1.2 Objectives of the Project

- To design Reduce Accidents and Improve Safety:
- To construct Enhance Public Transport Safety
- Develop and Implement Effective Speed Management Measures
- Evaluate the Impact of the Strategy

1.3 Problem Statement

The problem statement focuses on developing a sustainable speed management strategy for auto-rickshaws, a major mode of public transport in Bangladesh, to reduce risks and improve safety. This involves addressing the high accident rates and unsafe driving behaviors associated with auto-rickshaws, particularly in congested urban areas, while ensuring a sustainable and affordable public transportation system.

CHAPTER 02

LITERATURE REVIEW

2.1 Related Research/ Works

A sustainable speed management strategy for auto rickshaws in Bangladesh's public transport system involves implementing measures to reduce risk, improve safety, and promote environmental sustainability. This includes speed limits, infrastructure improvements, driver training, and public awareness campaigns.
Literature Review Highlights:

- **Speed Management Measures**:

Studies often highlight the need for speed limits and enforcement mechanisms to reduce accidents involving auto rickshaws.

- **Infrastructure Improvements**:

Better road infrastructure, including clear road markings and traffic signs, can contribute to safer and more predictable traffic flow.

- **Driver Training**:

Training programs for auto rickshaw drivers can focus on safe driving practices, accident prevention, and traffic regulations.

- **Public Awareness:**

Raising awareness about traffic rules, road safety, and the risks of speeding can help to change driver behavior and promote safer practices.

- **Sustainable Transportation**:

Promoting alternative modes of transport, such as buses and trains, can help to reduce the reliance on auto rickshaws and alleviate traffic congestion.

- **Environmental Impact**:

Transitioning to cleaner fuels like CNG and promoting fuel-efficient vehicles can reduce the environmental impact of auto rickshaws.
Key Research Areas:

- **Accident Analysis**:

Studies often examine accident data to identify trends and patterns related to speeding, poor road conditions, and other factors.

- **Traffic Flow Analysis**:

Researchers use traffic models to analyze the impact of speed management measures on traffic flow and congestion.

- **Driver Behavior**:

Studies explore driver behavior, including speed choices, risk-taking attitudes, and perceptions of traffic regulations.

- **Policy Recommendations**:

Researchers often propose policy recommendations to improve speed management, such as stricter enforcement of speed limits and improved traffic infrastructure.
Overall, a sustainable speed management strategy for auto rickshaws in Bangladesh requires a multi-faceted approach that combines infrastructure improvements, driver training, public awareness campaigns, and policy changes to reduce risk, improve safety, and promote sustainable transportation practices.

2.2 Hassle of Auto Rickshaw over Speed in Bangladesh

The widespread use of auto rickshaws in Bangladesh, while convenient, has led to several challenges—particularly related to unsafe speed practices. These problems affect not only passengers and drivers but also pedestrians and other road users. Key issues include:
Increased Road Accidents: Over-speeding is a leading cause of traffic accidents involving auto rickshaws, often resulting in injuries or fatalities due to the vehicle's low structural safety.
Passenger Safety Concerns: Many passengers feel unsafe due to reckless driving, lack of seat belts, and sudden main ever at high speeds, especially in congested urban areas.
Pedestrian Risk: Auto rickshaws frequently speed through busy streets and narrow lanes, increasing the risk of collisions with pedestrians, including children and the elderly.
Traffic Congestion: Speeding auto rickshaws often disrupt traffic flow by weaving between vehicles and ignoring signals, worsening congestion in already crowded cities.
Air and Noise Pollution: Rapid acceleration and braking contribute to higher fuel consumption and noise, adding to urban environmental issue

2.3 Problems Faced by People Due to Auto Rickshaw Speed Issues in Bangladesh

Excessive speeds of auto rickshaws have resulted in numerous accidents, leading to fatalities and injuries. For instance, in February 2024 alone, over 40 deaths were attributed to battery-operated auto rickshaws across various regions of the country . The lack of driver training and unfit vehicles exacerbate the situation .

2.4 Recent Worst News for Auto Rickshaw Over Speed

Artery-run rickshaw drivers engaged in sporadic clashes with locals in Gulshan and Banani yesterday while protesting a ban on their vehicles The protests disrupted traffic in both neighbourhoods, with drivers blocking roads and marching in procession. Tensions flared as scuffles broke out between the protesting drivers and locals, including pedal-rickshaw pullers and ride-sharing motorcyclists

