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Automatic Rain Sensing Car Wiper Using 8052 Microcontroller

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Abstract:
The project describes the design and development of an automatic rain sensing car wiper system with the 8052 microcontroller. The system is designed to increase driver comfort and safety through the automatic switching on of the windshield wiper when it senses rain, thus no manual operation is required. A rain sensor module senses the existence and intensity of rain, and the analog output is processed and converted into digital using an ADC (Analog-to-Digital Converter). The processed signal is then supplied to the 8052 microcontroller, which drives the operation of a DC motor coupled with the wiper mechanism. The microcontroller is set to change the wiper speed according to the intensity of the rain to provide maximum visibility under different weather conditions. The low-cost and efficient solution can be implemented in both new and old vehicles to minimize distractions and maximize driving safety under rainy conditions.

Keywords: Automatic rain sensing, car wiper system, 8052 microcontroller, rain sensor, ADC, digital signal processing, DC motor control, wiper speed adjustment, rain intensity detection, vehicle automation, driver safety, low-cost system, microcontroller-based design.

1. INTRODUCTION:

Rain driving can be quite a challenge—visibility decreases, roads become slippery, and drivers need to keep an added level of attention. Under these conditions, tiny distractions can cause large risks. One activity that tends to go unseen but has a significant contribution to safety is controlling the car windshield wipers. Being required to switch the wipers on and off by hand may not sound like a significant issue, but doing so while driving in traffic or bad weather can distract a driver from the road. That is where automation comes into play to make an impact. (Shrivastava, V., & Tripathi, R. 2023)

The project "Automatic Rain Sensing Car Wiper Using 8052 Microcontroller" aims at minimizing distractions through a smart wiper system which automatically starts when it rains. The idea is simple yet very powerful: put a rain sensor on the vehicle and let the microcontroller take care of turning the wipers on and off without the driver having to do anything.

The system uses as its core the 8052 microcontroller, which is one of the most popular microcontrollers in the 8051 family. It provides adequate performance for real-time embedded applications like these owing to its speed, reliability and ease of programming. A rain sensor detects moisture, and the microcontroller is triggered. The rain sensor sends a signal to the microcontroller. Subsequently, the microcontroller processes the signal and turns on the motor of the wiper via relay. Once the rain stops and the sensor no longer detects water droplets, the wiper motor is turned off automatically. Simple as the features of this system are, it is arguably its best attribute. The components are cheap and easy to find, and the system requires no complex installation or maintenance. This makes it ideal not just for modern cars, but also older models lacking smart functions. (Rao, S. R. 2019)

Besides convenience, this system improves the safety of the driver as well. It reduces the amount of choices that a driver has to make, especially during difficult weather. Perhaps in later models, the system could evolve to adjust wiper speed based on the severity of rainfall, more closely resembling the high-end car automation features.

To summarize what the project demonstrates, it shows that a microcontroller-based embedded system can design a solution to a problem in the most intelligent way conceivable. It shows how drivers can shift their focus to the most important matter, which is driving safely on the road, as technology works to automate repetitive tasks.

2. Literature Survey:

Car wiper systems have been automated to reduce the driver's workload over the years. These changes are most notable on the windshield wipers as visibility is a crucial aspect of driving, especially during the rain. Ranging from advanced sensors to smartphone controlled wipers, each system helps make driving easier and safer by improving the vehicle's responsiveness to rain.

A recent study from Mukul Joshi et al. (2022) recommended a new system based on a resistive-type rain sensor that uses a PIC microcontroller. In their work, they calculated rainfall by measuring the change in resistance across the sensor surface due to raindrops. The incorporation of a linearizing circuit was made to enhance system performance which dealt with sensor non-linearity. Furthermore, they had implemented fuzzy logic into the system so that the algorithm could better autonomously interpret the raw output from the signal conditioning hardware. Their system improved wiper speed adjustment with rain to a more sophisticated and intelligent control. Nonetheless, Joshi’s design contained additional complexity because of the use of fuzzy logic and PIC microcontrollers which increase the design and code complexity of the system (Joshi et al., 2022).

