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Automated Side Mirror Car Wiper System

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Abstract: *This document presents the design and implementation of an Automated Side Mirror Car Wiper System to enhance visibility and safety during adverse weather conditions. The system utilizes a rain sensor to detect water droplets and automatically activate the wiper mechanism, ensuring clear side mirrors without manual intervention. This automation improves driving convenience, reduces distractions, and enhances overall road safety. Index Terms— Automated wiper, Rain sensor, Vehicle safety, Side mirror cleaning*..

Keywords: Automated Wiper, Rain Sensor YL 83, Side Mirror, Vehicle Safety, Microcontroller STM 32 , Servo Motor Voltage Regulator 7812

I. INTRODUCTION

The need for clear visibility in adverse weather conditions is crucial for safe driving, especially in rain or snow. Traditional side mirror cleaning methods, such as manual wiping or relying on vehicle aerodynamics, often fail to provide the necessary efficiency and responsiveness required for optimal visibility, leading to potential safety hazards and driver discomfort. As automotive technology advances, there is a growing demand for automated, real-time solutions that enhance driving convenience and road safety. This highlights the need for an Automated Side Mirror Car Wiper System, which ensures unobstructed side mirror visibility without manual intervention. An innovative solution lies in the use of rain sensors for automated side mirror cleaning. Rain-sensing wiper systems offer several advantages over traditional manual wiping, such as real-time responsiveness and hands-free operation, ensuring uninterrupted visibility during adverse weather conditions. These sensors detect water droplets on the mirror surface and automatically activate the wiper mechanism, effectively clearing moisture. Rain-sensing wipers have been widely adopted in modern vehicles for windshield cleaning, demonstrating their effectiveness in enhancing driving safety and convenience. Implementing this technology for side mirrors can further improve visibility and reduce driver distractions, making it a valuable addition to automotive safety systems.

However, implementing an automated side mirror wiper system presents several challenges. One significant issue is ensuring the rain sensor's accuracy in varying environmental conditions, such as mist, dirt accumulation, and fluctuating humidity levels, which may affect detection precision. To address this, several research studies have proposed methods to enhance the reliability and performance of rain sensors. For instance, improved rain sensor accuracy by integrating machine learning algorithms to distinguish between raindrops and other environmental factors, reducing false activations. Similarly, developed an adaptive wiper control system using infrared-based moisture detection, achieving high responsiveness and efficiency in different weather conditions. These advancements highlight the potential for optimizing automated side mirror wiper systems to enhance driving safety and convenience.

Moreover, scalability and cost-effectiveness remain key challenges in deploying automated side mirror wiper systems on a larger scale, especially in budget-friendly or older vehicle models. Integrating rain sensors with automated wiper control mechanisms requires not only high-precision sensors but also efficient algorithms for real-time activation and responsiveness. Ensuring compatibility with different vehicle designs adds further complexity to the implementation. Research has shown that combining sensor technologies with machine learning can significantly enhance the accuracy of rain detection, minimizing false activations and optimizing wiper operation under varying weather conditions. Such advancements make automated side mirror wiper systems more adaptable and efficient, contributing to improved road safety and driving comfort.

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This research proposes a solution for an automated side mirror wiper system, focusing on enhancing the accuracy and reliability of rain detection for real-time activation. By integrating rain sensors with intelligent control algorithms, the proposed system aims to overcome the limitations of traditional manual wiping methods, ensuring improved visibility, enhanced driving safety, and greater convenience. The system is designed to be efficient, scalable, and adaptable to various vehicle models, making it a cost effective solution for modern automotive applications.

II. LITERATURE SURVEY

a) Traditional Side Mirror Cleaning Methods:

Historically, side mirror cleaning relied on manual wiping, aerodynamic water dispersion, or hydrophobic coatings. These methods often proved inefficient, inconsistent, or maintenance- intensive, especially in heavy rainfall or snowy conditions. Manual cleaning requires driver intervention, which can be inconvenient and unsafe while driving. Similarly, aerodynamic dispersion is highly dependent on vehicle speed, making it unreliable at lower speeds or in still conditions.

b) Integration of Rain Sensors in Automated Wiper Systems:

Rain sensors offer several advantages over traditional cleaning methods, including real-time responsiveness, handsfree operation, and improved visibility. These sensors detect water droplets on the mirror surface and automatically trigger the wiper mechanism, ensuring continuous clarity without driver intervention. By utilizing technologies such as optical, capacitive, or infrared-based rain detection, these systems enhance driving safety and convenience in diverse weather conditions.