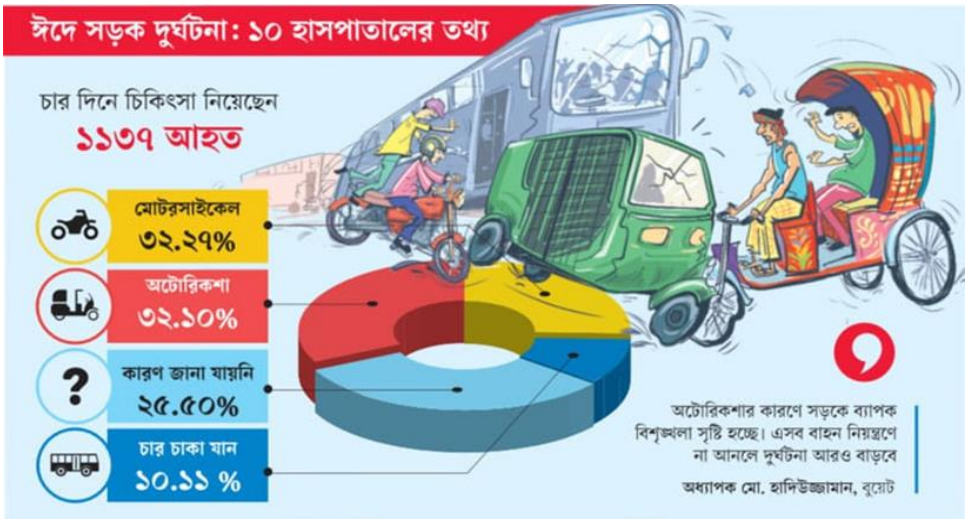


Figure: Recent Worst News for Auto Rickshaw Over Speed

CHAPTER 03

SOLUTION

There Are Two Types Solutions

1. Mechanical

2. Electrical

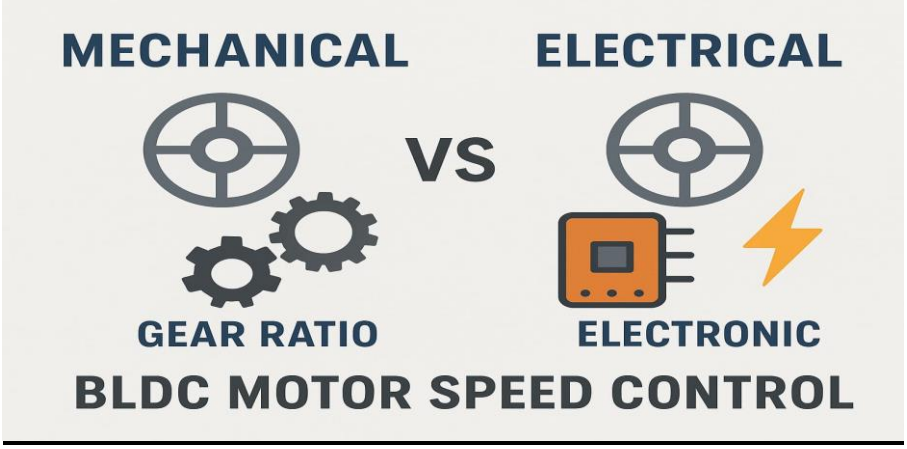


Figure: There Are Two Types Solutions

3.1 Mechanical Solutions in Motor Speed Control for Auto Rickshaws

Controlling the speed of motors in auto rickshaws—especially electric ones—is essential for safe and efficient operation. The following mechanical and electro-mechanical solutions can help regulate motor speed effectively:

3.2 Gear Ratio Optimization

Adjusting the gear ratios can limit maximum speed while maintaining torque for acceleration. This mechanical constraint reduces the chance of over-speeding in urban areas.

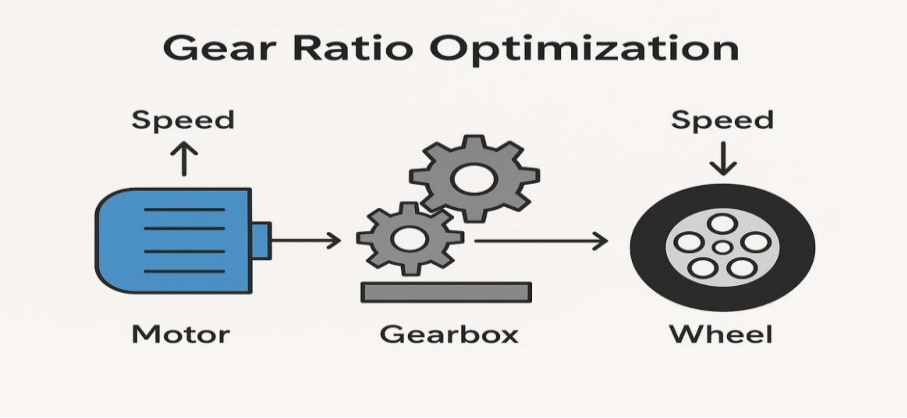


Figure: Gear Ratio Optimization

3.3 Throttle Limiter

A mechanical or electronic device that restricts how much the throttle can open, thereby capping the power delivered to the motor.
Simple and cost-effective for speed control in conventional l and electric rickshaws.

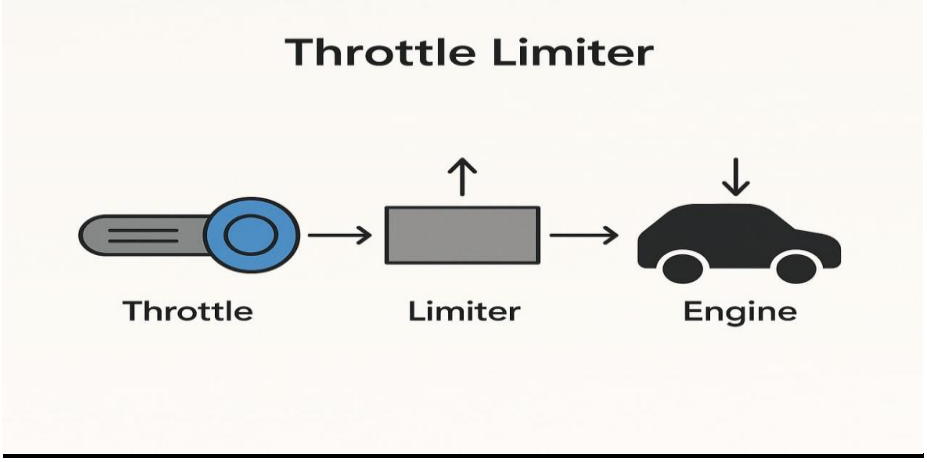


Figure: Throttle Limiter

A **Throttle Limiter** is a device or control mechanism used to **restrict or regulate the maximum output** of a throttle system—commonly found in **electric vehicles (EVs), motorcycles, drones, RC cars, e-bikes, and industrial machines**. It's often used to:

- Limit **speed**
- Control **acceleration**
- Improve **safety**
- Conserve **battery power**
- Ensure **legal compliance** (e.g., for road-legal e-bikes)

3.4 How a Throttle Limiter Works

A throttle controls power by sending a signal (typically a voltage between 0–5V or a PWM signal) to an Electronic Motor Controller (EMC). A throttle limiter modifies or caps this signal.

CHAPTER 04

Electrical Solutions for Motor Speed Control in Auto Rickshaws

4.1 Electrical Solutions for Motor Speed Control in Auto Rickshaws

Electrical speed control methods are critical in modern auto rickshaw particularly those powered by electric motors. These methods allow for precise and efficient regulation of motor output, improving safety, energy use, and overall vehicle performance.

