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Construction of Light-Activated Alarm System for Atmospheric Monitoring

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The work aims to create a dependable, effective, and affordable alarm solution that makes use of the characteristics of light-dependent resistors (LDRs). The specific objectives are to design and construct an alarm system that responds to changes in light levels, provide a cost-effective and reliable monitoring solution for various atmospheric applications, and test the device for optimal utilization. The construction process involved assembling electronic components on a breadboard or Vero board. The system's voltage source was a 9-volt battery, and the key components included resistors, capacitors, a transistor, an LDR (Light Dependent Resistor), and a buzzer. LDR was used as the primary sensor to detect changes in light levels, triggering the alarm when the light level fell below a predetermined threshold. The system was tested to ensure its effectiveness and reliability. Different light conditions and intensities are simulated to check if the alarm triggers appropriately. In troubleshooting the constructed light-activated alarm, related to the power source, connections, sensor positioning, interference, or alarm settings to ensure the alarm functions reliably and accurately were identified and resolved. Considering availability, accessibility and affordability the design and constructed light-activated alarm system is a veritable tool that compliments monitoring atmospheric applications in equipment-scarce regions.

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1. INTRODUCTION

With technology constantly evolving at such a fast pace, there has been the development of various monitoring systems designed for numerous applications [1]. One such innovation is the light-activated alarm system; it has attracted a lot of attention recently due to its versatility as both a monitoring tool and automation device [2]. Light-activated alarm systems are a type of monitoring system that uses light sensors to detect changes in light levels, triggering an alarm when a threshold is crossed [3]. These types of alarms operate on principles relying on photo-resistors or Light Dependant Resistors (LDRs). These are electronic components widely known for modifying their resistance levels depending on how much exposure they receive from external sources like sunlight or artificial lighting fixtures [4]. The alarm system automatically gets triggered when there is a significant increase or decrease in certain things, like sunlight entering through windows or lights dimming in a room. This alert informs the user about possible monitoring breaches or other events [5].

The main benefit of light-activated alarm systems is their capacity to offer an affordable and energy-efficient solution for automation and monitoring needs [6]. These systems are simple to tailor to the unique requirements of the user and can be quickly integrated into the current monitoring architecture [7]. Since light-activated alarm systems rely on changes in light intensity rather than motion or sound, which might be triggered by non-threatening occurrences, they have the potential to reduce false alarms [8]. A light-activated alarm system has the potential to considerably advance the fields of automation and monitoring of atmospheric parameters.

The light-sensitive alarm is an electronic circuit that detects a sudden shadow falling on the light sensor and then sounds the bleeper. Photodiodes and photoresistors are commonly used as light sensors due to their sensitivity to light and ease of integration into electronic circuits [9]. The circuit responds to gradual changes in brightness to avoid false alarms. The beeper sounds for only a short time to prevent the battery from running flat. Normal light can be used. The circuit will work best if a beam of light is made to fall on the light sensor [10]. Breaking this beam will then cause the bleeper to sound. A light-dependent resistor (LDR) serves as the light sensor: it exhibits low resistance in bright light and high resistance in dim light. The 100 kiloOhms (kΩ) preset can be changed to change the circuit's sensitivity to light. By employing a 1 milliOhm (mΩ) preset, the length of the beep can be adjusted from 0.5 to 10 seconds. The 7555 low-power timer keeps the circuit's current draw very low, around 0.5 milliamps [11]. The only time it draws more current is during the brief period when the bleeper rings, which is 7 milliamps. If the circuit is continuously switched on, an alkaline 9V battery can last for approximately a month. Studies on existing light activator alarm systems have shown that the electronic device is a monitoring system that utilizes light sensors to detect changes in ambient light levels [12,13]. When a significant change in light is detected, such as someone entering a room and triggering the sensor, the alarm is activated.

There are scarcity of atmospheric monitoring devices in developing countries and efforts to improvise reliable systems have been encouraged [14,15]. Studies have been conducted to test the performance and reliability of light-activated alarm systems [3,13]. Their effectiveness has shown far-reaching applications [16,17]. This research aims to create a dependable, effective, and affordable monitoring solution that makes use of the characteristics of light-dependent resistors (LDRs) to detect changes in light intensity and activate an alarm system for atmospheric monitoring. The objectives are to (i) design a cost-effective light activator alarm system from locally accessed materials, (ii) construct an efficient light activator alarm from locally accessed materials, and (iii) test and troubleshoot the light activator alarm for optimal utilization.