Moni Sree, Dharshana N, Dheekshitha S, Archana Presented A paper titled “Automatic rain sensing wiper system using a 555 timer” in article [1] . System activates a wiper through a sensor- based detection mechanism without manual switching, enhancing driver safety by reducing distraction. The circuit is divided into four main components: a 555 IC in astable mode, a comparator, motor driver circuitry, and a rain detector. Their design demonstrates the conversion of manual to automatic operation, targeting cost- efficiency and reliability in rain detection.

In [2] Vinayak Sagare, D. N. Sonawane, Mukul Joshi, M. A Joshi developed a resistive rain sensor with a linearized output using a customized PIC microcontroller. Their work, titled “A novel and cost-effective resistive rain sensor for automatic wiper manage: circuit modeling and implementation”, emphasizes efficiency by minimizing the non-linearity in sensor output through circuit-based linearization.

In [3] Lubna Alazzawi, Avik Chakravarty introduced a reconfigurable computerized rain-sensitive Side Mirror wiper system. Their paper “Design and implementation of a reconfigurable computerized rain sensitive Side Mirror wiper” highlights fuzzy logic control and PWM for motor actuation, ensuring adaptability and precision.

In [4] P. Abhilash Reddy, G. Sai Prudhvi, P. J. Surya Sankar Reddy, Dr. S. S. Subashka Ramesh proposed an Arduino-based automatic rain sensing car wiper system to enhance driver safety by eliminating manual intervention during rainfall. The system uses a rain sensor, LCD display, servo motor, and LM393 comparator, interfaced with an ATmega8 microcontroller. When moisture exceeds a threshold, the sensor triggers the Arduino, which processes the data and activates the wiper motor. The LCD module displays rainfall intensity and wiper speed, allowing real-time feedback to the driver. This system is intelligent, starts automatically during rain, and stops once the rain ends, thereby reducing driver distraction and enhancing road safety.

In [5] Akila Wijesinghe proposes an automated rain wiper system aimed at enhancing driver visibility during rainy conditions without manual intervention. The system automatically adjusts the speed of the wipers based on rainfall intensity using a rain sensor and microcontroller (PIC16F877A). It comprises components such as the L298D motor driver, L7805 voltage regulators, and a rain drop sensor to detect precipitation levels. The microcontroller processes sensor data to control wiper speed via PWM signals. This design is low-cost, energy-efficient, and suitable for standard vehicles, promoting road safety by reducing driver distractions. The research demonstrates a practical, cost- effective solution for rain-sensing automation in automobiles.

In [6] Prajapati and Khatri present a system titled “Rain Operated Automatic Wiper in Automobile Vehicle”, focused on enhancing driver safety and convenience by automating Side Mirror wiper operation without manual input. The

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system detects rainfall using sensors and activates the wipers accordingly, allowing drivers to concentrate on the road. It aims to eliminate the need for drivers to manually adjust wiper speed, especially during varying rain intensities. The proposed design employs an impedance and IR sensor-based rain detection mechanism connected to a microcontroller, which processes the input and activates a motor control logic for appropriate wiper speed. The data processing unit is built around an AVR Atmega8 microcontroller, selected for its high analog input capability. The system logic includes initialization, rain sensing, and speed regulation via relays, based on rainfall intensity. This project targets both retrofit and new vehicle applications to reduce accidents and improve vehicle automation using a cost-effective and modular design approach.

In [7] Devi et al. present a project titled "Automatic Rain Sensing Wipers Using Arduino," aimed at enhancing driver safety by automating Side Mirror wiper operation based on rainfall intensity. The system utilizes an Arduino Uno, a rain sensor, a servo motor, and an LCD module to detect precipitation and adjust the wiper speed accordingly. The proposed design eliminates the need for manual intervention, thus minimizing driver distraction and potential accidents during rainfall. The block diagram shows a four-stage system where rain is detected, processed, and used to control a servo motor that operates the wiper. The rain sensor functions based on the resistance change caused by water droplets, and the Arduino processes this signal to determine motor speed. This low-cost, efficient automation model is particularly suited for use in modern vehicles to improve road safety and driving comfort during adverse weather conditions.