In another paper, Lubna Alazzawi and Avik Chakravarty (2021) explained a reconfigurable wiper system that would be variable for different cars without changing the hardware. Fuzzy logic employed in their work also made it variable and easy to be changed. The intelligent algorithm made the wiper system automatically react to changing weather conditions. But as in the previous work, it relied on more sophisticated microcontrollers and was not designed for less complex, cheaper platforms like the 8052 microcontroller (Alazzawi & Chakravarty, 2021).

Another and unique approach was shown in the work of Sourish Mitra et al. (2020). They designed a wiper system controlled by Bluetooth that can be operated with an Android smartphone. With an HC-05 Bluetooth module and Arduino, users could turn the wipers on and off with commands sent from their phone. As novel as this method was, it does include the driver manually sending commands, which takes away from the idea of having a completely automated system (Mitra et al., 2020).

Unlike all these methods, our project focuses on simplicity, automation, and instantaneity using the AT89S52 microcontroller, which belongs to the 8052 family. The microcontroller is stable, low power, and easy to use. Other systems involve complex setups, but our model simply connects a basic rain sensor to the microcontroller. When rain is detected, the wipers switch on automatically, and they automatically switch off once the rain stops. No user input or fuzzy logic is required, and the system is thus practical, economic, and easy to implement on any vehicle.

3. Related Work:

Computer vision and the automotive industry have shown considerable attention in the past to the problem of controlling a car wiper system in the rain. The use of microcontrollers and rain sensors has been studied in context of improving safety by reducing driver distraction for worse weather conditions.

Sharma et al. (2018) were some of the first to develop an automatic wiper system which utilized an Arduino microcontroller, DC motor and a resistive rain sensor. The system was able to identify the rain and change the speed of the wipers according to the intensity of the rain. Its disadvantages were that the DC motor, which had poor granularity in movement, also used excessively more power than required, which led to inefficiency in the long run.

Ramesh and associates (2020) advanced an even more sophisticated system using an analog moisture sensor alongside an analog-to-digital converter (ADC). This enabled the microcontroller to obtain more precise data concerning the intensity of rain and precision in wiper speed control. This project illustrated that through the use of more sensitive sensors, the functionality of the system was greatly enhanced through added performance.

As far as our research is concerned, the closest comparative work is by Patel and Kumar (2019). They had constructed an automatic wiper controller using an AT89C52 microcontroller servo motor with PWM control for a wiper motor and a basic raindrop sensor for rain detection. Their project was low-cost, easy to construct and demonstrated the 8052-series microcontrollers can efficiently control automatic wiper systems, making it a great reference for academic and real-world applications. However, it is noteworthy that most commercial designs still center around rain detection and do not approach power economy, reconfigurability, or snow and fog weather operations. These gaps are what our project seeks to fill by harnessing the capabilities of the AT89S52 microcontroller, which is known for its low-power consumption and ease of programming. This would enable the system to detect rain and operate the wipers autonomously and in real-time—intuitive and economical to deploy in numerous vehicle models.

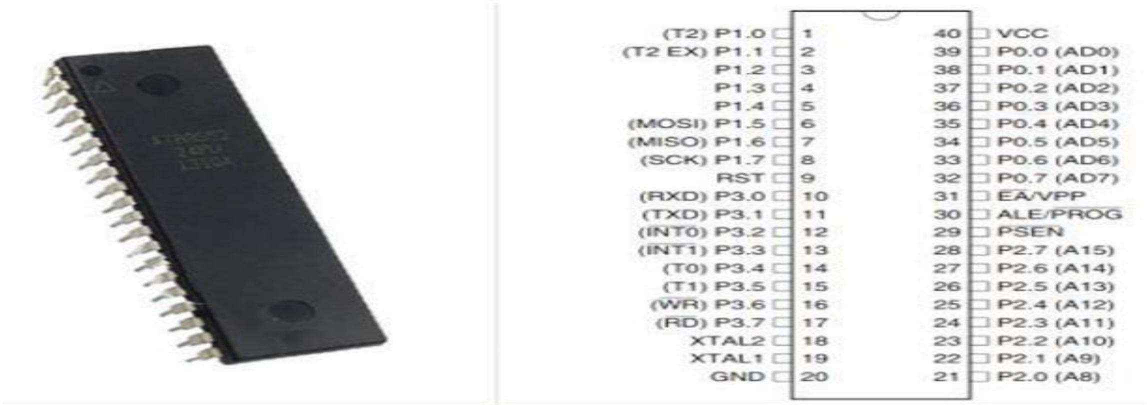
4. Experimental Setup:

4.1 AT89s52 Microcontroller:

We built our system around the AT89S52 microcontroller, which is an Atmel 8-bit chip costing very little yet being high in performance. One of the famous 8051 family members, it's the choice of application for the majority of embedded systems because it is reliable, cost-effective, and easy to program. It includes 8KB of Flash, 256 bytes of RAM, and 32 general-purpose input/output (I/O) lines, and therefore, it suits processing sensor output and input in order to activate devices like motors.

In this project, the microcontroller is written in Embedded C programming language and the code is downloaded onto the chip through the aid of a supporting programmer. Once configured, the AT89S52 continuously senses the signal of the rain sensor. When it detects rain, the microcontroller gives a control signal to the motor driving circuit, which powers up the wiper motor. The system also includes a small time delay to stop the motor once the rain has ceased, offering smooth and responsive action.

This technique has been already tested before in previous studies. For example, Okafor and Muoghalu (2019) used the AT89S52 in their rain-sensing safety system to show its effectiveness in using it in environmental monitoring. Another project working on the same topic by Das et al. (2021) also used the same AT89C51 microcontroller for a smart wiper system, to reiterate that 8051-family chips are ideal for real-time, low-cost automation application of automobiles.



AT89S52 8-bit Microcontroller AT89S52 Microcontroller Pinout

4.2 Rain water Sensor:

The rainwater sensor is our main sensor to detect rain in our system. It has a simple but strong mechanism: a flat sensor plate, usually a small PCB with bare copper tracks exposed on one side, and a comparator circuit. The instant the rain drops fall onto the plate, they provide a path for conductivity between the copper lines. This change in conductivity is picked up by the comparator and is converted to a digital signal which is easily interpreted by the microcontroller.

the sensor gives a LOW output (0V) during rain and HIGH (5V) when dry. The microcontroller interprets this signal in real time. Upon detecting rain (i.e., the signal becomes LOW), the controller activates the motor and initiates the wiper operation. When it rains stops and the signal again returns to HIGH, the system waits for an instant before it halts the wiper to ensure a smooth operation.

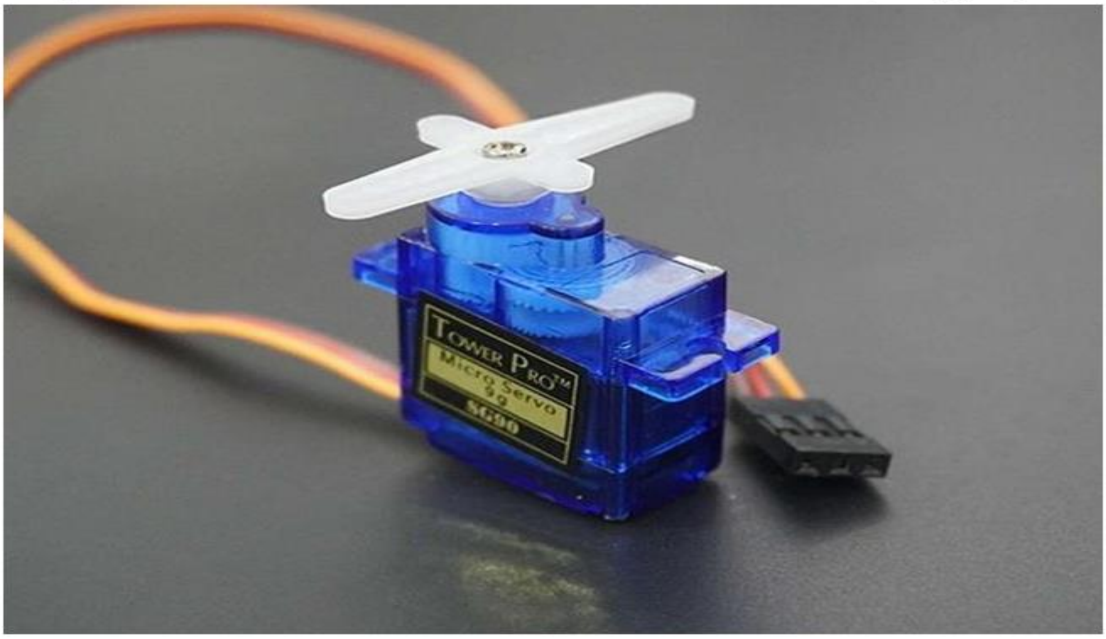
These sensors are widely utilized in rain detection projects due to their simplicity and reliability. For example, Yogesh et al. (2021) developed a similar system where a rain sensor was interfaced with an Arduino to detect rain and automate actions, demonstrating how easy water-sensing technology can be used effectively in real-world automation applications.