2. MATERIALS AND METHODS

2.1 Design

The light-activated alarm is designed using commonly locally available electronic parts, as shown in the schematic diagram in Fig.1. The alarm is activated as soon as light falls on the phototransistor. The output alarm may be redesigned to activate an electrically operated switch (Relay or Triac). The light-activated alarm circuit uses a light-dependent resistor, and two power supplies (MAL12 LDR) photoresistors as a sensor [12]. The 14011 quadrangle (quad), two (2) input NOT-AND (NAND) gate is wired up to oscillate when the input to it goes high, that is, the bipolar junction transistor with DC gain 300 (BC557) transistor turns on after light is detected by the light dependent resistor. The oscillating output from the 14011 turns the BC547 ON and OFF making the buzzer sound. After the alarm has started and it is put back into dark conditions, the alarm will continue to sound for about 3 - 5 seconds. This is due to the 1uF capacitor and 4.7 Mega Ohms (4M7) resistor which keep the input to the 14011 high. This design has considered the difficulty in cost and accessing electronic components in less developed regions of the world where atmospheric monitoring equipment is scarce compared to the complex components of the available branded devices in the open markets.

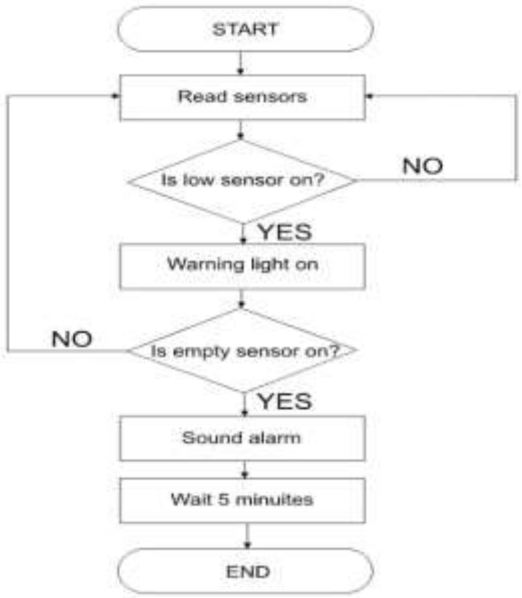


Fig. 1. Schematic diagram of the designed Light Activated Alarm system

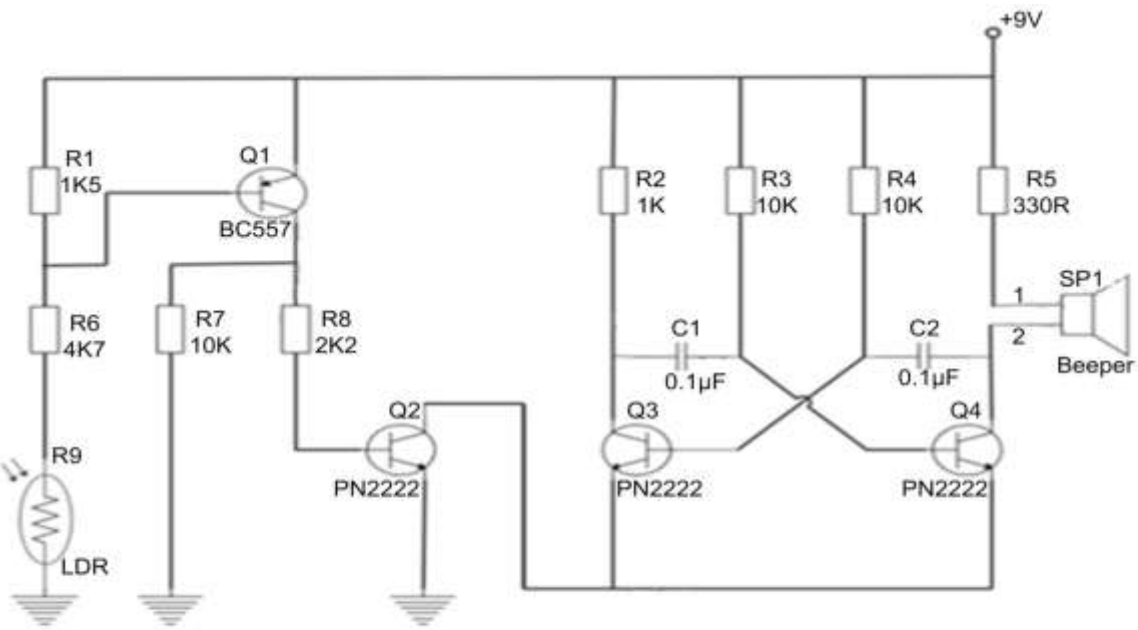


Fig. 2. Circuit diagram for the Light Activated Alarm system.

