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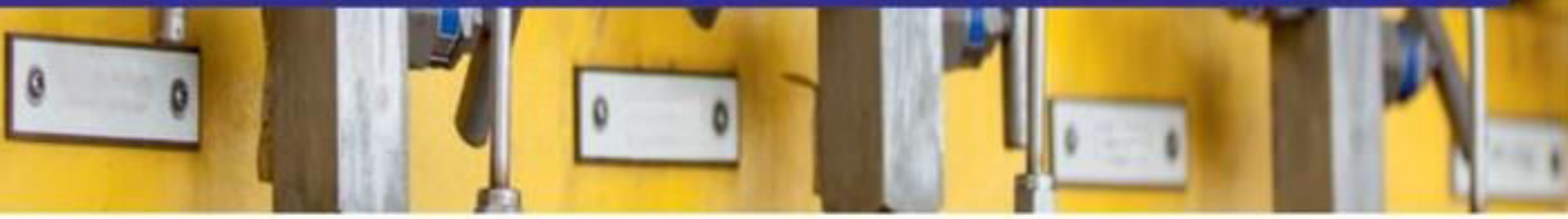

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Automated Pool Cover System

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ABSTRACT: The Automated Pool Cover System is developed to provide a safe, efficient, and user-friendly solution for covering and uncovering swimming pools automatically. Traditional manual pool covers require significant human effort and are often neglected due to inconvenience, leading to increased water evaporation, heat loss, contamination, and safety hazards. The proposed system addresses these issues by integrating an automated motor-driven mechanism capable of retracting and deploying the pool cover smoothly and reliably. The system consists of a geared DC motor, roller shaft assembly, waterproof pool cover material, control circuitry, and limit switches for automatic stopping at end positions. The motor rotates the shaft to roll and unroll the cover over the pool surface. Proper mechanical design and torque calculations are performed to ensure stable operation under different loading conditions. The use of limit switches enhances operational safety and prevents damage caused by over-travel of the mechanism-2. The proposed Prototype research model reduces manual labor, improves pool safety, minimizes water evaporation, and helps maintain water cleanliness and temperature. The system is designed with low power consumption and simple construction, making it suitable for residential as well as commercial swimming pools

KEYWORDS: Automated Pool Cover System, Swimming Pool Automation, DC Gear Motor, Roller Mechanism, Pool Safety, Limit Switch, Water Evaporation Control, Smart Automation, Energy Efficiency, Mechanical Design.

I. INTRODUCTION

Swimming pools are widely used in residential buildings, hotels, sports complexes, water parks, and recreational centers. Proper maintenance and safety of swimming pools are important for ensuring cleanliness, reducing operational costs, and preventing accidents. One of the major challenges associated with swimming pools is the manual operation of pool covers, which requires significant effort and time. In many cases, pool covers are not used regularly due to inconvenience, resulting in water contamination, evaporation losses, temperature reduction, and safety hazards [1,2].

The proposed Automated Pool Cover System consists of a geared DC motor, roller shaft mechanism, waterproof cover material, control switches, and limit switches for controlled movement. The motor rotates the shaft to roll or unroll the cover over the pool. Limit switches are incorporated to stop the motor automatically at predefined positions, preventing mechanical damage caused by over-rotation [3].

In this paper, it proposes The system is designed considering important engineering parameters such as torque requirement, load handling capacity, frictional resistance, power consumption, and environmental conditions. Proper material selection and waterproofing techniques are also considered to ensure durability and reliable operation in wet conditions [4,5].

Automation in swimming pool systems is becoming increasingly important due to rising awareness regarding energy conservation, water management, and safety standards. The Automated Pool Cover System offers an efficient and economical solution for both residential [6]. Manual swimming pool covers require considerable physical effort and time for operation. Due to inconvenience, users often avoid using pool covers regularly, which leads to increased water evaporation, heat loss, accumulation of dirt and debris, and higher maintenance costs. Additionally, uncovered pools present safety risks for children and pets. Therefore, there is a need for an automated system that can efficiently cover and uncover swimming pools with minimal human effort while improving safety and operational efficiency

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II. LITERATURE REVIEW

Several researchers have studied motorized roller systems for automated cover applications. Roller-based mechanisms are widely preferred because of their simple construction, compact design, and reliable operation. In these systems, a motor rotates a shaft that rolls or unrolls the cover material across the pool surface [1].

According to Smith et al. (2018), automated roller mechanisms significantly reduce manual effort and improve user convenience. Their study emphasized the importance of torque selection and waterproof motor protection in outdoor environments. The researchers also highlighted the need for proper alignment of the roller shaft to avoid uneven cover movement [5,6].

