RAIN WATER SENSING AUTOMATIC CAR WIPER

TEAM ID:47

NAME OF PROJECT:
Rain Water Sensing Automatic Car Wiper

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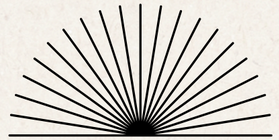


Glossary

Motivation/Background

Imagine driving on a rainy night with heavy rainfall and strong winds. The rain keeps blurring your vision, and your wipers struggle to keep up with the intensity of the weather. The fixed speed of wipers is not always effective – too slow in heavy rain, too fast in light rain, leading to inefficiency and driver distraction.

In such situations, visibility is compromised, driving safety is threatened, and drivers often feel frustrated when their wipers can't adjust properly to the conditions.

Motivation/Background

- Statistics show that heavy rain and poor visibility are major causes of road accidents. According to a National Highway Traffic Safety Administration (NHTSA) report, rain-related accidents account for around 46% of weather-related crashes, with over 5,000 fatalities annually in the U.S. alone.

- Distraction is also a major factor in accidents. The National Safety Council reports that distracted driving accounts for nearly 9 deaths per day in the U.S. Adjusting the wiper speed manually can take the driver's attention away from the road, further increasing the risk of accidents.

Motivation/Background

Our project aims to eliminate the need for manual wiper adjustments by introducing an intelligent rain-sensitive wiper control system that automatically adjusts the speed based on rain intensity. This system will ensure that the driver's focus remains on the road, improve visibility during rain, and reduce distraction, thus enhancing safety for both the driver and other road users.



Problem Statement

Driving in adverse weather conditions, especially during rain, presents several challenges to drivers. As rain intensity increases, the driver needs to manually adjust the wiper speed to maintain visibility. The continuous manual adjustment of wiper speeds becomes dangerous and distracting, as it diverts the driver's attention from the road. This issue, combined with reduced visibility, increases the risk of accidents.

Distraction

Reduced Visibility

Accidents

Inefficient Wiping Systems

Proposed Design

The Proposed Design focuses on an automated wiper control system for vehicles, enhancing driver safety and minimizing distractions during rainfall. The system uses a rain sensor to automatically adjust the wiper speed based on rain intensity, with speeds varying from slow to fast in Automatic Mode. In Manual Mode, users can control the speed through Bluetooth on a mobile app. The design integrates the sensor, Bluetooth module, servo motor, and user interface to reduce manual adjustments, ensuring a clear windshield while improving safety

Mapping of requirements from problem statement to sensor/control parameters

Block diagram

Explanation Of the Design

Circuit Diagram

Mapping of Requirements from Problem Statement to Sensor/Control/Actuator Parameters:

Servo Motor

Wiper Servo Motor (Actuator):

- Requirement: Adjust the wiper's speed based on the rain intensity measured by the rain sensor.
- Control Parameters:
  - Speed Control: The servo motor receives a PWM (pulse-width modulation) signal from the Arduino, which corresponds to different wiper speeds (low, medium, and high).
  - Movement Control: The servo moves the wiper arm across the windshield, adjusting the frequency and duration of the wipe based on the rain intensity.
  - Positioning: The servo has specific positions that align with different wiping speeds (e.g., 0-45°, 45-90°, 90-180° for low, medium, and high speeds, respectively).

Signal Reception

The servo motor receives a control signal (PWM signal) from the microcontroller (Arduino), which defines the position it needs to move to.

Movement of Servo

Based on the received signal, the servo motor rotates its shaft to the specified position, typically within a 0° to 180° range

Wiper Control

The servo motor's movement is used to control the wiper’s position, such as moving it from side to side (left and right) to clear the windshield based on the rain intensity or user input

Mapping of Requirements from Problem Statement to Sensor/Control/Actuator Parameters:

Rain Sensor

Rain Sensor (Sensor): Detects the presence of rain and measures rain intensity. This helps in determining the wiper speed in Automatic Mode.

- Requirement: Automatically adjust wiper speed based on rain intensity.
- Sensor Parameters: Digital and analog input to detect rain presence and measure intensity.