In [8] the article Tim Brophy, Darragh Mullins , Ashkan Parsi, Jonathan Horgan, Enda Ward, Patrick Denny, Ciarán Eising, Brian Deegan, Martin Glavin, and Edward Jones, presents a comprehensive review of how adverse weather conditions, particularly rain, affect the performance of visible spectrum cameras used in automated vehicles for tasks like object detection, classification, avoidance, and path planning. The authors introduce a data communication-inspired "Image Formation Framework", which maps the flow of visual information from real-world objects through environmental channels (like rain) to the sensor (camera), and finally through the processing pipeline. This model helps to systematically analyze where and how rain impacts image data quality and perception reliability.

In [9] paper by Saqlain Ahmed discuss the design and development of an Automatic Rain Operated Wiper system, which uses a conduction (touch) sensor, a control unit, and a wiper motor to automatically activate windshield wipers during rainfall. The system is powered by a battery and utilizes a PIC16F73 microcontroller to process signals from the sensor and control the wiper motor accordingly. When rain is detected on the vehicle glass, the sensor sends a signal to the control unit, which then turns on the motor without requiring driver intervention. The project highlights its applicability in four-wheelers and its reliability for industrial and domestic use, demonstrating how embedded systems can automate essential vehicle functions for enhanced safety and convenience.

Summary of the Literature Review

The reviewed literature presents a range of approaches for designing and implementing automatic Side Mirror wiper systems aimed at enhancing driver safety, comfort, and visibility during rainfall. Traditional manually operated systems are considered inconvenient and distracting, prompting the development of automated alternatives that activate wipers based on real-time environmental sensing. Most studies utilize moisture or rain sensors—such as resistive, capacitive, optical, or IR-based types— to detect precipitation on the mirror surface. These sensors are interfaced with microcontrollers like PIC, Arduino, or ATmega, which process the sensor signals and control wiper actuation through motors, actuators, or servo mechanisms. Some systems integrate advanced features such as fuzzy logic, PWM motor control, and real-time speed adjustments based on rainfall intensity. Cost-effectiveness and circuit simplicity are common design goals, with components like 555 timers, LM393 comparators, and L298D motor drivers frequently used to minimize complexity while maintaining reliability. Certain designs also include features such as lifting the wiper blade when the engine is turned off to prevent rubber damage from heat, particularly in hot climates. Other innovations include wireless activation via Bluetooth and the use of LCD displays for real-time feedback. Research also explores sensor output linearization to ensure accurate and consistent performance in varying weather conditions. Overall, these systems aim to eliminate manual intervention, reduce driver distraction, and offer a practical, low-cost solution for integrating rain-sensitive automation into both new and existing vehicles

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III. METHODOLOGY

The system utilizes rain-detecting sensors, such as optical and ultrasonic sensors, to monitor environmental conditions in real time. These sensors transmit data to a microcontroller, which processes the information and activates the wiper mechanism accordingly.

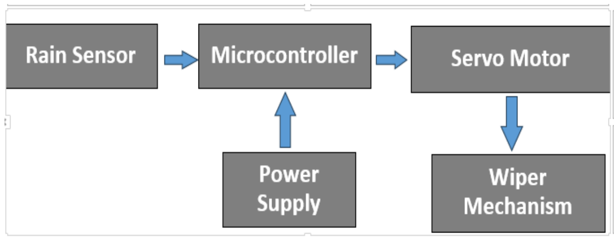

Fig.1. System Diagram

A. Sensor System

The core component of the automated side mirror wiper system is the rain detection sensor, which continuously monitors environmental conditions in real time. These sensors, including optical, capacitive, or ultrasonic rain sensors, are integrated with microcontrollers such as the Microcontroller805 to collect and process data on rainfall intensity and related parameters.

Microcontroller provide preliminary analysis, enabling immediate activation of the wiper upon detecting rain and minimizing reliance on centralized systems. This ensures rapid response, improved visibility, and enhanced driving safety in adverse weather conditions.