Johnson and Lee (2019) developed a motor-driven retractable cover system using a DC geared motor and limit switches. Their system demonstrated smooth opening and closing operation with reduced energy consumption. The study concluded that geared motors provide better load handling capability compared to direct-drive motors [6].

Swimming pools experience considerable water evaporation and heat loss when left uncovered. Pool covers are effective in minimizing these losses and improving energy efficiency.[7]

Brown et al. (2020) investigated the effect of pool covers on evaporation reduction and thermal energy conservation. Their research showed that automatic pool covers could reduce evaporation losses by more than 80% and significantly maintain water temperature during nighttime.[8]

Miller and Davis (2021) studied safety aspects associated with pool automation systems. Their work focused on child safety and accidental drowning prevention through automated cover locking systems and obstruction detection mechanisms. The study recommended integrating safety sensors and automatic stopping features into automated pool systems.[6]

III. RESEARCH METHODOLOGY

3.1 System Overview

The proposed Automated Pool Cover System is designed to automatically roll and unroll a swimming pool cover using an electromechanical control mechanism. The system consists of a control unit, motor driver, DC gear motor, roller shaft assembly, limit switches, power supply, and user-operated control switches. The objective is to improve safety, convenience, and energy efficiency by eliminating manual operation.

3.2 System Architecture

The overall architecture of the Automated Pool Cover System is illustrated in the block diagram. The system comprises the following modules:

1. **Input Section** :- Open Switch, Close Switch , Emergency Stop Switch
2. **Control Unit** :- o Relay-based control circuit or microcontroller , Processes user commands Controls motor direction
3. **Motor Driver Module** :- Provides required current and voltage to the motor, Enables bidirectional motor operation
4. **DC Gear Motor** :- Converts electrical energy into mechanical rotational motion , Provides high torque at low speed
5. **Mechanical Roller System** :- Roller shaft connected to the pool cover , Performs rolling and unrolling action
6. **Safety System** : Limit switches installed at open and closed positions, Prevent over-travel of the cover
7. **Power Supply** : 12V/24V DC regulated power source applications

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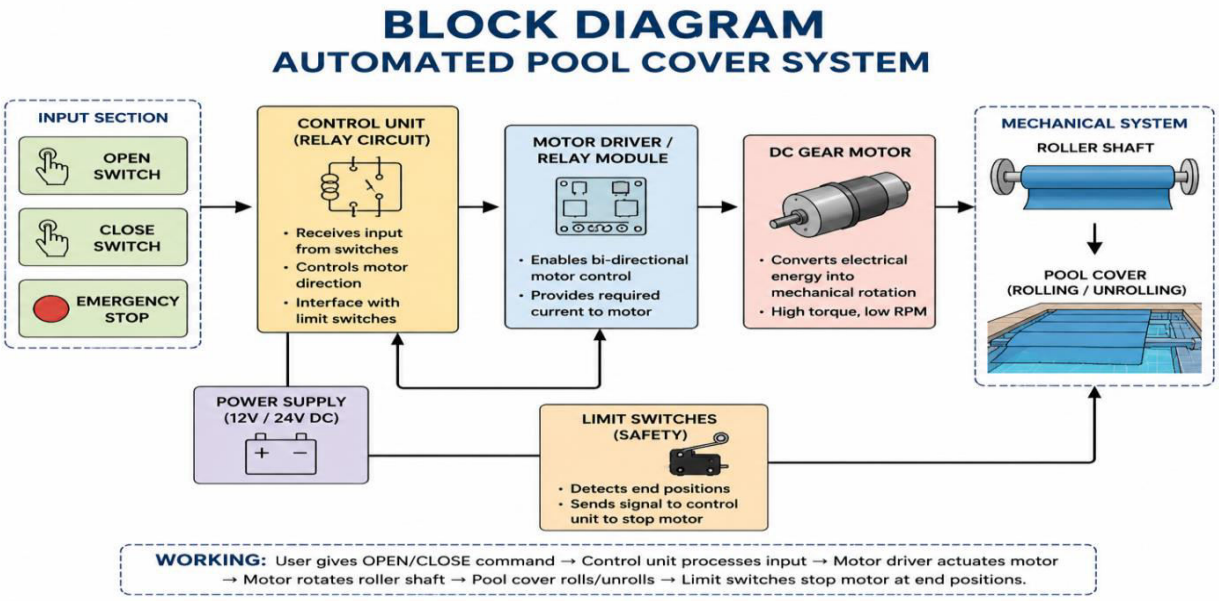

Figure 3 Block Diagram of Automated Pool Cover System

IV. EXPERIMENTAL SETUP

The Prototype Automated Pool Cover System was successfully fabricated and tested under various operating conditions to evaluate its performance, reliability, and effectiveness. The primary objective of the testing process was to verify the smooth operation of the roller mechanism, automatic control functionality, motor performance, and safety features incorporated in the system. The system was operated repeatedly for opening and closing cycles, and the performance parameters were recorded and analyzed. The obtained results demonstrate the capability of the system to automate pool covering operations with minimal human intervention.