4.2 Controller Electronic Motor (EMC)

The core component in electric rickshaws for speed regulation.
Controls the voltage and current supplied to the motor, effectively limiting acceleration and top speed.
Can be programmed with maximum speed thresholds for safety compliance.

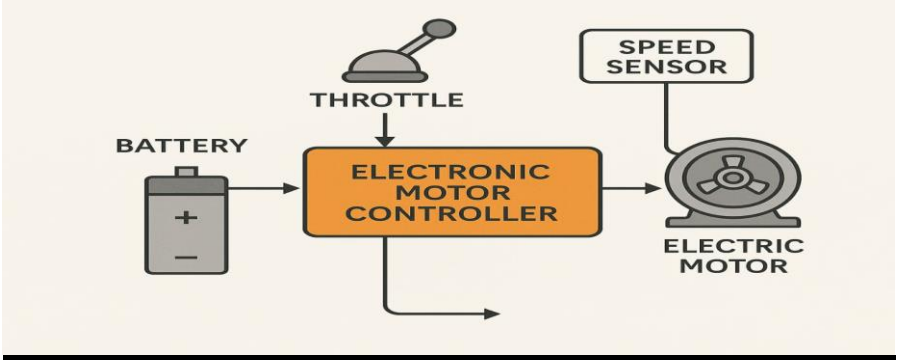


Figure: Controller Electronic Motor (EMC)

It sounds like you're referring to an **Electronic Motor Controller (EMC)**, also sometimes called an **Electric Motor Controller**. This device is responsible for managing the operation of electric motors. Here's a breakdown of what an EMC typically involves:

An **EMC** is an electronic device that regulates the **performance** of an electric motor. It can control parameters like:

- **Speed**
- **Torque**
- **Direction**

4.3 Pulse Width Modulation (PWM)

A widely used technique where the controller modulates power by rapidly switching it on and off. Adjusting the duty cycle allows fine control over motor speed with high efficiency.

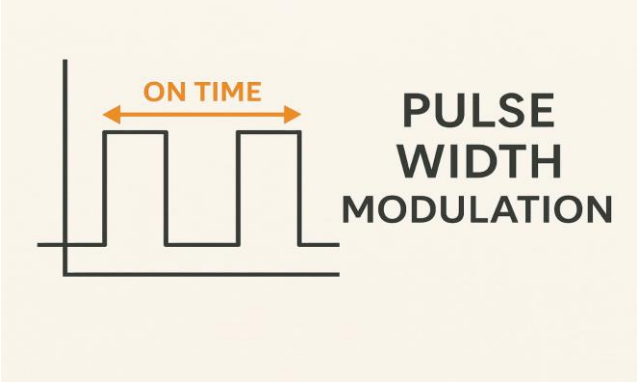


Figure: Pulse Width Modulation (PWM)

A Pulse Width Modulator (PWM) is a device or circuit that controls the width (duration) of a series of electrical pulses to regulate the amount of power delivered to a load. PWM is widely used in applications such as:
How It Works:

PWM works by turning a signal on and off rapidly. The duty cycle—the percentage of time the signal is on during one period—determines the average power delivered:
0% duty cycle = always off,50% duty cycle = on half the time,100% duty cycle = always on
For example:
If a 12V signal is on for 50% of the time, the load sees an average voltage of 6V.

Great! You want to reduce the throttle signal so that the motor runs at ~75% speed, given:
0.1V = full throttle (highest speed)
3.4V = minimum throttle (lowest speed / stop)
This is inverted logic, which is common in some throttle designs.
Let’s go over both solutions:
1. Voltage Divider Circuit (Analog Solution)
You want to adjust the throttle voltage upward, because higher voltage = lower speed in your case.

4.4 Pulse Width Modulation (PWM)

Pulse Width Modulation (PWM) is a technique used to **control power** delivered to electrical devices, especially motors and LEDs, by switching the supply on and off at a high frequency. The key idea is to adjust the **duty cycle** of the signal.

4.5 Objective

Let's say your throttle signal is normally 0.1V to 3.4V.
To get 75% of full speed, we need to raise the throttle signal voltage closer to the 25% mark (since 0.1V = 100% speed).

4.6 Pulse Width Modulation (PWM) and Its Formula

PWM is a technique used to control the power delivered to electrical devices by varying the width of the pulses in a pulse train. The formula for PWM is:
Duty Cycle (%) = (Ton / (Ton + Toff)) × 100
Where:

- Ton is the time the signal is high
- Toff is the time the signal is low

By adjusting the duty cycle, the average voltage supplied to the motor can be controlled, thus regulating its speed.

4.6 Use PWM

- **Efficient Power Control** (less heat than analog methods)
- Precise Motor Speed/Torque Control
- Brightness Control for LEDs
- Signal Generation and Communication
- **E-bikes** – Limit top speed to 25 km/h for street-legal use.
- **Electric scooters** – Set beginner mode with reduced throttle.
- **Industrial equipment** – Prevent abrupt startup by limiting initial torque.
- **RC/FPV drones** – Restrict throttle for training or battery life.

4.7 Speed Control Program with Arduino

```
Dc_to_Ac_Inverter | Arduino IDE 2.3.4
modified 8 May 2014
by Scott Fitzgerald
modified 2 Sep 2016
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman
This example code is in the public domain.
https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink
*/
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
}
// the loop function runs over and over again forever
void loop() {
  digitalWrite(8, HIGH);   // turn the LED on (HIGH is the voltage level)
  digitalWrite(9, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
  digitalWrite(8, LOW);    // turn the LED off by making the voltage LOW
  digitalWrite(9, HIGH);  // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
}
```

CHAPTER 05

Working Principle Of This Project

5.1 Components

1. BLDC Motor
2. Controller
3. Battery
4. Accelerator
5. Arduino
6. Relay Module
7. Display

5.2 BLDC Motor

Brushless DC motors have some significant advantages over their competitors, such as brushed motors, largely because of the electronic commutation. It allows the controller to switch the current promptly and thus regulate the motor's characteristics effectively. In this article, we will consider the peculiarities of a brushless DC motor controller. You will learn about its operating principles as well as the design features and challenges you should know about before building your own device.

