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Solar Powered LED Street Light With Auto Intensity Control

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ABSTRACT: The idea is for LED-based street lights with auto-intensity control that are powered by solar energy from photovoltaic cells. The charging of the battery is controlled by a charge controller circuit, and the ambient light is sensed by an LDR during the day. We've also tried to measure the solar cell properties using data from various sensors. A microcontroller from the ATMEGA328 family is used to monitor several solar panel data such as light intensity, voltage, current, and temperature in this system. During peak hours, the intensity of street lights must be maintained at a high level. The street lights are automatically turned on at dusk and turned off at dawn, thanks to a sensor system. LDR LED lights are the lighting of the future; due to their low energy usage and long lifespan, they are rapidly replacing traditional lights around the world. Where pulse width modulation allows for intensity control, white light emitting diode (LED) bulbs replace HID lamps.For energy savings in a solar-based system, a programmed microcontroller is used to give varied intensities at different periods of the night using PWM technology, as well as a charge controller to safeguard the battery from overcharging, overload, and deep discharge protection. For sensing reasons, a light sensor device called LDR (Light Dependent Resistance) is utilised, which has a resistance that drops dramatically in daylight. An LDR sensor , the voltage by voltage divider concept, the current by current sensor, and the temperature by temperature sensor are all used in the measurement circuit to monitor light intensity. All of this information is shown on a 16X2 LCD connected to the ARDUINO microcontroller. IoT is used to display the output of the system through webpage.

KEYWORDS: Smart Lighting, Sustainable Environment, Renewable Energy, Sensors detection, IoT Technology, Energy economical technique.

I.INTRODUCTION

Humans have gotten overly busy in recent years, and they are unable to find time to turn off lights when they are not required. The current system works like this: the lights are turned on before the sun sets in the evening, and they are turned off the next morning after there is enough light outdoors. However, the true time for these lights to be turned on is when it is completely dark. The electricity will be wasted to some extent as a result of this. The best solution for electrical power waste is presented in this paper. The lighting system's manual operation has also been deleted. Due to population expansion and economic development, the world's energy consumption is expanding at the quickest rates although the supply of energy sources remains severely limited. As a result, resource augmentation and expansion in energy supply have not kept up with rising demand, and major energy shortages persist. Streetlights are essential component of any growing community. They can be found on all major highways as well as in the suburbs.

Even when no one is there, streetlights are turned on at full level from sunset to sunrise every day. Millions of dollars are spent every day on these street lights to deliver the essential electrical energy on a global scale. Traditional incandescent bulbs have exorbitant maintenance and replacement expenses. They use a lot of electricity to operate, and their heat outputs are also extremely substantial. All of this contributes to increased electricity consumption and, as a result, increased carbon dioxide emissions from power plants. As a result, in addition to causing excessive light pollution, this behaviour also harms our environment. The initiative intends to capture energy from renewable energy

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sources such as the sun and to effectively utilise that energy for the benefit of inhabitants in distant communities who are experiencing severe power outages.

The project's major goal is to create a " IoT-basedAutomatic Street Lighting System " that runs on solar energy at night. We use the term "smart" because the system not only provides power to the street lights, but also assists the pedestrian by recognising his direction of movement and illuminating his path of movement until the next street light is reached. It is possible to systematically assist pedestrians in reaching their destination in remote rural locations where there is a significant electric power supply problem by combining all street lights with a Smart street light system. The same approach can be utilised in both small and large cities. Dimming the lights during off-peak hours is a simple and practical solution to this problem. The lights around it will shine in the normal (bright) mode whenever presence is sensed. This would save a important amount of energy while also lowering the cost of operating the streetlights.

We can check the status of street lights on the internet using IOT (Internet of Things) from any location in real time and resolve any difficulties that arise throughout the process. In addition, a tabletop version has been built to demonstrate how the concept works. To reproduce the ambiance, the mechanisms used in the real-life implementation are substituted accordingly.