Detection of Rain

The rain sensor detects the presence of rain by measuring the amount of water on its surface using the electrical conductivity of water droplets

Signal Transmission

The rain sensor sends the detected signal (either analog or digital) to the microcontroller (Arduino) to inform it about the presence and intensity of rain.

Adjustment of Wiper Speed

Based on the rain intensity signal, the microcontroller adjusts the wiper speed automatically by controlling the motor, allowing the wipers to move faster or slower depending on how much rain is detected

Mapping of Requirements from Problem Statement to Sensor/Control/Actuator Parameters:

Bluetooth Module

Bluetooth Module (Control/Actuator):

- Requirement: Enable communication between the mobile app and the wiper system, allowing the user to control and monitor the wiper speed and mode.
- Control Parameters:
  - Mode Switching: The Bluetooth module receives commands from the mobile app to switch between Automatic and Manual modes.
  - Speed Control: Based on the user input in Manual Mode, the Bluetooth module sends speed adjustment commands (SPEED:1, SPEED:2, SPEED:3) to the microcontroller.
  - Real-time Feedback: The module sends real-time feedback to the app, displaying the wiper system status, such as speed setting and mode, ensuring continuous communication between the user and the system.

Communication Initiation

The Bluetooth module pairs with the mobile device (via the app) and establishes a wireless connection