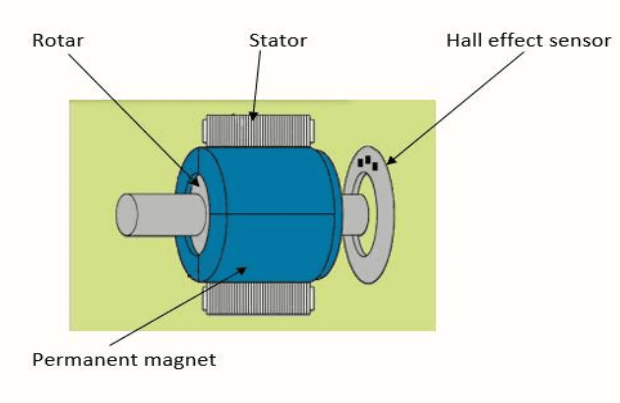


Figure: BLDC Motor

Brushless DC motors (BLDCs) have been a much-focused area for numerous motor manufacturers as these motors are increasingly the preferred choice in many applications, especially in the field of motor control technology. BLDC motors offer several advantages over brushed DC motors, including the ability to operate at high speeds, high efficiency, and better heat dissipation.

5.2.1 BLDC Motor Components and Construction

A BLDC motor has three main components: the stator, the rotor, and the Hall effect Sensor.



Stator

The stator is the stationary part of the motor that contains the windings. These windings are made up of insulated copper wire and are arranged in a specific pattern. The stator provides a magnetic field that interacts with the rotor to produce torque.

Rotor

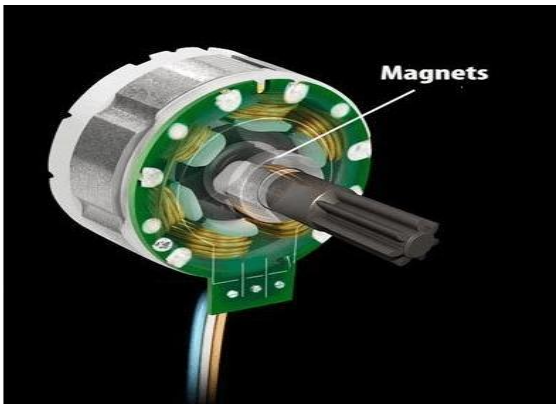
The rotor is the rotating part of the motor that contains permanent magnets. The magnets are arranged in a specific pattern, opposite to that of the stator. The interaction between the magnetic fields of the stator and the rotor produces rotational movement.

Hall Effect Sensor or Electronic Controller

The Hall effect Sensor is the brain of the motor. It is responsible for controlling the flow of current to the motor windings. The controller also senses the position of the rotor and adjusts the current accordingly to ensure smooth and efficient operation.

5.2.2 Working Principle of BLDC Motor

The working principle of BLDC motors is based on the interaction between the magnetic fields of the stator and the rotor. The stator produces a rotating magnetic field, which interacts with the permanent magnets on the rotor, producing a torque that causes the rotor to rotate.



The Hall Effect Sensor plays a crucial role in the operation of the motor. It controls the flow of current to the motor windings based on the position of the rotor. The controller senses the position of the rotor using sensors or Hall effect devices mounted on the stator. These sensors detect the position of the magnets on the rotor and send signals to the controller.

Based on the signals from the sensors, the controller adjusts the flow of current to the motor windings to ensure that the magnetic fields of the stator and rotor are properly aligned. This ensures that the motor operates efficiently and smoothly, without any loss of power or vibration.

5.2.3 Advantages of BLDC Motors

BLDC motors offer several advantages over conventional DC motors. Some of the advantages are:

Higher Efficiency

BLDC motors are more efficient than conventional DC motors due to the absence of brushes. This results in less friction and lower power loss.

Higher Power Density

BLDC motors have a higher power density compared to conventional DC motors. This means that they can produce more power in a smaller size.

Longer Lifespan

The absence of brushes in BLDC motors results in less wear and tear, making them more reliable and durable.

Low Maintenance

BLDC motors require less maintenance compared to conventional DC motors. This results in lower maintenance costs and longer service life.

5.2.4 Applications of Brushless DC Motor

Brushless DC motors (BLDC) use for a wide variety of application requirements such as

- Computer hard drives and DVD/CD players
- Electric vehicles, hybrid vehicles, and electric bicycles
- Industrial robots, CNC machine tools, and simple belt driven systems
- Washing machines, compressors and dryers
- Fans, pumps and blowers.

5.3 Controller

A BLDC motor controller regulates the speed and torque of the motor; it can also start, stop, and reverse its rotation. To understand the working principles of the controller, let us start first with the construction of a brushless motor. Its major components comprise:
an armature or rotor made of permanent and in many cases neodymium magnets; and
a stator with windings that create a magnetic field when energized.
The rotor's magnets and stator's windings provide the rotation of the motor. They attract each other with opposite poles and repel each other with the same poles. A similar process takes place in a brushed DC motor. The essential difference is in the method of switching the current applied to the wire windings.

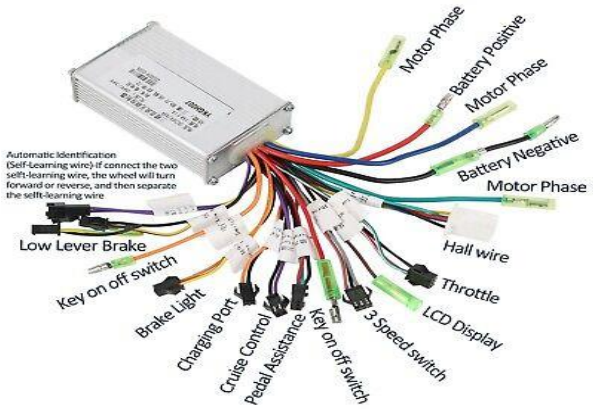


Figure: Controller

In electric auto rickshaws (e-rickshaws), the controller is the brain of the vehicle. It manages the power flow from the battery to the motor based on the driver's input (accelerator, brake, reverse, etc.).