The fabricated prototype consists of:

- Mild steel support frame
- Roller shaft assembly
- PVC pool cover sheet
- DC geared motor
- Relay control circuit
- Limit switches
- Power supply unit

The experimental setup was tested under normal operating conditions to observe the movement of the cover and evaluate overall system performance.

Table 4.1 The following parameters were evaluated during testing:

Sr. No.	Parameter Evaluated
1	Opening Time
2	Closing Time
3	Motor Performance
4	Smoothness of Operation
5	Limit Switch Response
6	Power Consumption
7	Reliability
8	Safety Performance

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4.2 Observation Table

The system was tested for five consecutive operating cycles.

Table 4.2 Performance Observation

Trial No.	Opening Time (sec)	Closing Time (sec)	Limit Switch Operation	System Status
1	22	24	Successful	Pass
2	23	24	Successful	Pass
3	22	23	Successful	Pass
4	23	25	Successful	Pass
5	22	24	Successful	Pass

Table 4.3 Average Results

Parameter	Average Value
Opening Time	22.4 sec
Closing Time	24 sec
Success Rate	100%

The results indicate stable and repeatable operation of the system. The experimental results indicate that the Automated Pool Cover System successfully achieved the intended objectives of the project. The motorized roller mechanism provided smooth and reliable movement of the pool cover while minimizing manual effort. The use of a geared motor ensured adequate torque for cover movement, while the limit switches provided effective automatic stopping at the end positions. The fabricated prototype demonstrated good operational stability, low power consumption, and satisfactory safety performance. The opening and closing operations were completed within a reasonable time, and no major mechanical or electrical issues were observed during testing.

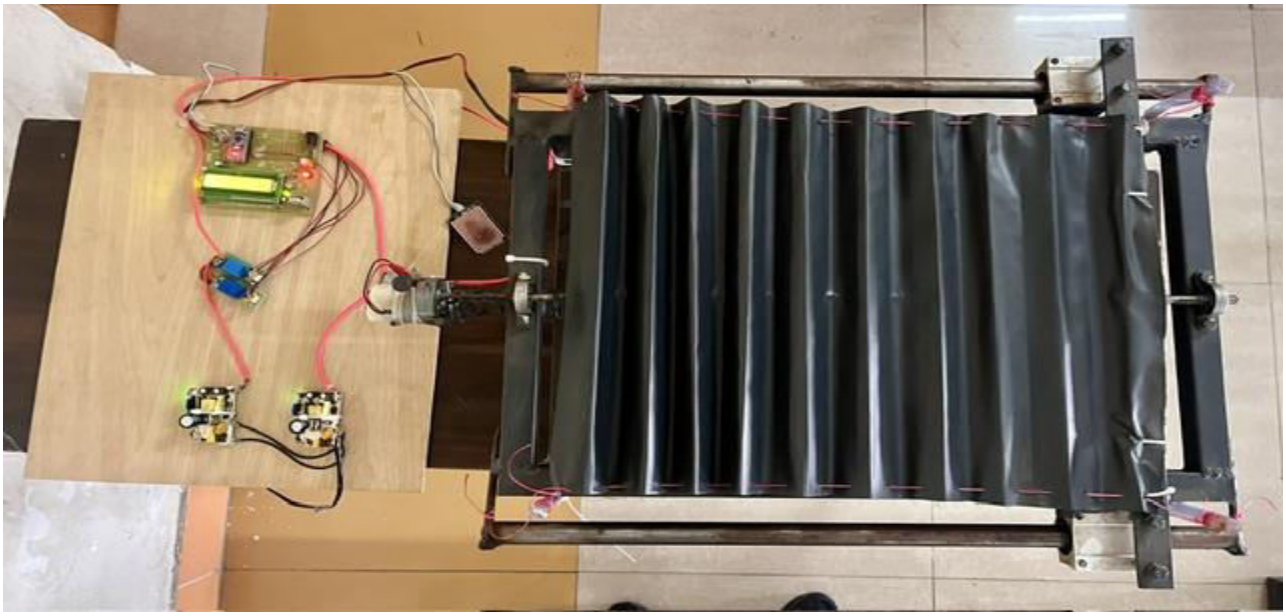

Figure 4.1: Front View Automated Pool Cover System (Pool Cover Closed)

