Rain Rain Go Away

Hostel Code:- 23

1 Introduction

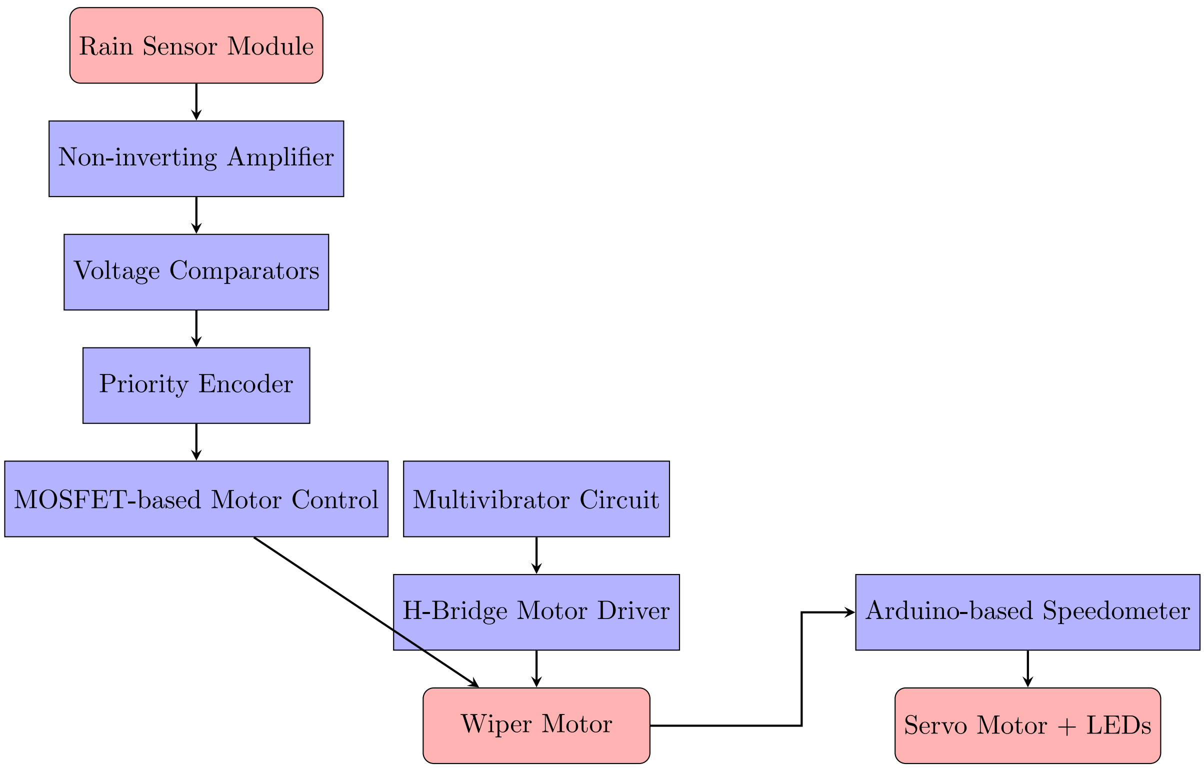
In this project, we have designed a rain-sensing wiper control circuit that automatically adjusts the speed of a motor-based wiper system according to the intensity of rainfall. The system utilizes a rain sensor, operational amplifiers, a priority encoder, MOSFET-based motor control, and an H-bridge circuit for periodic back-and-forth motion. Additionally, an Arduino-based speedometer is implemented to display the wiper's speed using an IR sensor and servo motor.

2 Components Used

- Rain Sensor Module
- Operational Amplifiers (Op-Amps)
- Resistors and Capacitors (for voltage dividers and reference voltage)
- Priority Encoder
- N-channel MOSFETs
- Multivibrator Circuit (Op-Amp based)
- H-Bridge Motor Driver
- Arduino Uno
- IR Sensor and IR Emitter Module
- Servo Motor
- LEDs

3 Circuit Design

3.1 Block Diagram



3.2 Rain Sensor and Signal Amplification

The rain sensor module detects the presence of rain and outputs an analog voltage proportional to the intensity of the rainfall. Since the sensor output is weak, we use a **non-inverting amplifier circuit** built using an operational amplifier (op-amp) to amplify the signal.

