



Automatic Window and Curtain Controller

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ABSTRACT

The Automatic Window and Curtain Controller is a smart home automation system that operates a window and a curtain according to sunlight intensity, rainfall and room temperature. An Arduino Uno receives the signals of an LDR sensor, a rain sensor and a temperature sensor and drives two separate DC geared motors through an L298N motor driver, one for the window and one for the curtain. When rainfall is detected, the window is closed automatically and a buzzer is sounded to prevent rainwater from entering the room. When the room temperature rises above a predefined limit the window is opened for natural ventilation, and it is closed again when the temperature falls back to the lower limit. The curtain is closed under strong sunlight and opened under low light according to the LDR reading. A 16x2 LCD displays the temperature, light level and the window and curtain status in real time. The prototype reduces manual operation, improves indoor comfort, protects the room from rain and offers a low-cost and energy-efficient smart home solution.

Keywords: Smart home automation; automatic window; automatic curtain; Arduino Uno; LDR sensor; rain sensor; temperature sensor

1. Introduction

Smart home automation has become an important technology for improving comfort, convenience, safety and energy efficiency in residential and office environments. Conventional windows and curtains are operated manually, which is inconvenient when environmental conditions change frequently. A window may have to be closed immediately during rainfall, and a curtain may have to be adjusted when sunlight becomes too strong. Manual operation can also allow unnecessary heat to enter the room and increase the dependence on artificial lighting and cooling systems.

This paper presents an Automatic Window and Curtain Controller that operates a window and a curtain according to the surrounding environmental conditions. An Arduino Uno is used as the main control unit. An LDR sensor detects the intensity of sunlight, a rain sensor identifies rainfall and a temperature sensor measures the indoor temperature. Based on these readings, the Arduino Uno controls two separate DC motors connected to the window and curtain mechanisms, and a 16x2 LCD shows the temperature, light level and the operating status of the window and curtain. The main objectives of the work are:

- To monitor sunlight intensity, rainfall and room temperature continuously and automatically;
- To close the window automatically during rainfall and to open or close it according to the room temperature for natural ventilation;
- To open or close the curtain according to the sunlight level detected by the ldr sensor; and
- To reduce manual effort, improve indoor comfort and support efficient use of natural light and ventilation at low cost.

The system is intended for homes, offices and other indoor spaces, and it can later be extended with IoT connectivity, mobile monitoring, additional environmental sensors and intelligent decision-making features.

2. Literature survey

Several researchers have developed automatic curtain systems based on light sensing. Meirita et al. [1] designed an Arduino Uno and LDR based automatic curtain prototype that opens and closes the curtain according to the surrounding light intensity, and Nusyirwan et al. [5] used a similar Arduino Uno and LDR arrangement with a servo mechanism to regulate the sunlight entering a room. Saha [7] presented an LDR-based curtain opener in which a DC motor folds or unfolds the curtain, and Putra [6] combined an LDR, a real-time clock and Bluetooth so that the curtain could be operated by sensor, by time or manually. Syafa'at and Bherlinda [9] used LDR and IR sensors for automatic curtain control, and Kapitány [8] described the mechanical construction, electrical circuit and motor selection of an automatic curtain moving system. Kindangen et al. [2] tested an automatic curtain at 1:1 scale in a humid tropical climate to control direct sunlight and solar heat gain.

Work on windows has concentrated on thermal comfort and brightness control. Gunasegran et al. [3] proposed an IoT-based smart window and temperature control system in which a wireless sensor network supplies real-time temperature data to a motorised window controlled through an Arduino board and a Node-RED interface. Kazi et al. [4] developed an IoT-enabled smart window to control indoor brightness and heat transfer. Material-based smart windows, such as thermochromic perovskite and hydrogel windows [10], [11], and other recent smart-window and control-strategy studies [12]-[15], regulate solar radiation and indoor temperature to save energy.

A common observation is that most of the reported low-cost systems control either the curtain from a light sensor or the window from temperature, while material-based smart windows need special glazing. The present work combines light, rain and temperature sensing in a single Arduino Uno based controller that operates the window and the curtain independently with separate DC motors and provides a local display of the status.