5.3.1 Working Principle of an E-Rickshaw Controller

The controller works based on Pulse Width Modulation **(PWM)** and feedback control systems to regulate speed and direction.

5.3.2 Main Functions of the Controller

1. Controls motor speed (based on how much you press the accelerator)
2. Manages torque and power output
3. Handles reverse and brake functions
4. Protects battery and motor from overcurrent or overheating
5. Provides soft start and cutoff features

5.3.3 Working Process (Step-by-Step)

1. **Driver presses the accelerator**
    - Accelerator sends a signal (usually voltage) to the controller (from a throttle potentiometer).
2. **Controller reads the signal**
    - It uses this signal to generate PWM (Pulse Width Modulated) signals.
3. **PWM signals control the power**
    - The controller switches power from the DC battery to the BLDC (Brushless DC Motor) or DC Series Motor.
    - By adjusting the pulse width, the controller regulates how much power the motor receives → this controls the speed.
4. **Motor responds accordingly**
    - More throttle = wider pulses = more voltage = higher speed.
    - Less throttle = narrower pulses = lower voltage = slower speed.
5. **Controller monitors**
    - Voltage, current, motor temperature, and battery condition in real time.
    - If any fault is detected (like overcurrent or overheating), it cuts off power to protect the system

5.3.4 Reverse and Braking

- Reverse switch sends a signal to the controller to change motor direction (by changing polarity or through motor phase control).
- Regenerative braking (if available) is also handled by the controller.

5.3.5 Basic Inputs to Controller

- Throttle signal
- Brake signal
- Reverse switch
- Ignition or power switch
- Battery input (typically 48V or 60V DC)

5.3.6 Basic outputs to Controller

- Power to motor (PWM-controlled DC voltage)
- Feedback to display (speed, battery level, faults)

5.3.7 Simple Terms

The controller is like the driver's assistant — it takes your foot/hand input and tells the motor exactly how fast to spin, when to stop, and when to reverse, all while protecting the system.

5.4 Battery

In Bangladesh, most battery-powered rickshaws, or "battery rickshaws," utilize lead-acid batteries. These are relatively inexpensive and widely available, making them a practical choice for the low-cost transportation option. However, lead-acid batteries are also heavy, requiring a set of multiple 12-volt batteries to provide the necessary power for the rickshaw's motor. A typical set can provide enough energy for a range of 80 to 120 kilometers on a single charge, depending on various factors. Charging these batteries typically takes 6 to 10 hours, usually overnight, with garages and drivers often relying on the national grid for power.



Figure: Battery

A DC battery (Direct Current battery) stores chemical energy and converts it into electrical energy in the form of direct current (DC). This means the electric charge flows in one constant direction, which is ideal for powering devices like flashlights, vehicles, smartphones, and more.

5.4.1 Basic Components

1. **Anode (Negative Terminal)**
    - Loses electrons (oxidation occurs).
2. **Cathode (Positive Terminal)**
    - Gains electrons (reduction occurs).
3. **Electrolyte**
    - A medium that allows ions to move between the anode and cathode.
4. **Separator**
    - Keeps the electrodes apart to prevent short circuits.

5.4.2 How It Works (Discharging Process)

1. **Chemical reaction:** occurs at the anode, releasing electrons.
2. **Electrons flow:** from the anode → through the external circuit → to the cathode (this is the electric current you use).
3. **Ions flow:** through the electrolyte inside the battery to balance the charge.
4. The chemical energy is gradually depleted as the battery discharges.

5.5 Accelerator

In every energy efficient electric vehicle, accelerator form a critical component that is important for the functioning of the vehicle. Similarly, E Rickshaw accelerator is used to speed up or slow down the e-rickshaw. This component is engineered, assembled and tested in-house. The accelerator handle is covered with rubber sheet for providing a stronger grip to the driver. What connects this E rickshaw accelerator handle with the controller and other components is the PVC insulated cable. The proper interconnection between the components is necessary to smoothly operate the rickshaw for the long run.



Figure: Accelerator

The auto rickshaw accelerator works on a simple mechanical throttle control principle, typically found in small internal combustion engine (ICE) vehicles. Here's an explanation of how it works

5.5.1 asic Components Involved

1. **Accelerator Pedal (or Handle Twist)**
    - In traditional auto rickshaws, it may be a foot pedal or a hand-operated throttle (like in scooters).
2. **Throttle Cable**
    - A flexible steel cable that connects the accelerator to the throttle valve.

5.5.2 Step-by-Step Working

1. Driver presses the accelerator (pedal or handle twist).
2. This pulls the throttle cable.
3. The cable movement opens the throttle valve in the controller or throttle body.
4. This increases the motor RPM (revolutions per minute), making the motor run faster.
5. The faster motor speed turns the transmission and wheels, moving the auto rickshaw faster.

5.5.3 For Electric Auto Rickshaws

- The accelerator is usually a potentiometer (like a variable resistor).
- Pressing it sends an electrical signal to the motor controller.
- The controller regulates power to the electric motor, controlling speed accordingly.

5.6 Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

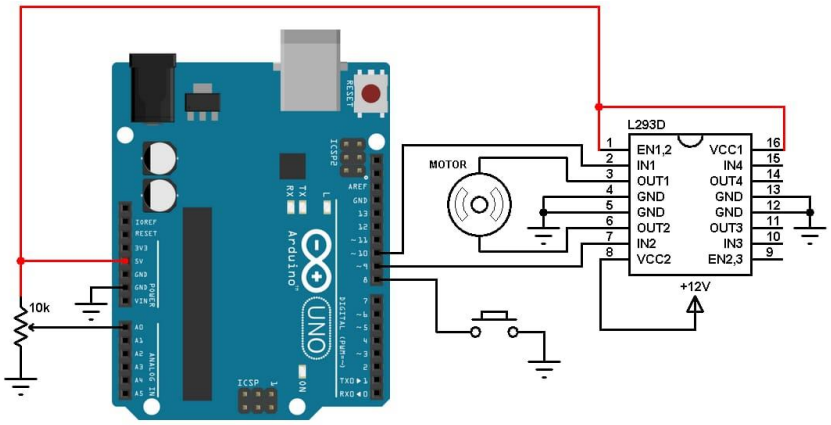


Figure: Arduino

An Arduino is an open-source microcontroller platform that allows users to create interactive electronic projects. It's the brain behind many DIY and industrial projects, often used to control sensors, motors, lights, and other electronic devices.