3.3 Voltage Comparators

After amplification, the signal is fed into **four voltage comparators** built using op-amps. Each comparator has a different reference voltage:

- 0.5V
- 2.1V
- 4.8V

Figure 1: Rain Module of Rain Rain Go Away.

- 7.6V

Each comparator outputs **10V** when the input voltage exceeds its respective reference voltage. To prevent damage to subsequent integrated circuits (ICs), the outputs are passed through a **voltage divider** that reduces the voltage by half.

3.4 Priority Encoder

The outputs of the comparators are labeled as **A, B, C, and D**, where:

- **A** corresponds to the highest rainfall intensity
- **D** corresponds to the lowest rainfall intensity

A **priority encoder** is used to generate encoded outputs:

$$\begin{aligned} X &= A \\ Y &= A'B \\ Z &= A'B'C \\ W &= A'B'C'D \end{aligned}$$

These outputs determine the speed of the motor.

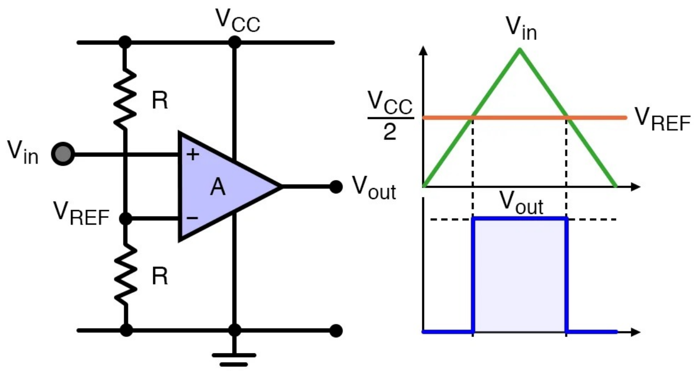


Figure 2: Voltage Compartor of Rain Rain Go Away.

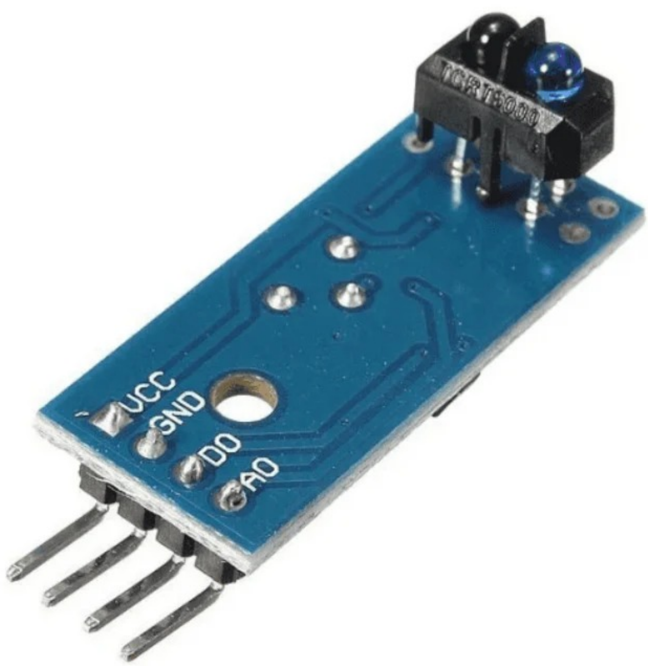


Figure 3: IR Sensor of Rain Rain Go Away.