4.3 Servo Motor (SG90)

In this, a servo motor (SG90) is used instead of a regular DC motor to achieve the fine control over the movement of the wiper blade. Servo motors are ideal for applications requiring fine angular positioning, and thus they are an excellent option to replicate the to-and-fro motion of windshield wipers.

The SG90 servo operates using Pulse Width Modulation (PWM). That is, the motor responds to the pulse width it gets: the longer or shorter the pulse, the more or less the motor rotates, typically between 0° and 180°. The microcontroller generates these PWM signals, telling the servo motor exactly how far to rotate. In our setup, if the rain sensor is activated due to moisture, the microcontroller sends commands for the servo motor to rotate through pre-set angles—like 45° to 135°—to replicate the natural motion of car wiper movement. This provides a smooth, self-contained wiping action without the intervention of humans.

This design is validated in prior work, for instance, by Das et al. (2021), who demonstrated a similar system utilizing PWM-controlled servo motors for autonomous wipers, confirming its effectiveness and reliability in such embedded systems.



5. Circuit Simulation & PCB designing:

To ensure that the "Automatic Car Wiper Using Microcontroller AT89S52" project functioned correctly; we first conducted a circuit simulation followed by PCB design which is two steps, this made it possible to confirm the system functionality prior to any hardware implementation, making sure that the components' layout was physically compelling and structured for maximum achievement and performance.

Using EasyEDA, we incorporated more components such as a web-based schematic and PCB software which also includes a simulator for circuits (Patel & Kumar 2019). The objective was to analyze the servo motor control along with the different results that would be obtained by sensing rain. There were some basic components that were selected, AT89S52 microcontroller together with the rain sensor, servo motor, voltage regulator and of course, LEDs and many more required unto EasyEDA's component library during simulation (Sharma, Kumar, & Desai 2020).

In order to represent rain as an input to the microcontroller, a rain sensor was simulated as a switch (Venkatesh & Rao 2020). The microcontroller was instructed to translate the output of the rain sensor into PWM pulses that would simulate wiper motion. In light of the fact that this was a prototype, we added LEDs that would enable the user to imitate the action during shower rain.

The simulation effectively proved that, the moment the rain sensor picked up on water (closed switch), the servo motor rotated between specified angles (e.g., 45° and 135°) to simulate the standard wiping pattern. The LEDs turned on and off to represent the status of the system, providing immediate feedback about circuit behavior. This phase was crucial in identifying any bugs before moving on to the hardware level, hence reducing the probability of bugs or faults when implementing the system practically.

Once the simulation validated the circuit's performance, we moved on to PCB design using the schematic that we had established. At this point, the EasyEDA tool was again employed to automatically convert the schematic to a PCB layout (Shukla & Joshi, 2021). The focus here was on precision and continuity among components. The AT89S52 microcontroller was kept in the center of the board, and the rain sensor and servo motor connectors were at the sides for easy wiring during assembly. The LEDs were also positioned at the side of the PCB so that they would be easily seen when the PCB is being used.