B. Data Analysis & Control

The data collected from the rain detection sensors is analyzed using advanced computational techniques to improve the accuracy and responsiveness of the automated side mirror wiper system. combining multiple models, such as Random Forest and enhances the reliability and performance of the system by reducing false activations and adapting to different environmental conditions

TABLE 1. METHODOLOGY OVERVIEW (Sensor System)

Sr No.	Category	Techniques/Methods	Key Features	Limitations
1.	Sensor Integration	Rain Sensors	Real-Time Rain Detection, High Sensitivity & Accuracy	Limited Detection Range, Power Consumption
2.	Component Intergration and Visualization	Proteus .	Imtegration of components and real time simulation	No Real-Time Cloud Connectivity.
3.	Embedded Systems	Servo Motor, Microcontroller .	Low-cost, flexible microcontrollers for sensor integration	Limited processing power for complex data tasks

IV. SOFTWARE DESIGN

The proposed methodology aims to deliver an efficient and responsive solution for automatic mirror cleaning using environmental sensing and embedded control. This approach leverages sensor data and real-time motor control to maintain mirror visibility under adverse weather conditions.

The system revolves around the Automated Side Mirror Car Wiper System , which utilizes rain sensors to detect moisture or water droplets on the side mirrors. Additional proximity or infrared sensors may be integrated to enhance detection accuracy.

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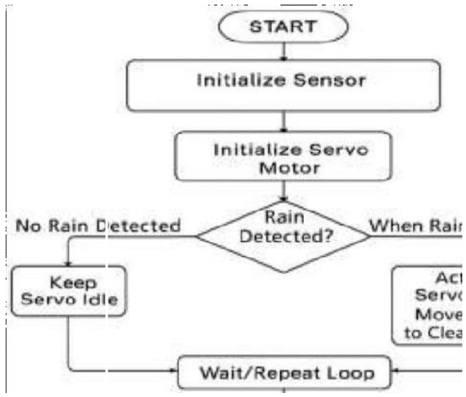

Fig.2. System Flowchart

A. Architecture Flow of Proposed Methodology The architecture for the automatic side mirror car wiper system follows a systematic step-by-step approach:

1. Step 1: Data from rain detection sensors is gathered and processed to standardize rainfall intensity values, ensuring consistency for further analysis.
2. Step 2: The processed data undergoes filtering techniques to enhance signal quality, improving the accuracy of rain detection.
3. Step 3: Feature extraction algorithms identify key parameters such as rain intensity variations and environmental conditions affecting visibility.
4. Step 4: Control algorithms analyze the extracted features to determine necessary adjustments in wiper speed and activation, ensuring optimal performance.
5. Step 5: Embedded threshold-based anomaly detection algorithms identify unexpected sensor behaviors or malfunctions and trigger corrective actions.
6. Step 6: The processed results are transmitted to a central system for monitoring, reporting, and predictive maintenance, enhancing the reliability and efficiency of the system.

V. RESULT AND DISCUSSIONS:

The automated side mirror wiper system is provide accurate and efficient real-time rain detection, ensuring timely activation and adaptive wiper speed control. The system will enhance driver visibility, reduce manual intervention, and optimize energy efficiency.

The key results include:

1. Accurate Rain Detection: The rain sensor is expected to offer precise detection of water droplets on the side mirror surface, ensuring timely and consistent activation of the wiper system. This enhances visibility and system responsiveness under varying weather conditions.

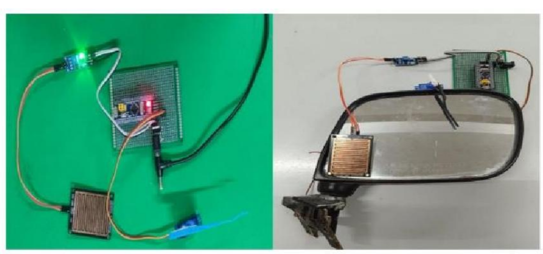

Fig.3. hardware setup and real time mirror attachment

2. Real-time Response: The system is designed to respond instantly to rain detection, enabling immediate activation of the wiper mechanism. This real-time operation ensures the side mirror remains clear, improving driver safety and visibility during adverse weather.