1) Prof. Bhargav B Patel [24] have introduced the design and implementation of advanced, low cost and LED street light with the help of maximum power point tracking method. This algorithm is used to obtain maximum amount of power from the solar panels. To boost the voltage level MPPT boost converter circuit is used and the voltage is stored in the battery which is used for led light to glow during night time. For designing MPPT, I2C bus is built for communication between the microcontroller and ADC is used to obtain current and voltage samples. For automatic operation of street lights, RTC is used. The system performance is monitored by the microcontroller.
2) Dr. Saravanan [3] have proposed an innovative street light model using array of LEDs. This project also has more sensors to monitor and control the system. To sense the presence of a human a sensitive thermal sensor D6T is used. So the lights will be in ON position only when the person is in the detection range, othwewise it is kept OFF. To check the situation of street light PIC controller is used which sends the message through the technology. So the energy consumption is low and manual work is reduced.
3) Y.Zhang [22] have connected single-stage solar LED harvester with power channel time multiplexing technique is prefered to obtain simultaneous MPPT and two control variables is udes for LED current regulation. The running state is selected automatically between power hungry and power rebundant states to execute adaptative power steering. The D-hopping method is suggested to secure fast LED current recovery during LED powering and PWM dimming. During PWM dimming no fluctuations are identified.
4) Omprakash Singh [12] have introduced IoT which is to execute a very large amount of heterogeneous end systems, the digital service provide open access to subset of data. This paper mainly focus to analyze and design cost efficient street light system with advanced technology that will detect faults in panel with the help of PHP and ESP32 microcontroller. Street lights has been made necessary for road safety but the problem today occurred in street lights is using of sensors will be helpful to target the criminals or theft in the street.
5) Ching-Cheng Sun [7] has said that street lighting consumes more enegy and the efficient lighting of roadways should be implemented with different shapes. For maximizing illumination performance, a roadway-shape pattern is delivered by the LED lamp. This light reduces glare and both the visual ability and eye comfort of car drivers and pedestrians has been improved. The adaptive mechanism is easy and well planned for a freeform roadway by using microlens sheet.

II.METHODOLOGY

There are still several issues with the LED in its current state that need to be addressed. For instance, the LED chip's quality, heating issues, package issues, power driver issues, and the electronic component's lifetime. Although the luminous efficiency of LED lighting is improving and the cost of LED lighting is decreasing, it will take a long time to totally replace traditional high-pressure sodium street lighting. As technology advances, led lights will be able to utilise more low-power goods to create the same effect as traditional lighting, and the price will drop dramatically in the coming year . LED technology has advanced to the point that it will soon be able to totally replace traditional street lighting. The LED has a promising future ahead of it.

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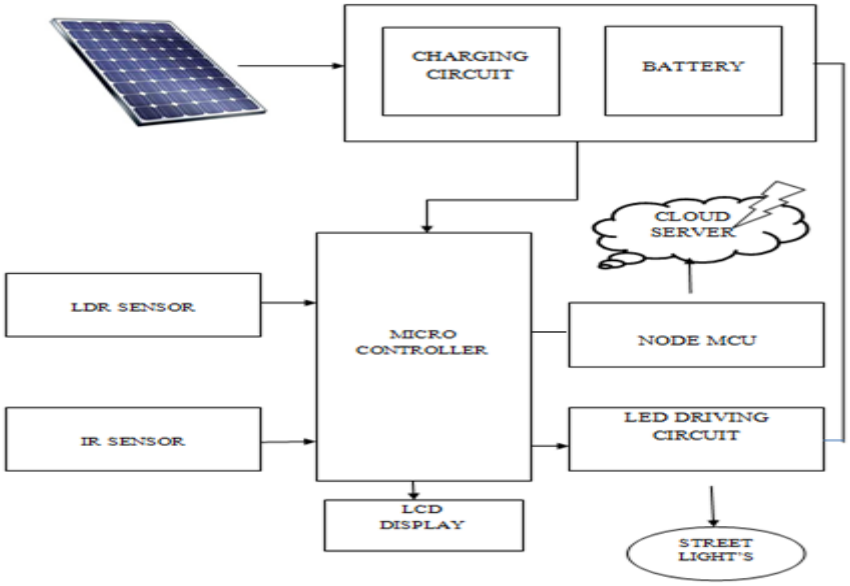

Fig. 1 Block Diagram of Proposed System

Fig. 2 Block Diagram of Receiver side

The current arrangement delivers power to the streetlight via a single phase circuit. To regulate the power delivery, the proposed system includes five extra components. The Arduino then sends commands to the street light to switch between dim and bright modes, depending on the situation, and so adjusts the brightness. The sensors and Arduino are powered by a battery eliminator that is also powered by the single phase line. There are three primary working modes in the design: -

- **OFF mode:** The complete system is shut off and the batteries are charged when there is enough natural light in the area, which is during the day.
- **Active mode:** When the natural light level falls below a specified threshold, the system activates and the motion sensors are activated.
- **ON mode:** The sensors activate in the presence of pedestrians, which then activates the LED lights. After a certain amount of time, these lights will turn off.