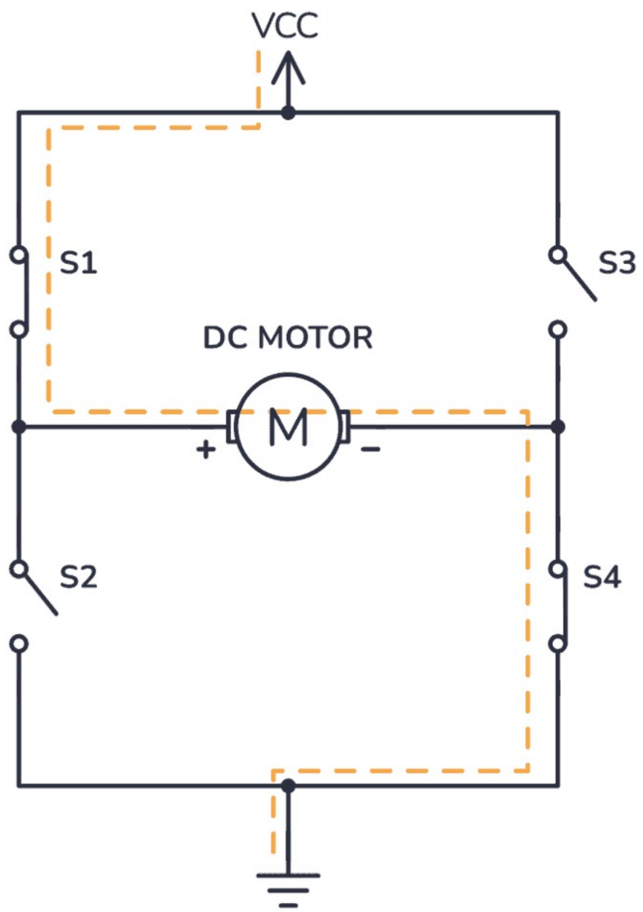


Figure 4: H Bridge of Rain Rain Go Away

3.5 MOSFET-Based Motor Speed Control

The priority encoder outputs (X, Y, Z, W) are connected to four **N-channel MOSFETs**, each acting as a switch. When a particular output is high, the corresponding MOSFET is triggered, allowing a specific voltage to be applied to the motor, thus controlling its speed.

3.6 H-Bridge for Periodic Motion

To achieve **back-and-forth movement** of the wiper, a **multivibrator circuit** using an op-amp is designed to generate a **square wave** with a nearly **50% duty cycle**. The output of the multivibrator is labeled as **A**.

- **A** is fed into a NOT gate to generate **B**.
- These signals are used as inputs for an **H-Bridge motor driver**:
  - When **A is high**, the motor rotates **clockwise**.
  - When **B is high**, the motor rotates **anticlockwise**.
  - This results in periodic **0-180** motion of the wiper.

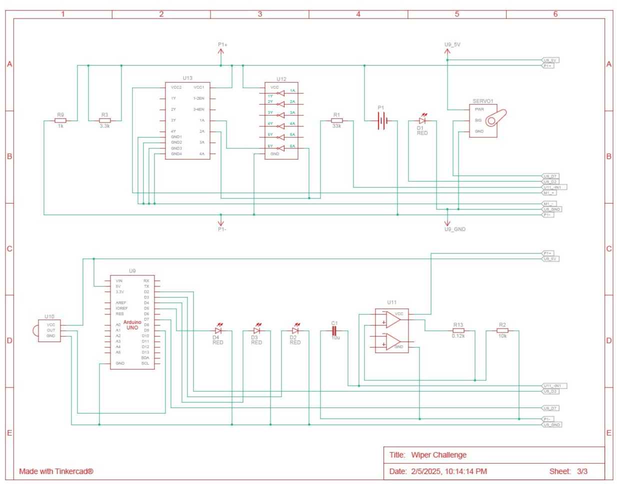
3.7 Speedometer using Arduino

A speedometer system is implemented using **Arduino, an IR sensor, and an IR emitter module**.

- The IR sensor detects the time interval during which the wiper moves from 0-180 degrees.
- The Arduino calculates the difference in time and derives the **half-period** of the wiper's motion.
- Depending on the measured time period, the Arduino rotates a **servo motor** to different angles:
  - 0(slowest speed)
  - 45
  - 90
  - 135
  - 180(fastest speed)
- Corresponding LEDs are triggered to indicate speed levels.