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TABLE 2. Time per Sweep and Speed of Wiper for different Rain Intensities

Rain Rate	Voltage	Time Per Sweep(s)	Speed (m/s)
Light drizzle	3.2	10.0	0.0314
Light Rain	2.6	9.0	0.0349
Moderate Rain	2.0	8.0	0.0393
Steady rain	1.4	7.0	0.0419
Heavy rain	0.8	6.0	0.0523

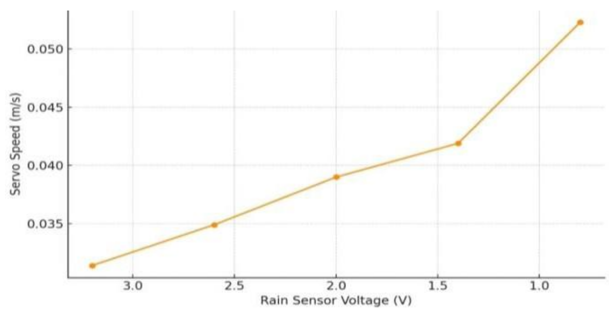

Fig.4 Change in speed of wiper vs output voltage

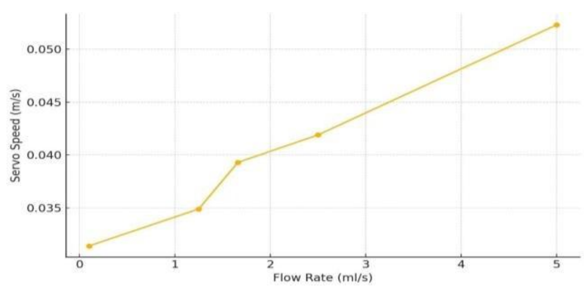

Fig.5 Rain Fall (ml) vs change in servo speed

3. Efficient Automation: The wiper system operates autonomously, eliminating the need for manual activation. This enhances overall vehicle functionality by providing hands-free mirror cleaning, contributing to a safer and more convenient driving experience.

4. Scalability and Reliability: The system is designed to function reliably under diverse environmental conditions such as rain, mist, or dust. Its modular design ensures easy scalability and adaptability to different vehicle models with minimal hardware adjustments.

VI. CONCLUSION

This article presents a practical, cost-effective, and intelligent solution for automated side mirror cleaning using a rain sensor integrated with an STM32 microcontroller and a servo motor. By continuously monitoring environmental conditions and responding instantly to rain or moisture detection, the system ensures clear visibility on vehicle side mirrors without manual intervention.

The primary strength of the system lies in its real-time responsiveness and compact hardware design. The integration of smart sensing with precise servo motor control allows for reliable and efficient wiping action only when necessary, minimizing mechanical wear and power consumption. The solution can be easily adapted to various vehicle types, implementation. supporting scalability and broader.

Overall, the project demonstrates a robust and user-friendly approach to automated mirror maintenance. It effectively addresses key concerns such as weather adaptability, safety enhancement, and system autonomy—establishing a foundation for future upgrades such as rain intensity-based wiping speed, wireless diagnostics, and integration with broader vehicle safety systems.

VII. FUTURE SCOPE:

This research envisions several promising advancements for enhancing and expanding the automated side mirror wiper system. As technology progresses, various improvements can be explored to optimize system performance, increase efficiency, and extend its applicability.

Integrating additional sensors such as humidity, temperature, and wind speed sensors can enhance the system's adaptability to varying environmental conditions, ensuring precise and efficient operation. Additionally, incorporating wireless communication technologies like Bluetooth, Wi-Fi, or LoRa will enable remote monitoring and control, improving user convenience and accessibility.

The use of artificial intelligence (AI) and machine learning algorithms can introduce predictive analytics and adaptive control, allowing the system to anticipate rainfall intensity, optimize wiper speed, and enhance performance. AI-driven automation will contribute to better energy efficiency and minimize unnecessary wiper activation.

Another promising future development is the integration of mobile applications, enabling users to remotely monitor and adjust the system's settings. Real-time alerts and notifications can enhance system responsiveness and reliability, providing users with timely updates on weather conditions and system status.

Furthermore, leveraging IoT-based cloud platforms can facilitate large-scale data collection and analysis, offering insights into weather patterns and improving predictive maintenance strategies. Cloud integration will enable seamless updates and optimization of the wiper system based on real-world data.

To enhance sustainability, the system can be designed to operate on energy-efficient components or renewable energy sources such as solar power, making it suitable for electric and hybrid vehicles. This approach will contribute to eco-friendly and low-power vehicle solutions.

Scalability is another crucial area for future research. Efforts should focus on developing a modular and cost-effective design that can be adapted to various vehicle types, including commercial trucks, public transport, and autonomous vehicles.

By addressing these future directions, the automated side mirror wiper system can evolve into a more intelligent, efficient, and adaptable solution, ensuring enhanced visibility and safety for drivers while contributing to sustainable automotive innovations.

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