Here, a 5Watt solar panel is utilized to convert received daylight into electrical energy, which is then used to charge the battery via a switching circuit that converts changing voltage into stable voltage . This charged battery is now used to power the rest of the system . We will feed power to Arduino via the battery, which will regulate the operation of the LDR and IR sensors in response to the presence of a vehicle. The Arduino then controls the power LED circuit based on the changes in the IR sensor and LDR. Using IoT, the serial monitor data from Arduino is now shown on a web browser.

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III.IMPLEMENTATION OF AUTO INTENSITY CONTROL USING IoT

The proposed plan has been successfully simulated using the software tool Proteus Design Suite which is used primarily for electronic design automation. The output of an LDR module is determined by the quantity of light that drops on its surface. Because sunlight falls on LDR during the day, the AC bulbs are turned OFF and there is no source of bright light after sunset, the AC bulbs are turned on. This method can help you save a lot of money on electricity. We utilise a relay module to turn ON the light automatically. An arduino is connected to a relay module. Arduino collects all of the sensor data. The data is sent to the node mcu via serial connection. The ESP8266 wifi module on the node mcu sends data to the cloud server. The output of this system is displayed on a serial monitor, an LCD display and an IoT web page.

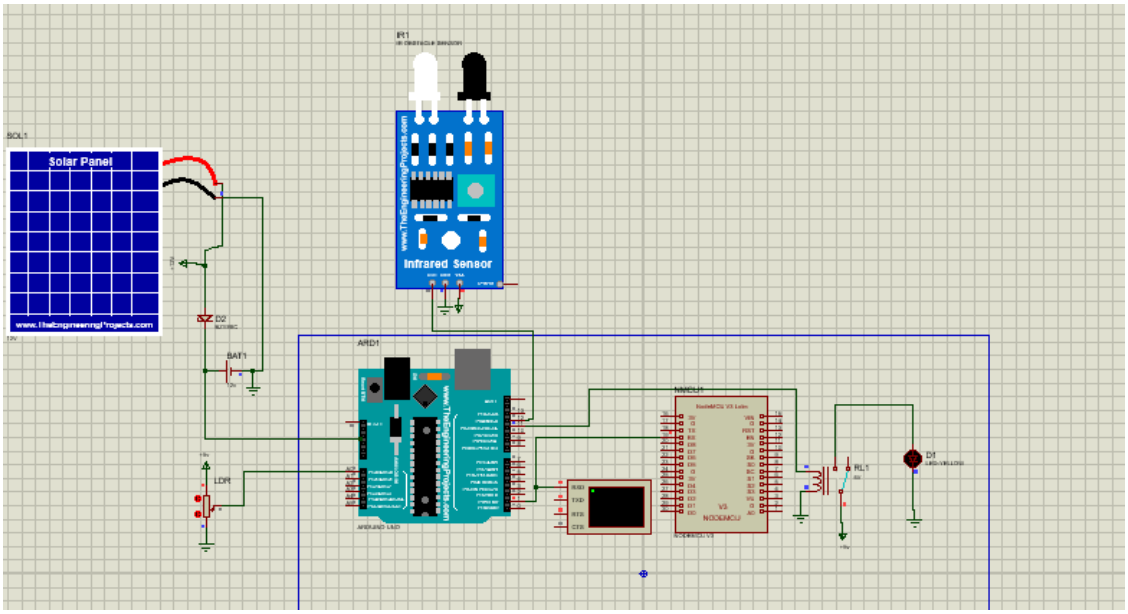

Fig. 3 Simulation Circuit Design

The above figure is the circuit design of this project. Here the solar panel is connected through battery to the power supply pin in the arduino board and LDR is connected to the analog input pin A0. The output pin of the IR sensor is connected to pin number 12(MISO) in the arduino. The RX pin in node mcu and RXD pin in virtual terminal box is connected to the digital pin numer 1 of the arduino. A relay is connected to the digital pin 11(MOSI) which acts as a switching operation to turn ON and OFF the LED light.