4 Working Principle

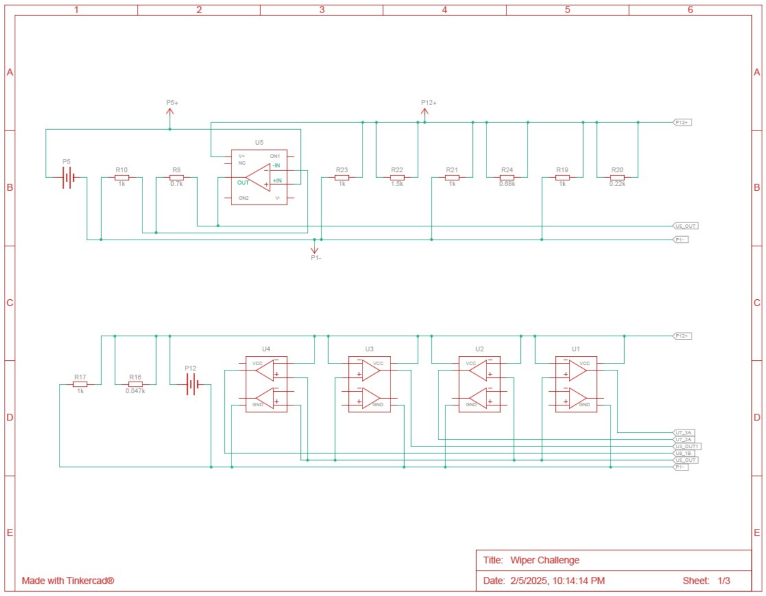
1. The **rain sensor** detects rainfall intensity and produces an analog voltage.
2. The **non-inverting amplifier** amplifies this voltage.
3. The **comparators** classify the voltage into four levels.
4. The **priority encoder** encodes the comparator outputs into digital signals.
5. The **MOSFET switches** control the motor speed based on the priority encoder output.
6. The **multivibrator and H-bridge** create back-and-forth motion.
7. The **speedometer** measures the wiper's speed and visually represents it using a servo motor and LEDs.



5 Components

6 Conclusion

This project successfully implements an automatic rain-sensing wiper system with **adaptive speed control** and **real-time speed monitoring**. The circuit ensures efficient wiper operation by responding dynamically to rainfall intensity while incorporating a robust **motor control mechanism** and **speed indication system**. The combination of analog and digital components demonstrates an effective embedded system for automotive applications.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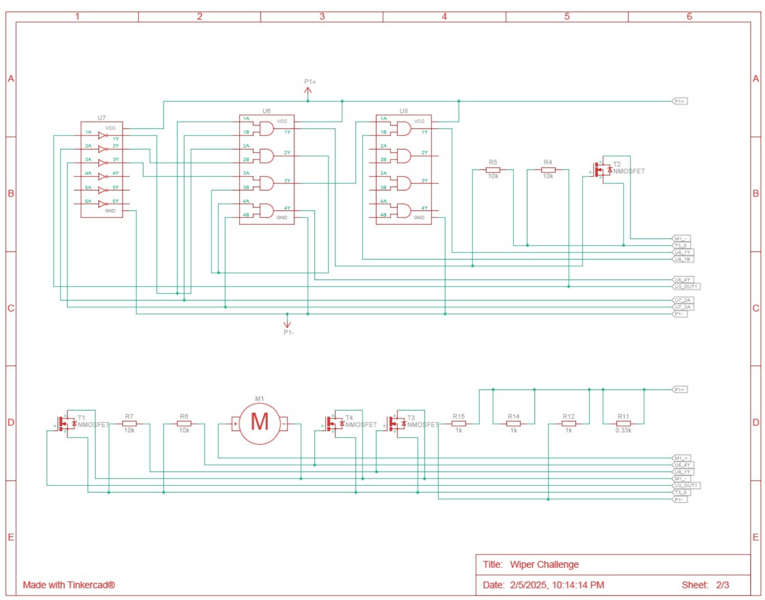
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Name	Quantity	Component
U1, U2, U3, U4, U5, U11	6	OpAmp (LM358)
R8	1	0.7 kΩ Resistor
R10, R9, R12, R14, R15, R17, R19, R21, R23	9	1 kΩ Resistor
P5	1	3, 5 Power Supply
U6, U8	2	Quad AND Gate
U7, U12	2	Hex Inverter
P1	1	5, 0.5 Power Supply
M1	1	DC Motor
U13	1	H-bridge Motor Driver
P12	1	12, 5 Power Supply
T1, T2, T3, T4	4	nMOS Transistor (MOSFET)
R4, R5, R6, R7, R2	5	10 kΩ Resistor
R3	1	3.3 kΩ Resistor
R11	1	0.33 kΩ Resistor
R16	1	0.047 kΩ Resistor
R20	1	0.22 kΩ Resistor
R24	1	0.68 kΩ Resistor
R22	1	1.5 kΩ Resistor
U9	1	Arduino Uno R3
U10	1	IR Sensor
SERVO1	1	Positional Micro Servo
D1, D2, D3, D4	4	Red LED
C1	1	10 μF Capacitor
R1	1	33 kΩ Resistor
R13	1	0.12 kΩ Resistor

Table 1: Component List