3. System analysis

3.1 Existing system

In the existing practice, windows and curtains are operated manually according to the user's requirement and the surrounding conditions. The user has to open or close the window and adjust the curtain according to sunlight, rainfall and indoor temperature, which requires continuous human attention and may not give an immediate response when the weather changes. Some automated systems use individual sensors, such as LDR sensors for curtains, temperature sensors for ventilation or rain sensors for closing windows, but they usually address a single environmental parameter and do not provide integrated control of both the window and the curtain.

3.2 Limitations of the existing system

Windows and curtains require manual opening and closing, which increases the user effort.

Conventional systems cannot close the window automatically when rainfall occurs.

Curtains do not adjust automatically to the changing sunlight intensity.

Basic systems do not monitor the room temperature continuously for ventilation control.

Manual operation cannot respond quickly to sudden changes in weather or environmental conditions.

Improper control of sunlight and ventilation increases the need for artificial lighting and cooling.

Users have to check and adjust the window and curtain positions regularly.

4. Proposed system

4.1 System overview

The proposed system is an Automatic Window and Curtain Controller that operates a window and a curtain according to changing environmental conditions. An Arduino Uno acts as the main control unit and reads an LDR sensor, a rain sensor and a temperature sensor, which monitor the sunlight intensity, rainfall and room temperature respectively. Based on predefined light conditions, the controller drives the curtain motor to regulate the amount of sunlight entering the room. When rain is detected, the controller activates the window motor to close the window and sounds a buzzer. When the temperature reaches the predefined level, the window is opened for natural ventilation. Two DC geared motors driven through an L298N motor driver are used for the window and the curtain, so that they can be controlled independently, and a 16x2 LCD displays the sensor values and the window and curtain status.

4.2 Advantages of the proposed system

Automatic operation of the window and curtain without continuous manual effort.

Rain protection: the window is closed automatically when rainfall is detected.

Automatic sunlight control: the curtain is adjusted according to the LDR reading.

Temperature-based ventilation through automatic opening and closing of the window.

Improved indoor comfort and better use of natural light and ventilation, which can reduce the use of artificial lighting and cooling.

Real-time monitoring of temperature, light level and window and curtain status on the LCD.

Independent control of the window and the curtain through separate DC motors.

4.3 Block diagram

The block diagram of the proposed system is shown in Fig. 1. The LDR sensor, temperature sensor and rain sensor, together with the power supply, are connected to the inputs of the Arduino Uno. The outputs of the Arduino Uno drive the LCD display, the two DC motors of the window and curtain and the buzzer.