5.6.1 Core Components of an Arduino

Microcontroller (ATmega328P on Arduino Uno, for example): This is the brain of the Arduino board. It processes inputs, runs programs, and controls outputs.
Digital Pins: Pins that can either input or output digital signals (HIGH or LOW).
Analog Pins: Used for analog input, usually from sensors, that can read continuous signals (like temperature or light intensity).
Power Supply: Provides the necessary voltage to run the microcontroller and connected components (typically 5V or 3.3V).
USB Interface: Used to upload programs from a computer to the Arduino via the Arduino IDE.
Crystal Oscillator: Provides the clock signal, allowing the microcontroller to keep track of time and execute instructions.
LED (Onboard): Typically used for simple visual feedback (such as showing if the system is powered on or working)

5.6.2 How Arduino Works (Step-by-Step)

1. Programming the Arduino:

- You write a program (called sketch) in the Arduino IDE (Integrated Development Environment), usually in C/C++.
- You upload this code to the Arduino board via a USB cable.

2.Starting the Program:

- When powered on, the Arduino runs the program from beginning to end.
- It first runs the setup**()** function, where initial configurations like pin modes are set (e.g., input/output).
- Then it enters the loop**()** function, where it continuously checks inputs and controls outputs.

3. Input and Output:

- Arduino can read inputs from sensors (e.g., temperature sensor, motion sensor) via analog or digital pins.
- Based on inputs, it can trigger outputs (e.g., turning on an LED, rotating a motor, sending data to a display).

4.Communication:

- The Arduino can communicate with other devices via Serial Communication (USART) (sending/receiving data over USB), I2C (for multiple devices), or SPI (for high-speed communication).

5.6.3 How Input and Output Works

1. Reading an Input (Sensor)

- **Analog Input:** Reads a continuous signal (e.g., temperature or light intensity). The Arduino converts this to a digital value (0 to 1023) using an Analog-to-Digital Converter (ADC).
- **Digital Input:** Reads a signal that is either HIGH (1) or LOW (0), like a button press.

2. Controlling an Output (LED, Motor, etc.)

- Digital Output: Send HIGH or LOW to a pin, which could turn on/off a device like an LED or relay.
- PWM (Pulse Width Modulation): Used to control the brightness of LEDs or speed of motors by varying the duty cycle of the output pin (simulates analog control).

5.6.4 In Simple Terms

Arduino is a mini computer with pins that can read inputs (like a temperature sensor) and control outputs (like turning on a light), based on the program you write for it.

5.7 Relay Module

A relay module is a pre-fabricated electronic circuit that uses one or more relays to switch high-power devices on or off using a low-power signal. It essentially acts as an electrical switch, controlled by an electromagnet, allowing a small current to manage a larger current in a separate circuit. These modules are widely used in various applications like home automation, industrial control, and automotive electronics.

Relay modules are more than just a relay. They also include supporting components like diodes, resistors, and terminal blocks for easy connectivity, making them versatile and user-friendly, especially for complex applications. They are designed to be easily integrated with microcontrollers like Arduino and Raspberry Pi.



Figure: Relay Module

5.7.1 What Is a Relay

A relay is an electrically operated switch. It uses an electromagnet to mechanically switch a circuit on or off, isolating the low-voltage side (control side) from the high-voltage side (load side).

5.7.2 Relay Module Pinout (Typical 1-Channel)

Pin	Description
VCC	Power supply (typically 5V or 3.3V)
GND	Ground
IN	Control signal from microcontroller
COM	Common terminal (for the load side)
NO (Normally Open)	Circuit closes when relay is activated
NC (Normally Closed)	Circuit opens when relay is activated

5.7.3 Relay Module Components

A typical relay module includes:

Component	Function
Relay	The main switch component
Transistor or MOSFET	Amplifies control signal to drive the relay coil
Flyback Diode	Protects the circuit from voltage spikes
Optocoupler **(**in some modules**)**	Electrical isolation between control and load
Screw Terminals	For connecting high-power load wires
Indicator LED	Shows when the relay is active

5.7.4 How It Works

- **Control Side**: Microcontroller sends a HIGH or LOW signal to the IN pin.
- **Load Side**: The relay either **c**onnects or disconnects the NO or NC terminal to COM**,** allowing or cutting off power to the load.

5.7.5 Typical Use Cases

- Turning on AC appliances (like lamps or fans)
- Switching DC motors or pumps
- Home automation systems
- Industrial control panels
- Safety interlocks

5.7.7 Safety Tips

- Always know whether your relay is rated for AC or DC, and its maximum voltage and current.
- Ensure proper isolation when working with high voltage.
- Use fuses or circuit breakers for protection.

5.8 Display

An auto rickshaw typically displays details on a digital or analogue meter, including fare, distance, and time. It also features a speedometer, and may have other indicators like a mode indicator to show the current operational mode. Some models include features like a built-in real-time clock, totalizers for trips and distance, and roof light support.



Figure: Display

The "Rickshaw display" refers to the dashboard or control panel of a rickshaw, which provides the driver with information about the vehicle's operation, such as battery status, speed, and odometer reading.

5.8.1 Here's a more detailed look

- **Battery Status:**

  Displays the current charge level of the battery, which is crucial for electric rickshaws.

- **Speed:**

  Shows the rickshaw's current speed, helping the driver to maintain safe and efficient driving.