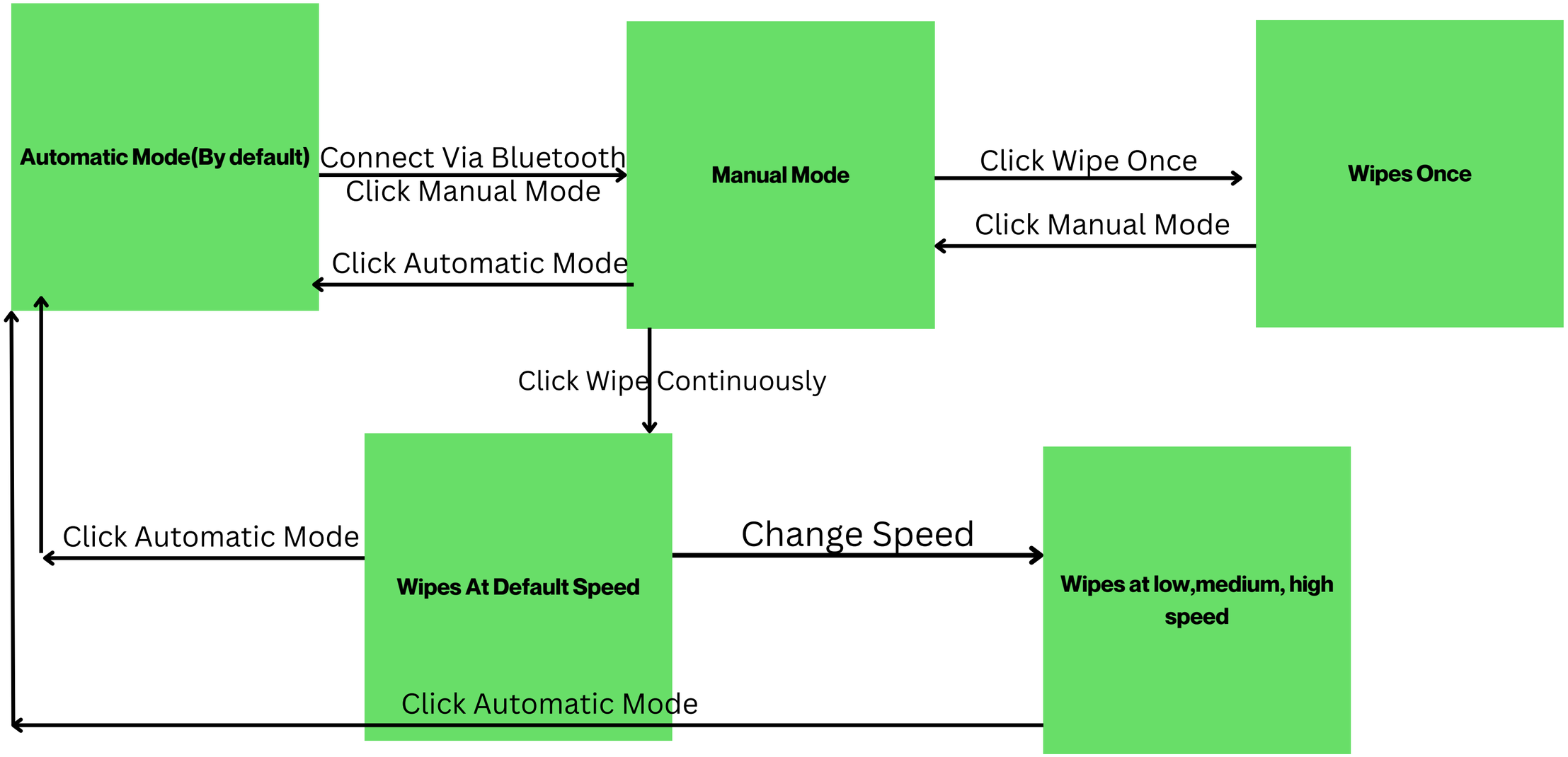
Command Reception

The module receives commands (e.g., mode change, speed control) sent from the mobile app to the Arduino microcontroller

Feedback Transmission

It sends real-time feedback (e.g., current mode, speed settings) from the Arduino to the app, ensuring that the user is informed about the wiper system's status.

Block Diagram



Design

Design Explanation

The design of the automatic wiper system involves a rain sensor that detects the presence and intensity of rain, sending this data to an Arduino for processing. The system operates in two modes: **Automatic Mode**, where the wiper speed adjusts based on rain intensity, and **Manual Mode**, where the user controls the speed through a mobile app. Bluetooth communication is used to send commands between the Arduino and the app, allowing the user to change modes and speed settings. A servo motor is used to adjust the wiper's position according to the speed setting

Rain Detection

The rain sensor detects the presence and intensity of rain by measuring the amount of water on its surface using electrical conductivity.

Signal Transmission

The rain sensor sends the detected signal (either analog or digital) to the Arduino, which processes the data to assess the intensity of rain

Control Mode

The system operates in two modes:

- Automatic Mode: The wiper speed is automatically adjusted based on the rain intensity.
- Manual Mode: The user controls the wiper speed and wiping actions through the mobile app.

Bluetooth Communication

The Arduino communicates with the mobile app using the Bluetooth module (HC-05). Commands for adjusting speed and wiping mode are sent and received via Bluetooth.

Design

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Servo Motor

The servo motor adjusts the wiper arm's position according to the received command (e.g., high, medium, or low speed) by interpreting PWM signals from the Arduino.