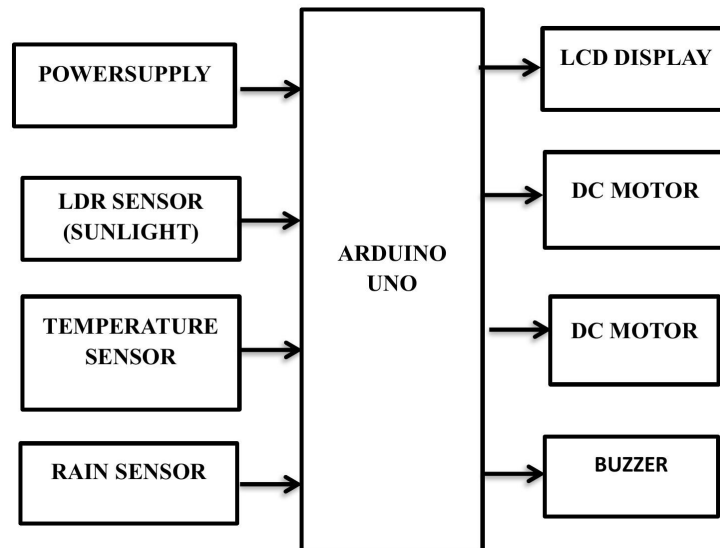
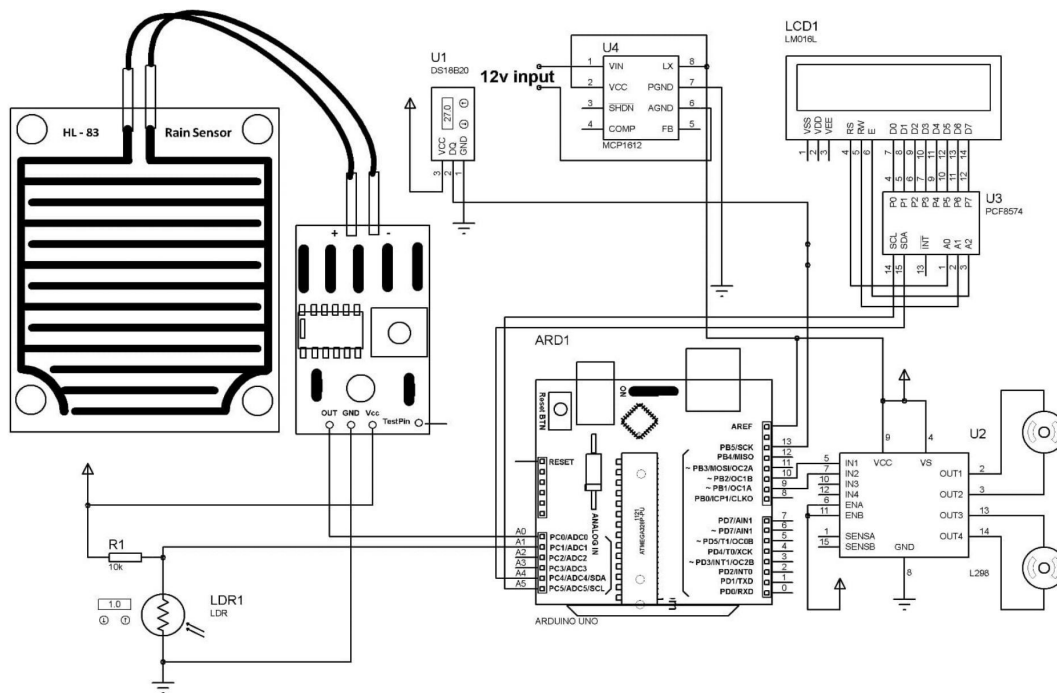


Fig. 1 - Block diagram of the Automatic Window and Curtain Controller.

4.4 Circuit diagram

The circuit diagram is shown in Fig. 2. The rain sensor module, the LDR with a 10 kΩ resistor forming a voltage divider and the temperature sensor are connected to the analog inputs A0 to A2 of the Arduino Uno. A 12 V supply is used for the motor-driver stage, and a regulated 5 V rail supplies the sensors and logic. The window motor is driven through the ENA, IN1 and IN2 inputs of the L298 dual H-bridge driver (digital pins 5, 6 and 7) and the curtain motor through ENB, IN3 and IN4 (pins 9, 10 and 11). The buzzer is connected to pin 12, and the 16x2 LCD is connected through an I²C expander so that only the two I²C lines (SDA and SCL) are required.



4.5 Working principle

The Arduino Uno reads the LDR, temperature and rain sensors continuously and compares the readings with the predefined thresholds. Rain has the highest priority. When the rain sensor value falls below the rain threshold, rainfall is declared, the buzzer is turned on and, if the window is open, the window motor is run in the closing direction. While rain is present, the temperature-based opening of the window is disabled so that rainwater cannot enter the room.

When there is no rain, the buzzer is turned off and the window is controlled by the room temperature. If the temperature is equal to or above the upper limit and the window is closed, the window motor is run in the opening direction to improve ventilation. When the temperature falls to the lower limit or below and the window is open, the window is closed again. The gap between the two limits prevents the window from opening and closing repeatedly around a single value.

The curtain is controlled independently by the LDR reading. When the light level is equal to or above the upper light threshold, which indicates strong sunlight, the curtain is closed if it is open. When the light level is equal to or below the lower light threshold, the curtain is opened if it is closed. Each motor is run at a fixed PWM speed for a fixed time and is then stopped, and the controller keeps the present position of the window and curtain so that a new command is not given while a motor is still moving. The LCD is refreshed every second and shows the temperature, the LDR value and the window and curtain status, and it shows a rain message when rainfall is detected.