- **Odometer:**

  Records the total distance traveled by the rickshaw, useful for tracking usage and potentially for calculating fares.

- **Other Indicators:**

  Depending on the rickshaw, the display might also include indicators for gear selection, brake status, and other relevant information.

CHAPTER 06

6.1 Block Diagram

The block diagram we are using the 48 v Dc battery, BLDC controller, Monitor & Arduino, Throttle and motor.

Below we are showing Block Diagram:

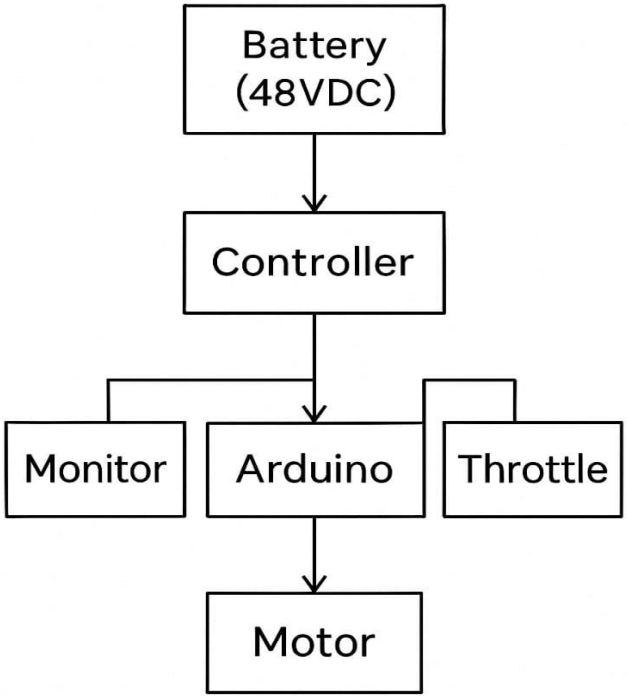


Fig. 8: Block Diagram
BLDC Motor Speed Control Circuit

A typical BLDC (Brushless DC) motor speed control system involves several components, including the motor itself, a speed controller (usually a microcontroller), power electronics (like a PWM controller or a motor driver), and feedback systems (such as encoders or hall sensors). Below is the basic block diagram of a BLDC motor speed control circuit.

6.2 Advantages of The Project

- **Easy Installation** — Wire mesh is flexible and pliable to easily insert or connect to a wall, railing, or flat surface.
- **Electronics Storage** — Computers, monitors, and other electronics have to be placed in well-ventilated storage areas. Wire mesh makes it possible for delicate and sensitive electronics to be held securely with limited access.
- **Convenience** — Wire mesh can be used as partitions to separate work positions but afford easy accessibility. It can be easily removed or rearranged to meet the needs of changing organizational dynamics.
- **Visibility** — In warehousing, wire mesh can be used to separate items but make them easily detectable and visible for retrieval. The use of wire mesh removes time- consuming searches and inventory checks.
- **Customer Area Partitions** — Wire mesh can be used to allow customer interaction while preventing them from entering the work area.
- **Strengthening and Support** — In the construction industry, wire mesh is added to a building to provide extra support and backing for walls and ceilings.
- **Cost-Effective** — Wire mesh is a cost-effective way to replace panels, shelves, and supports. It is easy to man ever and place. The superior strength of wire mesh makes it a positive Alternative to other forms of filtering and support materials.

6.3 Disadvantages of The Project

- This type machine various sizes wire mesh, various sizes wire bending die is required due to initial costing higher.
- **Initial Implementation Cost:** Installing speed control devices (electronic or mechanical) and upgrading motor controllers can be costly for low-income drivers or small fleet owners.
- **Driver Resistance:** Some drivers may resist speed restrictions due to fear of reduced income from slower trips and fewer daily passengers.
- **Technical Complexity:** Electronic solutions like motor controllers or IoT-based systems may require technical knowledge and reliable maintenance, which can be lacking in rural or low-resource areas.
- **Power Dependency in Electric Rickshaw:** Electronic control systems depend on a stable power supply and can malfunction if the battery voltage drops too low.
- **System Tampering Risk:** Without strict enforcement, drivers may tamper with speed limiters or controllers to bypass restrictions.
- **Inconsistent Road Infrastructure:** Poor or unplanned roads in many regions make uniform speed control difficult, reducing the effectiveness of a standardized strategy.
- **Limited Awareness and Training:** Lack of driver training programs on the benefits and proper use of speed control systems can lead to misuse or rejection.
- **Impact on Emergency Response:** In cases where faster travel is needed (e.g., emergencies), speed restrictions may delay response unless override options are integrated.
- **Data Privacy Concerns (for IoT-based systems):** Real-time monitoring and GPS-based speed control may raise concerns over driver privacy and data security.

6.4 Future scope

Nationwide Implementation after successful pilot programs, the proposed strategy can be rolled out across major cities and eventually rural areas of Bangladesh. Customizations can be made to suit specific local conditions such as road infrastructure, population density, and traffic volume.

Integration with Smart City Initiatives This strategy can be embedded within the broader smart city framework by linking speed-monitoring systems with traffic signal controls, urban mobility platforms, and public safety networks.

Advanced Driver Monitoring Systems (DMS) Future advancements could include AI-based monitoring tools that track driver behavior such as fatigue, abrupt manoeuvres, or distraction, ensuring higher safety standards for passengers and pedestrians alike.

Electrification and Green Mobility The strategy can be aligned with environmental goals by encouraging the use of electric auto-rickshaws. Coupling speed control with green energy usage can support the nation's sustainable transport policies.

Mobile Application for Public Engagement dedicated mobile application could empower commuters to track vehicle speed, rate drivers, and access real-time travel information, improving transparency and accountability.

AI & Data Analytics for Policy Making Data gathered from GPS and on board systems can be analysed to identify accident-prone areas, optimize routes, and support urban planning decisions based on empirical evidence.

Exportable Model for Developing Countries With refinements, the strategy can serve as a template for similar transportation challenges in other South Asian and African countries, promoting regional development and knowledge exchange.