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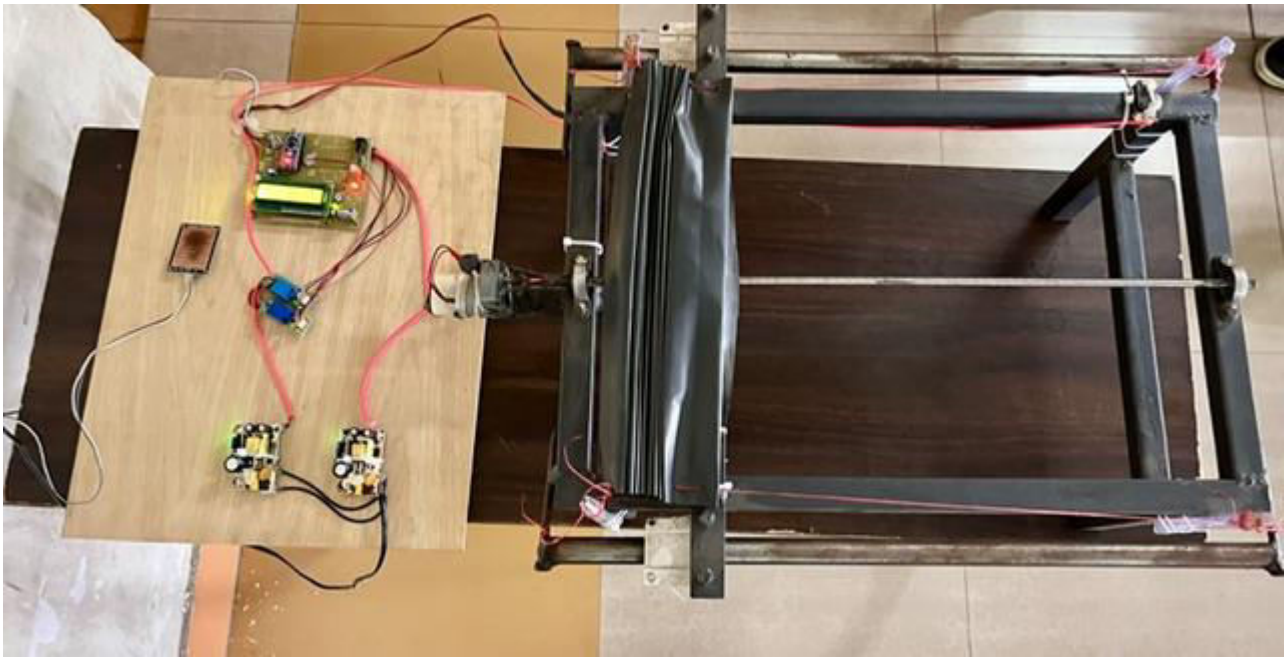

Figure 4.2: Front View Automated Pool Cover System (Pool Cover Open)

V. RESULT

The Automated Pool Cover System was successfully designed, fabricated, and tested to provide an efficient solution for automatic covering and uncovering of swimming pools. The project was undertaken with the objective of reducing manual effort, improving safety, minimizing water evaporation, and enhancing overall pool maintenance efficiency. The developed system utilizes a DC geared motor, roller shaft mechanism, control circuitry, and limit switches to achieve smooth and reliable operation. The motorized roller mechanism effectively rolls and unrolls the pool cover over the swimming pool surface with minimal human intervention. The incorporation of limit switches ensures automatic stopping of the motor at predefined positions, preventing over-travel and mechanical damage. Experimental testing demonstrated that the system operates efficiently under various operating conditions. The opening and closing operations were completed successfully within a reasonable time, and the motor provided sufficient torque to handle the pool cover load. The system exhibited stable performance, low power consumption, and reliable operation throughout multiple testing cycles. The Prototype Model also achieved its intended safety objectives by incorporating automatic stopping mechanisms and controlled low-speed movement. The use of a waterproof cover material contributes to reducing water contamination, heat loss, and evaporation, thereby improving overall pool efficiency and reducing maintenance requirements.