5. Experimental setup

5.1 Prototype implementation

The hardware prototype is shown in Fig. 3. The Arduino Uno controller, the LCD, the sensor modules and the motor driver are assembled on a wooden base board that is fixed beside a model window frame with a curtain. Two DC geared motors are used, one to move the window and the other to move the curtain, and the sensors are connected to the controller with wires.

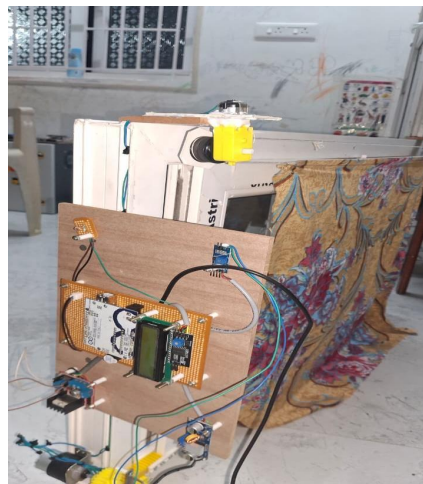


Fig. 3 - Hardware prototype of the system.

5.2 Control parameters

The threshold values used in the prototype are listed in Table 1. The LDR and the rain sensor readings are the 10-bit analog values (0 to 1023) of the Arduino Uno, the motors are driven at 200 out of 255 PWM and each motor is run for 1500 ms for one opening or closing action.

Table 1 - Control parameters used in the prototype.

Parameter	Symbol in code	Value	Action
Upper temperature limit	TEMP_HIGH	30 °C	Window opens
Lower temperature limit	TEMP_LOW	27 °C	Window closes
Upper light threshold	LIGHT_HIGH	700 counts	Curtain closes
Lower light threshold	LIGHT_LOW	400 counts	Curtain opens
Rain threshold	RAIN_THRESHOLD	500 counts	Rain declared below this value; window closes and buzzer on

Parameter	Symbol in code	Value	Action
Motor speed	MOTOR_SPEED	200/255	PWM applied to ENA and ENB
Motor run time	MOTOR_TIME	1500 ms	Fixed time for one open or close action

6. Results and discussion

The Automatic Window and Curtain Controller was assembled and tested with the Arduino Uno, LDR sensor, rain sensor, temperature sensor, DC motors and LCD (Fig. 3). The LDR sensor detected the change in sunlight intensity, and when the light level crossed the predefined thresholds the curtain motor changed the curtain position accordingly. The rain sensor detected rainfall, and the Arduino Uno then moved the window to the closed position and sounded the buzzer, which helps to prevent rainwater from entering the room. The temperature sensor monitored the room temperature continuously, and when the temperature exceeded the predefined limit the window position was changed to support natural ventilation. The separate DC motors gave independent control of the window and curtain, and the LCD displayed the temperature, light level, rain status and the window and curtain status in real time. The response of the system to the different conditions is summarised in Table 2.

Table 2 - Response of the system to different environmental conditions.

Condition	Sensor input	Controller action	LCD / indication
Rainfall	Rain value below 500 counts	Window closes if open; buzzer on	Message RAIN W:CLOSE
High temperature (no rain)	Temperature at or above 30 °C	Window opens if closed	Window status OPEN
Temperature back to normal	Temperature at or below 27 °C	Window closes if open	Window status CLOSE
Strong sunlight	LDR value at or above 700	Curtain closes if open	Curtain status CLOSE
Low light	LDR value at or below 400	Curtain opens if closed	Curtain status OPEN

The results show that the proposed system can provide automatic environmental-based control, reduce manual effort, improve indoor comfort and give protection against rainfall. Since the motors are run for a fixed time and the position is tracked in the controller, limit or position sensors would make the position feedback more reliable, and a detailed quantitative study of the response time and the temperature and light thresholds under different weather conditions is still required.