Incentive-Based Insurance Programs Collaborations with insurance companies could introduce performance-based premiums, rewarding drivers who maintain consistent and safe speeds, thus fostering a culture of responsibility and safety.

6.5 Practical View of This project

A sustainable speed management strategy for auto rickshaws in Bangladesh's public transport system should focus on a multifaceted approach that includes traffic regulations, infrastructure improvements, and public awareness campaigns. This strategy aims to reduce risks by promoting safe speeds while also considering the economic and social needs of both auto rickshaw drivers and passengers. Key Elements of a Sustainable Speed Management Strategy:

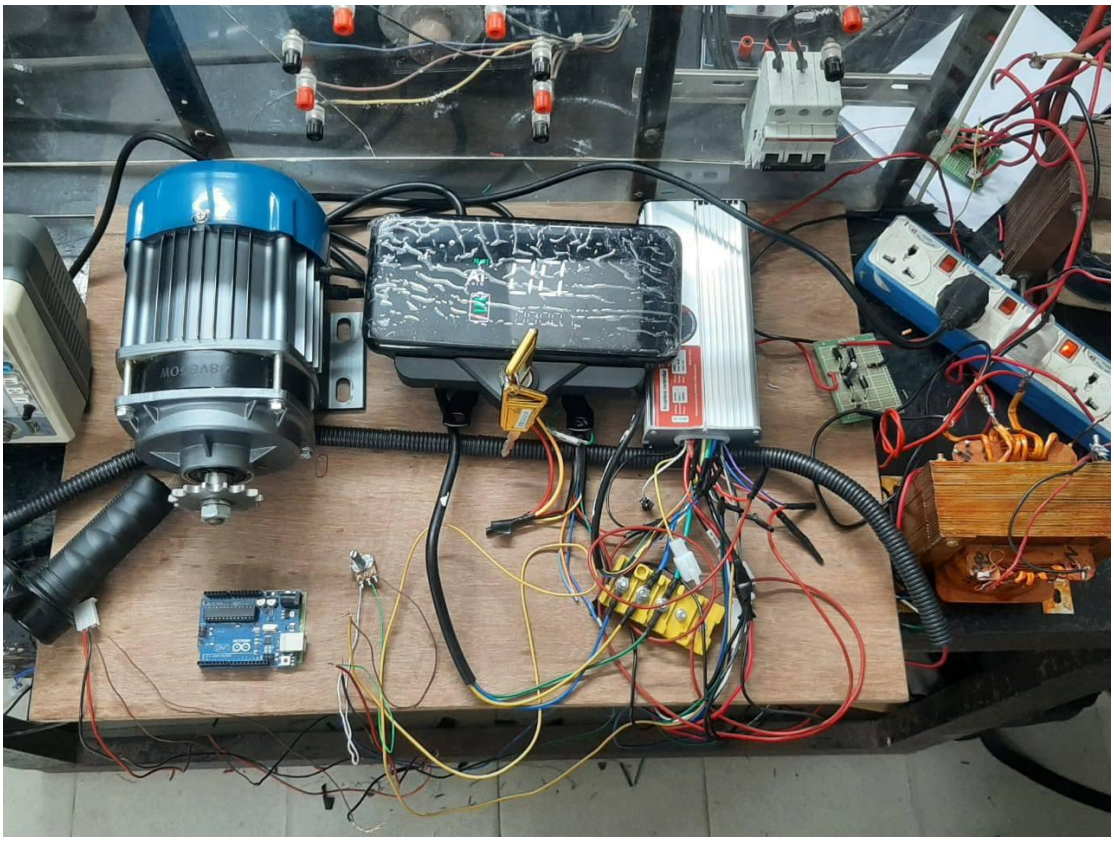


Figure: Practical View of This project

To give you a practical view of an Arduino-based project, let's walk through a simple project: Controlling an motor with a speed. This project will help you understand how to interact with inputs (voltage) and outputs (motor) using an Arduino, giving a hands-on experience.

BLDC Motor Speed Regulation || Risk Mitigation Part 2 - YouTube

Reference

- Bangladesh Post. (2019). Battery-run auto rickshaw, Misuk increase accidents, traffic jam in Munshiganj. Retrieved from https://bangladeshpost.net/posts/battery-run-auto-rickshaw-misuk-increase-accidents-traffic-jam-in-munshiganj-12750

- The Business Standard. (2024). Govt sets 30kmph speed limit for bikes; stakeholders fear adverse impacts. Retrieved from https://www.tbsnews.net/bangladesh/transport/govt-sets-30kmph-speed-limit-bikes-stakeholders-fear-adverse-impacts-846161

- The Daily Star. (2024). Speed limit set for all types of vehicles. Retrieved from [https://www.thedailystar.net/news/bangladesh/transport/news/speed-limit-set-all-types-vehicles-3604456](https://www.thedailystar.net/news/bangladesh/transport/news/speed-limit-set-all-types-vehicles-

Conclusion

This thesis has examined the critical role of sustainable speed management in enhancing the safety of auto rickshaws within Bangladesh's urban public transport system. The findings underscore that the unregulated proliferation of battery-operated auto rickshaws, colloquially known as "Bangla Teslas," has exacerbated traffic congestion and increased the risk of accidents due to their high speeds and inadequate safety features. Notably, these vehicles often lack essential safety mechanisms such as hydraulic brakes and proper structural designs, rendering them ill-equipped to handle the speeds they achieve .Bangladesh Post+3The Financial Express+3TBS News+3
The study highlights that the absence of formal training for drivers and the lack of regulatory oversight contribute significantly to the unsafe operation of these vehicles. Implementing a comprehensive speed management strategy, encompassing vehicle design improvements, driver education, and stringent enforcement of traffic regulations, is imperative to mitigate the risks associated with auto rickshaw operations.
In conclusion, adopting a holistic approach to speed management, which includes technological advancements, regulatory reforms, and public awareness campaigns, is essential to ensure the safety and sustainability of auto rickshaw services in Bangladesh's urban transport landscape.