In making the PCB design, we used EasyEDA's auto-router to create a draft design, then manually adjusted. We minimized track paths, eliminated overlaps, and made clean, tidy connections. Extra special care was exercised when routing power supply traces, particularly traces to servo motor lines, so they were able to carry the current needed with minimal voltage drops. The 7805 voltage regulator IC was placed near the power input to reduce noise and give stable voltage. Bypass capacitors were incorporated to further stabilize the power supply (Sharma et al., 2020).

A ground plane was included in the PCB layout so that electrical noise would be reduced, stabilizing the circuit. After the layout was finished, we ran a Design Rule Check (DRC) so that we could verify there were no clearance or connectivity issues. After that passed, we generated Gerber files, which are industry-standard files required to fabricate a PCB.

By utilizing this systematic approach—starting with simulation and followed by PCB design—we ensured that the automatic car wiper system would be more efficient, smaller in size, and professionally designed. The process not only ensured the system would function correctly but also made it easier to replicate or upscale the project into a product prototype at the field level.

Figure 6.1 Schematic of the prototype

Figure 6.2 PCB Layout

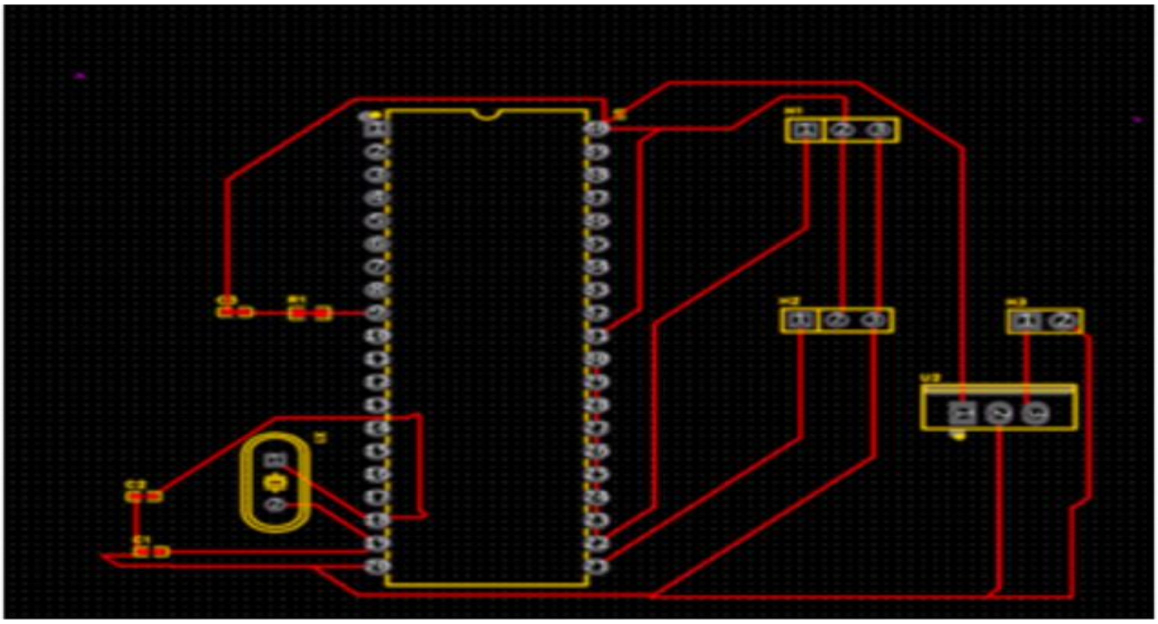
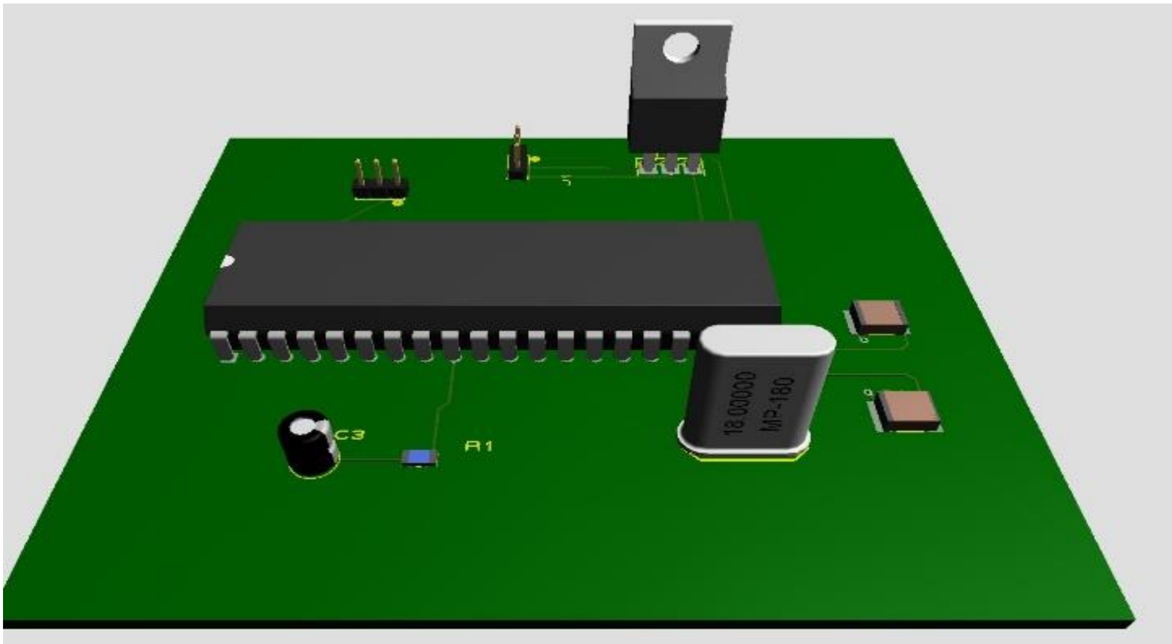