7. Conclusion

The Automatic Window and Curtain Controller has been designed and implemented to provide automatic control of a window and a curtain according to environmental conditions. The Arduino Uno processes the inputs of the LDR sensor, rain sensor and temperature sensor and controls separate DC motors for the window and the curtain. The LDR sensor enables automatic curtain adjustment according to sunlight intensity, the rain sensor allows the window to close automatically during rainfall and the temperature sensor supports automatic window adjustment for natural ventilation. The LCD gives real-time information on the temperature, sunlight, rainfall and the operating status of the system. The system reduces manual effort, improves indoor comfort, protects the room from changing weather conditions and supports efficient use of natural lighting and ventilation. The project demonstrates a simple, low-cost and practical approach to smart home automation that can be enhanced with advanced sensing, IoT connectivity and intelligent control techniques.

8. Future scope

The system can be extended into a complete smart-home solution. IoT connectivity through an ESP8266 or ESP32 module can allow remote monitoring and control, and a mobile application can show the temperature, rainfall, sunlight and system status. Weather forecast integration can enable predictive adjustment before adverse conditions, and humidity sensors can improve the ventilation control. Voice assistant support and solar-powered operation can add convenience and energy efficiency, while artificial intelligence can learn user preferences and optimise natural light and airflow. Obstacle detection and position sensors can improve safety, the system can be expanded to manage several windows from a centralised controller, and it can be integrated with lights, fans, air conditioners and security systems.

References

- [1] C. Meirita, Syahril, and Azizahwati, "Automatic Curtain Prototype Design Based on Arduino Uno," 2024.

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- [2] J. I. Kindangen, L. M. Rompas, and J. C. Mandey, "An Automatic Curtain System for Indoor Daylight Control," 2024.
- [3] S. Gunasegran, R. Abdulla, T. Vinesh, L. N. Shyan, N. Chandrasekharan, M. R. Ehsan, A. Bathich, and C. Y. Lau, "IoT-Based Smart Window and Temperature Control System for Optimized Thermal Comfort," 2024.
- [4] A. S. Kazi, N. R. Shinde, S. S. Mujumdar, T. G. Kulkarni, and P. R. Potdar, "IoT enabled smart window for controlling brightness: A perspective of heat transfer rate," *International Journal of Industrial and Systems Engineering*, vol. 44, no. 2, pp. 220–257, 2023.
- [5] D. Nusyirwan, D. N. Hasi, and P. P. P. Perwira, "Automatic Curtain Prototype Using LDR Sensor and Arduino Uno," 2020.
- [6] A. Putra, "Automatic Curtain Control Using Light Dependent Resistor and Real-Time Clock," 2020.
- [7] G. Saha, "Automatic Curtain Operation Using LDR," 2021.
- [8] P. Kapitány, "Design and Build Prototype of Automatic Curtain Moving System," 2022.
- [9] M. D. M. Syafa'at and Y. Bherlinda, "Automatic Curtain Design With LDR And IR Sensors at The BAPPENDA Kebumen," *Jurnal E-KOMTEK*, vol. 5, no. 1, pp. 55–64, Jun. 2021.
- [10] Liu et al., "Near-Infrared-Activated Thermochromic Perovskite Smart Windows," 2022.
- [11] G. Chen et al., "Printable Thermochromic Hydrogel-Based Smart Window for All-Weather Building Temperature Regulation in Diverse Climates," 2023.
- [12] Y. You, X. Deng, X. Yang, R. Yang, W. Liu, F. Shi, and X. Hong, "Performance analysis of an all-climate thermotropic smart window for enhancing energy saving and daylighting comfort," *Energy and Buildings*, vol. 347, p. 116432, Nov. 2025.
- [13] H. J. Jo, Y. J. Jang, H.-D. Kim, et al., "Glare-Free, Energy-Efficient Smart Windows: A Pedestrian-Friendly System with Dynamically Tunable Light and Heat Regulation," *ACS Energy Letters*, vol. 10, no. 6, pp. 2997–3004, Jun. 2025.
- [14] M. Krarti, "Energy performance of control strategies for smart glazed windows applied to office buildings," *Journal of Building Engineering*, vol. 45, p. 103462, Jan. 2022.
- [15] W. Yu, Y. Zhou, Z. Li, D. Zhu, L. Wang, Q. Lei, C. Wu, H. Xie, and Y. Li, "When thermochromic material meets shape memory alloy: A new smart window integrating thermal storage, temperature regulation, and ventilation," *Applied Energy*, vol. 372, 2024.