Table 1. Description of the acquired construction components

Qty	Item of Components	Designator	Notes	Function	Price (Naira, ₦)
3	10,000-Ohms resistors (brown-black-orange)	R3,R4,R7	1/4W, 5% or better	Resistor	50
1	4,700-Ohms resistor (yellow-violet-red)	R6			50
1	2200-Ohms resistor (red-red-red)	R8			50
1	1500-Ohms resistor (brown-green-red)	R1			50
1	1000-Ohms resistor (brown-black-red)	R2			50
1	330-Ohms resistor (orange-orange-brown)	R5			50
2	0.1microfarad (µF)	C1,C2	Electrolytic capacitors, 16V or more	Capacitor	100
3	PNP2222	Q2, Q3,Q4	NPN transistor	Semiconductor	100
1	BC557	Q1	PNP transistor		100
1	LDR	R9	Light dependent resistor	Transducer	200
1	Beeper (3 V-24 V)	SP1			300
1	9 V battery with clip	+9 V	9 V or better	Power source	300
Grand Total					2,500

2.2 Construction

The construction components were sourced within the local markets situated in Owerri city of Imo State Nigeria. Table 1 presents the list of our construction components, the quantity needed for the construction and their designator (the letters on the circuit diagram in Fig. 2). The choice of construction procedures is based on easy replication in regions where there may not be sophisticated devices for electronic couplings, though needing such imperative atmospheric monitoring devices. Using components easily accessible and simple construction techniques encourages local scientists to produce and calibrate this device for their peculiar atmospheric monitoring needs.

The following processes were taken during the construction:

STEP I: Put on electrical gloves for protection from shocks, burns and injuries. Then providing the basic tools and the electronic components listed in Table 1 required for the construction of the system.

STEP II: Setting up a well-lit and organized workspace with a workbench and also ensuring access to electrical outlets and any necessary safety equipment, such as safety goggles and a fire extinguisher.

STEP III: Followed the circuit diagram shown in Fig. 2 in assembling the components on a breadboard, and using the screwdriver and pliers to tighten and secure any screws and connectors.

STEP IV: Connected the light sensors to the appropriate pins of the microcontrollers and used wire conductors to make the necessary connections between the sensors and the board. Ensure the proper polarity and connections according to the sensor's specifications.

STEP V: Used wire cutters to ensure clean-cut desired wire lengths and stripping the end of the wires with wire strippers. Soldering the exposed wire ends to ensure better conductivity. The components were also connected by soldering the wires to their respective pins and terminals. Heat shrink tubing was used to insulate and protect the soldered connections by sliding the tubing over the connection and applying heat using a heat gun to shrink it tightly around the joint.

STEP VI: Connected the power source to the circuit and tested its functionality by verifying if the LED lights up, and checked if the sounds produced by the buzzer when the light activator is triggered.

Finally, used the multimeter to measure voltages and ensure values were within the appropriate ranges.

3. RESULTS AND DISCUSSION

3.1 Testing

The constructed light-activated alarm system in Fig. 3 provides a reliable and effective monitoring solution by utilizing light sensors, a control panel, and an alarm unit to detect and respond to unauthorized access or intrusion promptly and efficiently. Multi-meter was used to test the output of the power supply circuit and 9.95 V was obtained. The automatic buzzer of the light-activated alarm system is designed to detect changes in light conditions, activate an audible alarm, and sustain the alarm sound for a set duration. The response time of the constructed light alarm is measured to determine how quickly it detects the selected light source and initiates the alarm function. Fig. 3a shows the internal composition of the constructed light-activated alarm whereas Fig. 3b reveals the external feature of the light-activated alarm.