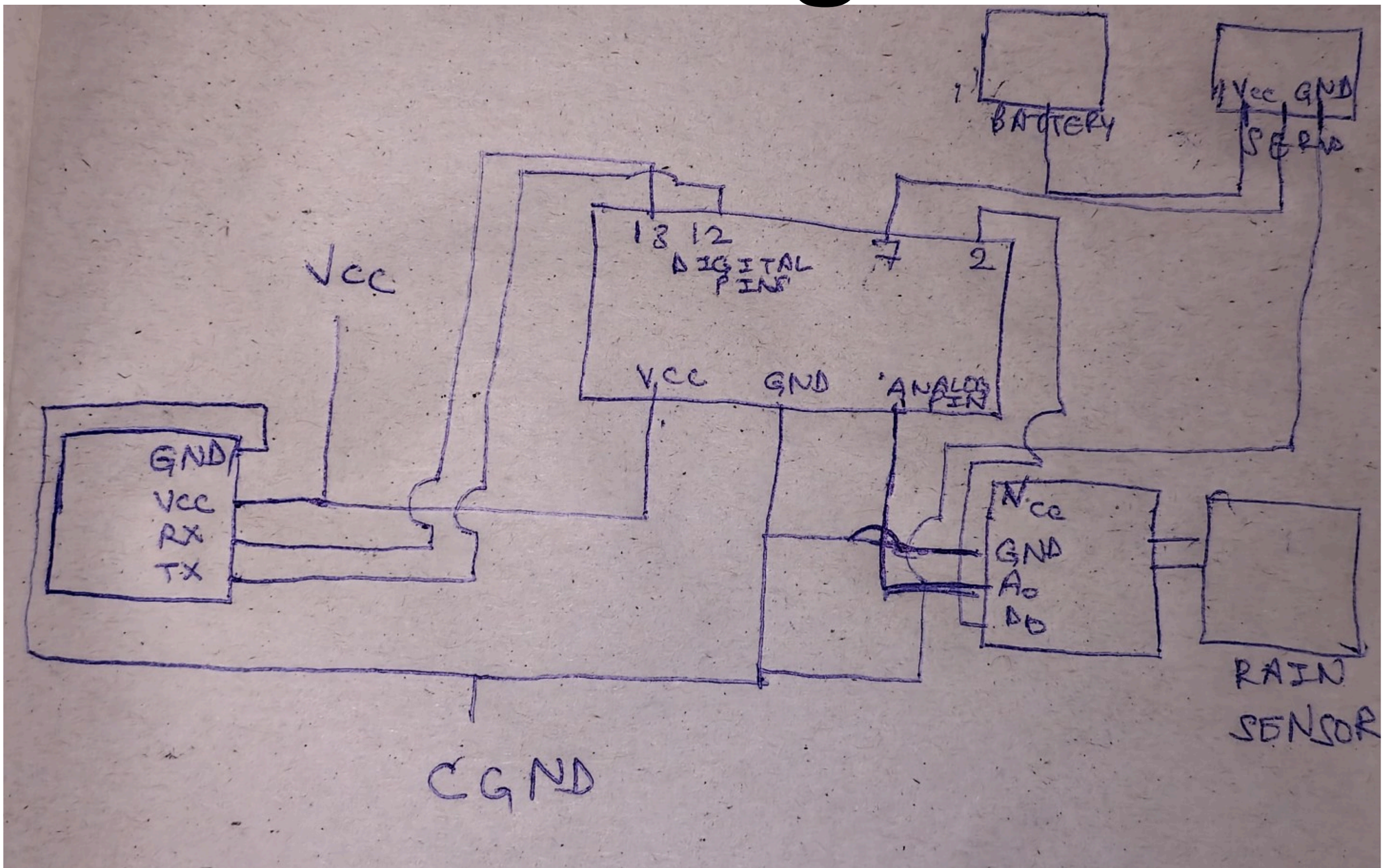
User Interaction

The mobile app (MIT App Inventor) displays wiper status and allows the user to change modes and adjust wiper speed using buttons. It sends commands back to the Arduino for action.

Safety and Efficiency

By automating wiper control based on rain intensity or allowing user control in manual mode, the system ensures safer driving conditions and reduces driver distraction.

Circuit Diagram



Demo Video

https://drive.google.com/file/d/1QIFQOikV-6hKcCsYBDYr8lm1Wl_OrsaL/view?usp=sharing

Key Performance Indicators

Key Performance Indicators (KPIs) for the proposed design can help in assessing the effectiveness and success of the automatic rain-sensing wiper system. Some key metrics to consider include:

Effectiveness in terms of hardware complexity

The system responds quickly to rain detection with minimal delay. The rain sensor accurately detects moisture, and the servo motor adjust sthe wiper speed accordingly without lag. Time response is below 500 ms for switching between different wiper speeds)

Ease of Control and Adjustability

Control via Bluetooth: The app should allow seamless manual control of the wiper's speed, with the ability to switch between automatic and manual modes. The system must allow the user to press a button to change the speed to low, medium, or high, and these changes should be reflected immediately on the wiper's movement

Practical Deployment Complexity

- Installation Ease: The system is designed to be easily integrated into any vehicle. The rain sensor can be mounted on the windshield, and the servo motor can be connected to the wiper arm with minimal modification. Wiring is simple and can be done in a few steps.

Key Performance Indicators

Key Performance Indicators (KPIs) for the proposed design can help in assessing the effectiveness and success of the automatic rain-sensing wiper system. Some key metrics to consider include:

Cost Efficiency:

- Component Cost: The system uses affordable components like the Arduino, rain sensor, and servo motor, which keeps the overall cost low while maintaining the quality of the product. For a budget-friendly version, these parts are readily available and cheap in bulk.