VI. CONCLUSION

From the results obtained, it can be concluded that the proposed Automated Pool Cover System is a practical, economical, and user-friendly solution for residential and commercial swimming pool applications. The system successfully fulfills the objectives of automation, safety enhancement, energy conservation, and operational convenience with Emergency Stop Mechanism, End-position Detection using Limit Switches., Bidirectional Motor Interlocking., Over-travel Protection., Low-voltage DC Operation (12V/24V)., Reliable Relay-Based Motor Control., Automatic operation with minimal human effort., Improved user safety., Protection against accidental pool access., Reduced wear and tear on pool covers., Energy-efficient operation., Cost-effective and easy maintenance, Suitable for residential and commercial swimming pools.

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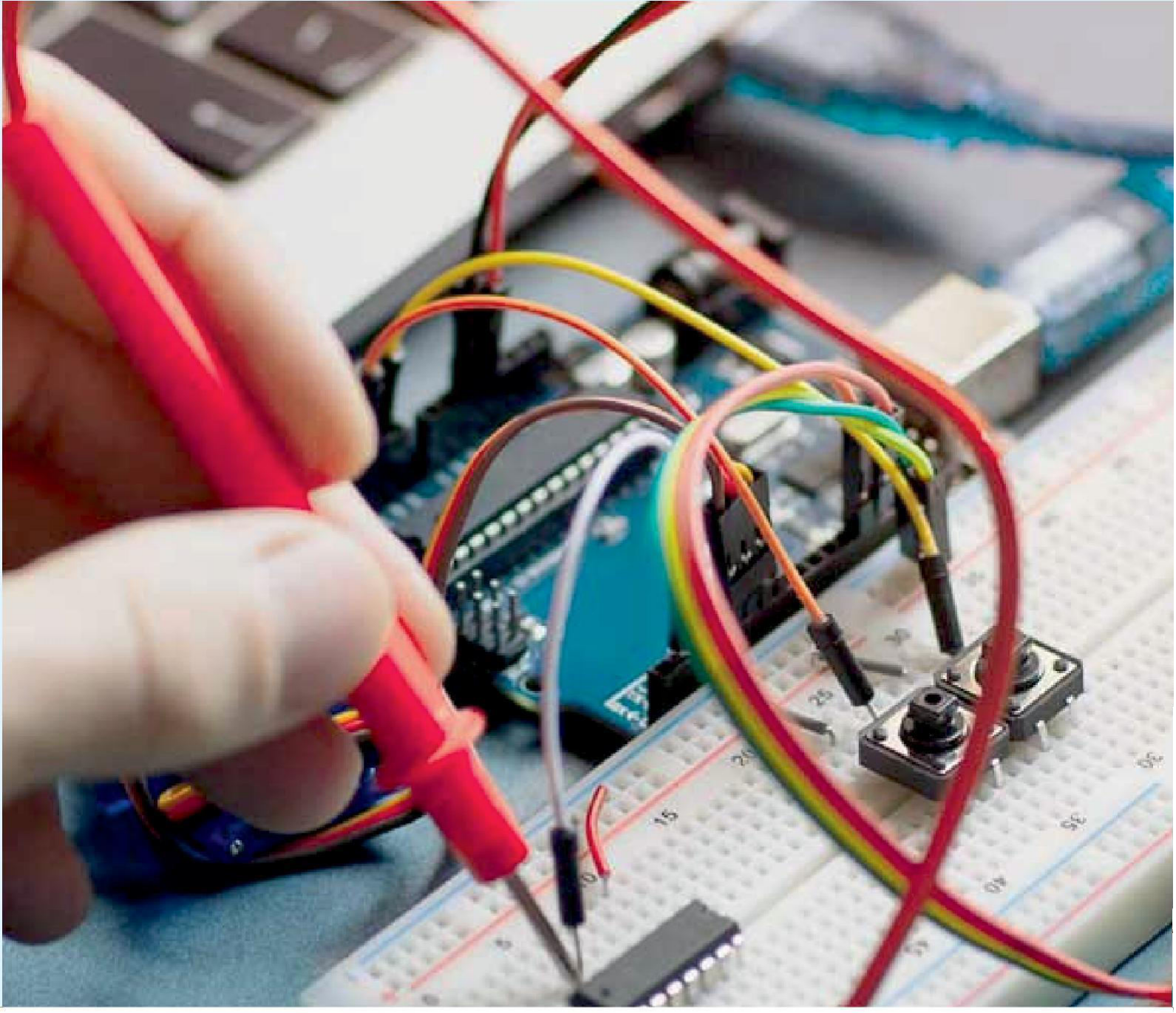

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