Table 2 shows the operational sequence of the automatic buzzer in the light-activated alarm system. It indicates that the buzzer only activates 'ON' when there is light on it. The light-activated alarm system is subjected to selected light sources to determine its response time to varying light sources. Table 3 shows the calibration of a constructed light-activated alarm system by adjusting the sensitivity of the device to light levels to accurately trigger the alarm when the desired threshold is reached. This process involved testing the alarm in various lighting conditions and making adjustments to the sensitivity settings until the desired response was achieved. The calibration ensured that the alarm responds consistently and effectively to changes in light levels, providing a reliable and accurate detection system. Table 4 reveals the response time of the selected light sources with the Sunlight being the fastest. The light-activated alarm system is a veritable tool that compliments monitoring atmospheric applications (such as sunshine hours, incident global solar radiation and visibility) in equipment-scarce regions.

Table 2. Sequence of the operation for the automatic buzzer

Main power	Power indicator	LDR	BUZZER
Off	Off	Darkness on it	Off
Off	Off	Light on it	Off
On	On	Darkness on it	Off
On	On	Light on it	On

Table 3. Calibration of the constructed light-activated alarm

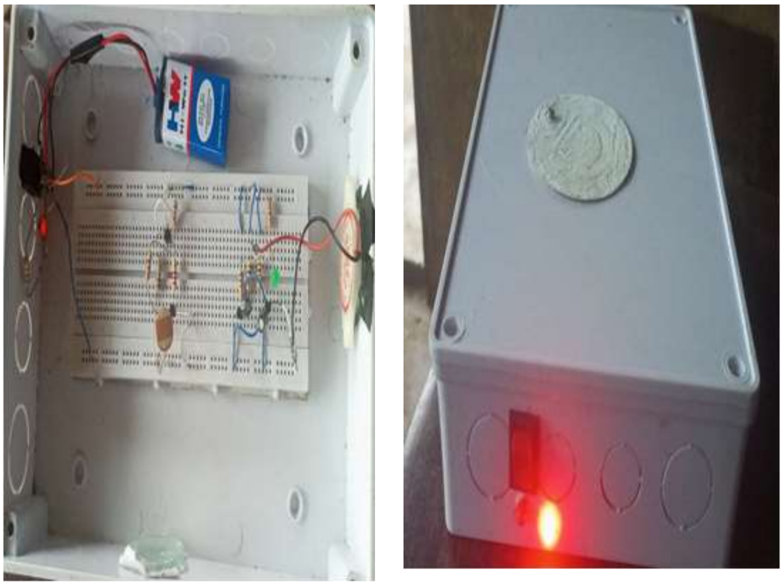
S/N	Light illuminance (Lux)	Resistance (Ω)	Buzzer
1	0	11900.90	OFF
2	100	1269.18	ON
3	200	630.04	ON
4	300	547.10	ON
5	400	411.87	ON
6	500	342.09	ON
7	600	292.52	ON
8	700	264.66	ON
9	800	230.77	ON
10	900	212.04	ON
11	1000	190.30	ON

Table 4. Response time of the constructed light alarm to selected light sources

Source of Light	Time Taken for Alarm to buzz
Sunlight	0.22 millisecond
Light Emitting Diode (LED light)	0.60 millisecond
Infrared light	0.70 millisecond

Table 5. Troubleshooting of the constructed light alarm

S/N	Problem	Troubleshoot
1	Battery running down after 12hrs of usage during testing.	Purchased new batteries and had the previous one replaced.
2	The system triggers the alarm even when there was no actual light activation.	The system wiring connection was checked, the sensitivity settings was adjusted. The sensor was shielded from other light sources.
3	The alarm failed to activate even when exposed to the specified light intensity or in the presence of direct light.	The power supply, sensor connection and the sensitivity settings were checked. We also ensured that the light source is adequately reaching the sensor.
4	The alarm system activated intermittently and only under specific light conditions.	The connections were inspected and any damaged components were replaced and the system was recalibrated where necessary.
5	The system triggered the alarm too easily, even with minimal light exposure.	The sensitivity level was adjusted carefully to find the optimal setting and ensure that the sensor's readings are accurate.
6	The alarm system displayed a delayed activation time after the light stimulus.	We verified that the sensor is working correctly and also checked for any delays in the system's components.



(a) (b)

Fig. 3. The constructed light-activated alarm system indicating (a) the internal composition of the constructed light-activated alarm and (b) the external feature of the light-activated alarm

3.2 Troubleshooting

Troubleshooting of the constructed light-activated alarm system involved identifying and resolving any issues related to power, connections, sensor positioning, interference, or alarm settings to ensure the alarm functions reliably and accurately. The descriptions of the troubleshooting are outlined in Table 5.