Maintenance

The system's components (sensor, servo motor) are widely available and can be easily replaced in case of failure. Calibration should also be minimal and can be done via the app or a simple manual adjustment

Hardware Complexity

The system is built on simple components like a rain sensor, servo motor, and an Arduino board, which reduces overall hardware complexity while maintaining a reliable solution

The cost of this rain-sensing wiper system is significantly lower than commercial alternatives. Professional wiper systems with rain sensors can cost anywhere from ₹5,000 to ₹20,000 ($60 - $250), making this DIY solution a cost-effective alternative.

CONSTRUCTION COST ₹

PPROJECT NAME: IMPACT WIPE

CATEGORY: RAIN-SENSITIVE WIPER SYSTEM

FOLLOWING TABLE DESCRIBES THE PRODUCTION COST

MATERIAL COST

DESCRIPTION	QTY	PRICE	COST
Arduino Uno (Microcontroller)	1	₹300	₹300
Rain Sensor Module	1	₹250	₹250
Servo Motor (SG90)	1	₹200	₹200
Bluetooth Module (HC-05)	1	₹150	₹150
Cables, Connectors, and Miscellaneous	1 set	₹50	₹50
Power Supply (Battery)	1	₹200	₹200
Enclosure/Box for Circuit	2	₹75	₹150
		TOTAL:	₹1300

Contribution from Team Member: Gautam Arora

`1. Hardware Integration:

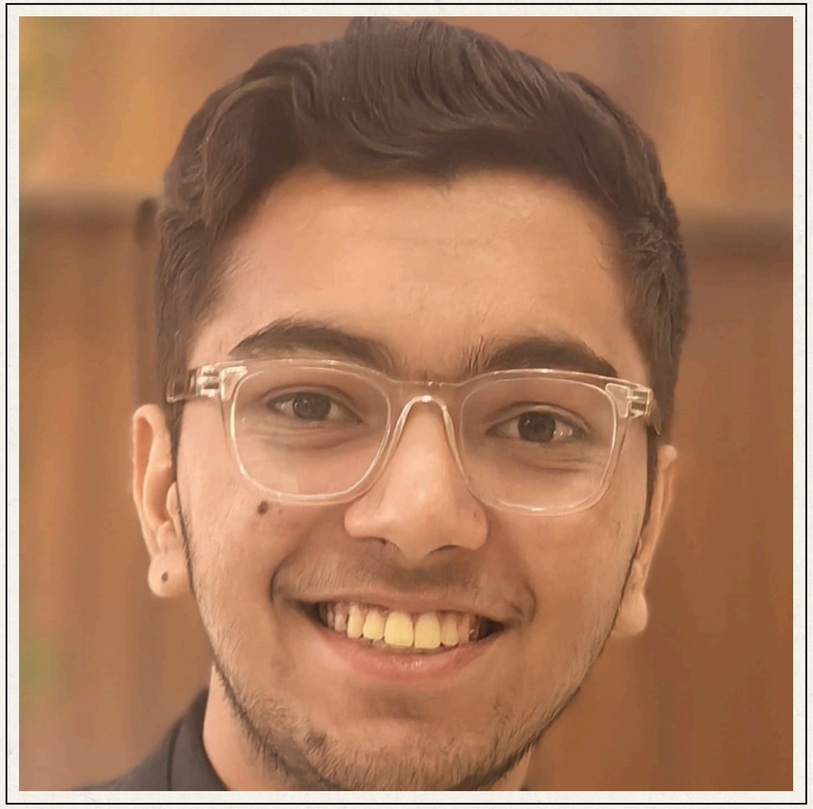
- Responsible for integrating all hardware components, including the rain sensor, servo motor, and Arduino.
- Managed the connections and ensured correct hardware functioning.

2. Soldering & Assembly:

- Soldered key components onto the PCB and assembled the physical setup of the project.

3. Implemented the core Arduino code for controlling the servo motor based on input from the rain sensor and Bluetooth commands.