Figure 6.3 3D visualizer

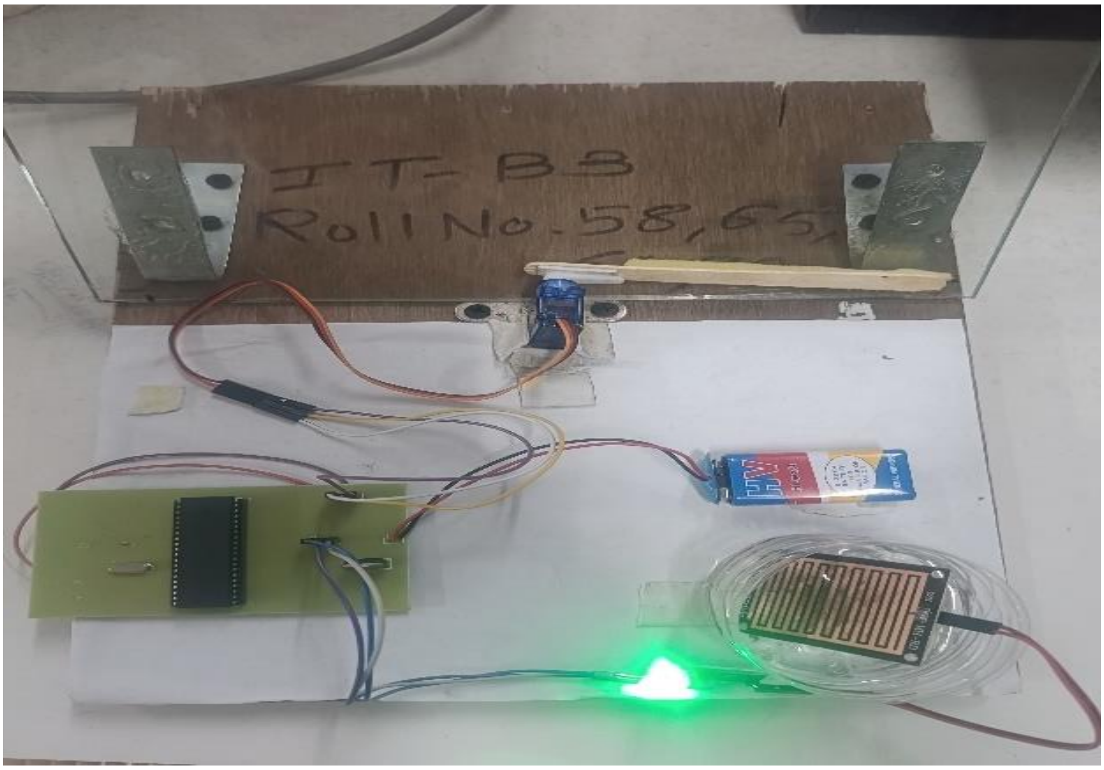


6. Results and Conclusions:

The experiment confirmed that the AT89S52-driven auto car wiper system performed as intended. The rain sensor effectively detected moisture, and the microcontroller responded by sensing and activating the servo motor to simulate a wiper's sweeping action. The system operated independently without the need for human intervention, proving that embedded solutions of this nature are capable of delivering under real-world environmental conditions.(Ahmed et al., 2020)

The wiper system responded promptly to rainfall variations, turning on the moment rain was sensed and shutting down when the sensor was no longer able to sense moisture. This confirmed the ability of the microcontroller to process real-time inputs and control external devices like the servo motor using PWM

signals.(Alkhazraji et al., 2021)
In summary, the project demonstrates how an inexpensive microcontroller-based solution can enhance driver convenience and safety. With scope for future extension such as rain intensity-based speed control or manual override, this design forms a useful automotive automation platform in educational and industrial applications. (Ramesh et al., 2020)



7. Future Scope:

The "Automatic Car Wiper Using Microcontroller AT89S52" project is a wonderful starting point to utilize, and the project provides an incredible head-start on which even more things can be built further and improved further. The current system successfully achieves rain sensing and auto wiping, but in several directions, it can evolve for serving modern motor vehicles and supporting future automotive automation needs.
One of these exciting fields for development would be the integration of adaptive wiper speed control. Under this facility, the wiper speed may be made variable with rain intensity. It may be achieved by mounting a more sophisticated rain sensor that is capable of detecting various levels of rain intensity. According to research, such dynamic systems wherein wipers are regulated according to evolving situations have the capability to greatly enhance the user experience (iarjset.com).
In addition, the integration of IoT (Internet of Things) platforms with the system would revolutionize the way the car interacts with the environment. For instance, it would allow the owner to monitor and control the wiper system remotely using a smartphone. This could further be extended to real-time weather updates, maintenance alerts, and even predictive behavioral adjustment. These IoT deployments are already in place in automobile companies, enhancing the overall user experience (researchgate.net).
The project would also be improved by switching to a more powerful microcontroller, such as Arduino or STM32. The microcontrollers would offer more processing power, better PWM management, and better

wireless communication capabilities. Such modifications would make the design more straightforward and enable connectivity with other intelligent car technologies, rendering the system more sophisticated (jetir.org).
Mechanically, replacement of the current servo motor with a more powerful motor coupled with an actual wiper linkage mechanism would move the system to industry standards for real-world automotive use. This would also equate to the upgrading of the system's durability by waterproofing the parts and subjecting them to harsh outdoor conditions. Moreover, the addition of an automatic headlight on feature would be an upgrade to the wiper system, contributing to safety and comfort during bad weather (iarjset.com).
In conclusion, the future potential of this project is vast and highly promising. With adequate upgrading and innovation, this basic system can be upgraded to a sophisticated vehicle automation system that enhances safety and comfort for drivers. The system's modular design also renders it highly flexible, with potential for small and medium-sized enterprises (SMEs) to manufacture it at a competitive cost. The project can be a top contender in the emerging automobile electronics market, driving innovation in automotive automation and intelligent technology.

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