4. CONCLUSION

The primary objective of this work was to design construct and test a light-activated alarm system that responds to changes in light levels, providing a cost-effective and reliable monitoring solution for various atmospheric applications. The construction process involved assembling electronic components on a breadboard or Vero board. The system's voltage source was a 9-volt battery, and the key components included resistors, capacitors, a transistor, a Light Dependent Resistor (LDR), and a buzzer. LDR was used as the primary sensor to detect changes in light levels, triggering the alarm when the light level fell below a predetermined threshold. After the construction, the system was tested to ensure its effectiveness and reliability. Different light conditions and intensities are simulated to check if the alarm triggers appropriately. Considering the availability, accessibility and affordability of the system components in equipment-scarce regions, the construction techniques and procedures have presented and easily available and affordable atmospheric monitoring device adequate for local needs. The light-activated alarm system has shown to be a veritable tool that compliments monitoring atmospheric applications in equipment-scarce regions.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Ullo SL, Sinha GR. Advances in smart environment monitoring systems using IoT and sensors. Sensors. 2020;20(11):3113.
2. Smith A, Johnson B. Advances in monitoring systems: The rise of light activated alarms. Monitoring Technology Review. 2020;3:34-42.
3. Oyediran OF, Oyeyinka OA. Design and construction of a light-activated alarm system. International Journal of Scientific & Engineering Research. 2015;6(5):1041-1046.
4. Doe J, Brown R. Light-dependent resistors: Principles and applications in monitoring systems. Electronics Today. 2019;34(6): 23-29.
5. Patel R, Kumar S. Design and implementation of a light activated alarm system for home monitoring. Journal of Electronic Systems. 2021;10(4):65-73.
6. Lee S, Kim J. Energy-efficient monitoring solutions: The role of light activated alarm systems. Journal of Green Technology. 2022;7(1):12-20.
7. Garcia M, Lopez J. Customizing light activated alarm systems for residential and commercial use. International Journal of Monitoring Systems. 2020;15(2):89-102.
8. Chen X, Wang Y. A review on light activated alarm systems for monitoring applications. Journal of Monitoring and Automation. 20211;2(3):45-58.
9. Elango A, Senthilkumar R. Design and implementation of a light-activated monitoring system. International Journal of Engineering and Technology. 2017;9(2): 102-107.
10. Ibrahim H, Mohammed AA, Aliyu IA. Design and Implementation of an Arduino Based Light Dependent Alarm System. Arid Zone Journal of Engineering, Technology and Environment. 2019;15(2): 259-67.
11. Marinho F, Carvalho CM, Apolinário FR, Paulucci L. Measuring light with light-dependent resistors: an easy approach for optics experiments. European Journal of Physics. 2019;40(3):035801.
12. Ahmad MB, Abdullahi AA, Muhammad AS, Saleh YB, Usman UB. The Various Types of sensors used in the Security Alarm system. International Journal of New Computer Architectures and their Applications (IJNCAA). 2019;9(2):50-59.
13. Jafari MJ, Pouyakian M, Hanifi SM. Reliability evaluation of fire alarm systems using dynamic Bayesian networks and fuzzy fault tree analysis. Journal of Loss Prevention in the Process Industries. 2020;67:104229.
14. Antai RE, Osuji LC, Obafemi AA, Onojake MC, Antai HR. Seasonal Investigation of Meteorological Variables Effects on Air Pollution in Eleme, Rivers State, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). 2020;14(4):23-30.
15. Abulude FO, Oluwafemi MO, Arifalo KM, Elisha JJ, Yusuf A. Real-time air quality index app: The use of eWeather HDF App for education in monitoring of pollutants and meteorological parameters in Nigeria. ASEAN Journal of Science and Engineering Education. 2022;2(2):157-162.
16. Kumar S, Sharma A. Light-activated alarm system for agricultural field protection. International Journal of Advanced Research in Computer Science and Software Engineering. 2016;6(6):1-5.

17. Zhang S, Zhang W, Deng T, Feng X, Ma F. Design and technical analysis of alarm device in electric power construction inspection system. InSecond International Conference on Applied Statistics, Computational Mathematics, and Software Engineering (ASCMSE 2023) 2023;12784: 541-545.

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