4. Ensured the correct functioning of the system by writing efficient and optimized code.



Contribution from Team Member: Siddhant Gudwani

1. Simulations & Circuit Design:
   - Developed the simulations to test the functionality of the rain sensor and servo motor.
   - Designed the complete circuit diagram, project report and presentation.
2. App Development:
   - Built and designed the app on MIT App Inventor to control the system.
   - Integrated Bluetooth communication for controlling the servo motor and adjusting wiper speed via the app.
3. Soldering Tasks:
   - Contributed to part of the soldering work, connecting components to the breadboard and ensuring proper connections.

Remarks: Technical Challenges

01. Instability of Bluetooth Module

One of the major technical challenges faced during the project was the instability of the Bluetooth module (HC-05) when the servo motor (SG90) was connected. As soon as the servo was powered on, the Bluetooth connection would drop, preventing communication with the app.

The issue was traced back to power supply limitations, where the servo and Bluetooth module were drawing power from the same source. After providing the servo with an external power supply, the system worked as expected

Remarks: Technical Challenges

02. Delay Issues with Bluetooth

- One of the significant challenges was the inability to add delays in the code due to the Bluetooth module (HC-05). The system couldn't handle delays effectively because they caused communication breakdowns with the MIT App Inventor and Bluetooth.

- The system required real-time interaction between the Bluetooth module and the microcontroller, but the introduction of delays often interfered with Bluetooth communication, causing frequent disconnections.

Remarks: Technical Challenges

03. Code and MIT AI Issues:

- The complexity of the code increased as we tried to manage real-time responses and interaction between the microcontroller, Bluetooth module, and app. Specific areas of difficulty included:

- Buffer Overflows: The serial data buffers would overflow, especially when there were multiple continuous inputs, causing the system to drop important commands.
- Concurrency Issues: With both Bluetooth and sensor readings running simultaneously, ensuring proper timing and synchronization in the code became complicated.

Feasibility of the Problem Statement:

- The problem statement of automatically adjusting the wiper speed based on rain intensity is highly feasible. The system is capable of achieving real-time adjustments based on rain sensor readings.
- The combination of a rain sensor, servo motor, and Bluetooth module proved effective in meeting the requirements of the project, and after overcoming the technical challenges, the system functions well under both automatic and manual modes.

Learnings from the Project

- The project helped improve the understanding of sensor integration and the challenges of handling multiple components like a microcontroller, Bluetooth module, and motors together.
- The difficulties faced with the Bluetooth module highlighted the importance of power management in systems.
- The experience of integrating software (MIT App Inventor) and hardware (Arduino, Bluetooth, Servo) provided valuable insights into real-world applications of IoT and systems.
- Lastly, troubleshooting the disconnection issue taught me the significance of debugging communication-related problems in embedded systems.

References and Sources Used

Bluetooth Module (HC-05) Documentation

- Retrieved from: https://www.electronicwings.com/
- Describes the working and pin configuration of the Bluetooth HC-05 module, which was a core part of the communication system.

Arduino Servo Motor Control

- Retrieved from: https://www.arduino.cc/en/Reference/Servo
- This page provided the reference for controlling a servo motor using Arduino, which was essential for wiper control in the project.

Rain Sensor Circuit Guide

- Retrieved from: https://circuitdigest.com/
- Gave insight into the working of rain sensors and how to integrate the with an Arduino to detect rain.

MIT App Inventor Documentation

- Retrieved from: https://appinventor.mit.edu/
- Provided guidelines on creating mobile apps with Bluetooth control, which was used to send commands from the app to the Arduino.

References and Sources Used

Servo Motor Control and PWM Signals

- Retrieved from: https://www.robotshop.com/
- Detailed the process of controlling a servo motor using PWM signals, which was critical for controlling the speed and movement of the wiper.

Arduino Serial Communication Guide

- Retrieved from: https://www.arduino.cc/en/Tutorial/SerialWrite
- Provided insights on how serial communication is handled in Arduino, which was used for debugging and sending data from Arduino to the app.

Bluetooth Communication with Arduino

- Retrieved from: https://www.instructables.com/
- Offered practical examples and tutorials on establishing Bluetooth communication between Arduino and smartphones.