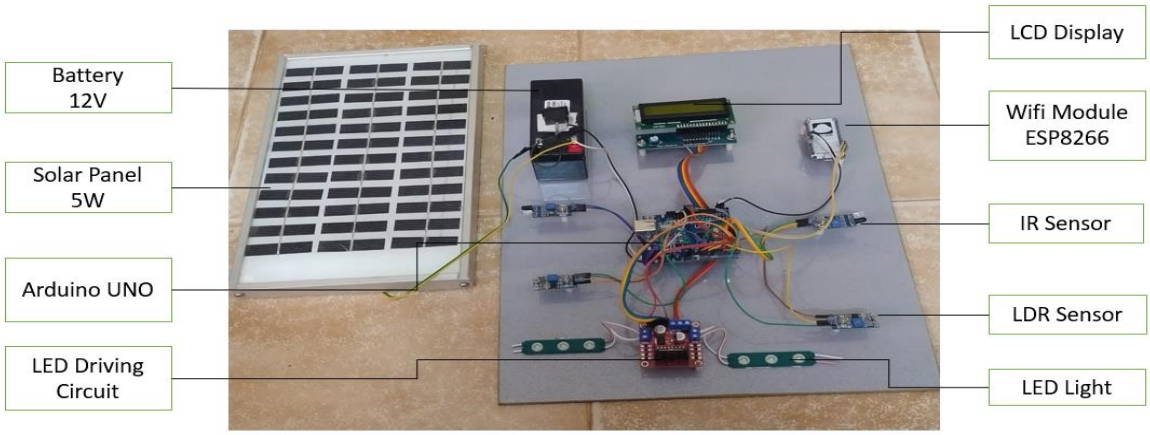

Fig. 4 Circuit Design of Hardware Implementation

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The above figure is the hardware design of this project. Here the solar panel is connected through battery(12V) to the power supply pin in the arduino board and LDR1 is connected to the analog input pin A0. Similarly LDR2 is connected to the analog input pin A1. The output pin of the IR sensor1 and IR sensor2 is connected to the digital pin number 12 and 13 in the arduino. The TX pin and RX pin in the wifi module is connected to the digital pin number 2 and 3 in the arduino board. The pins D4, D5, D6, D7, RS and EN in LCD board are connected to the digital pin numbers D4, D5, D6, D7, D8, D9 in the arduino board respectively. The pins IN1, IN2, IN3, IN4 in LED driving circuit are connected to the analog pins A2, A3, A4, A5 in the arduino board. The LED light1 and light2 are connected to D10, D11 pins in the arduino board. This is the circuit connection of the hardware implemented.

IV.RESULTS AND DISCUSSION

Once the simulation starts running, the virtual terminal box displays the result whether the street light is turned ON or OFF. When the LDR sensor detects light level in the presence of light or in brightness then the LDR resistance decreases. If the LDR resistance is below 40% then the LED light is turned OFF during those time which is shown in the figure below.

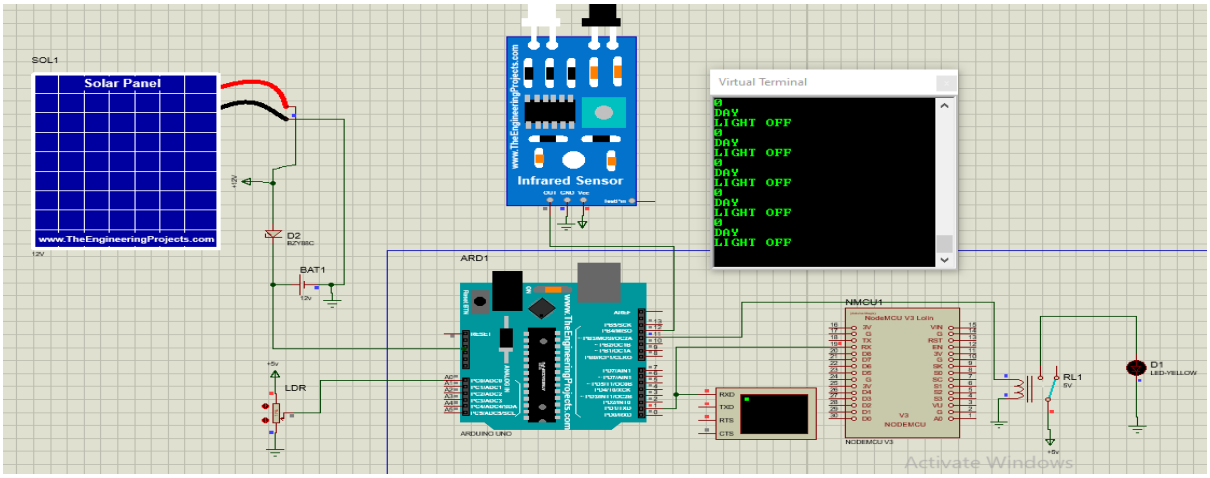

Fig. 5 Simulation of street light during day time

When the LDR sensor detects light level in the time of darkness then the LDR resistance increases. If the LDR resistance is above 40% then the LED light is turned ON during those time which is shown in the figure below.

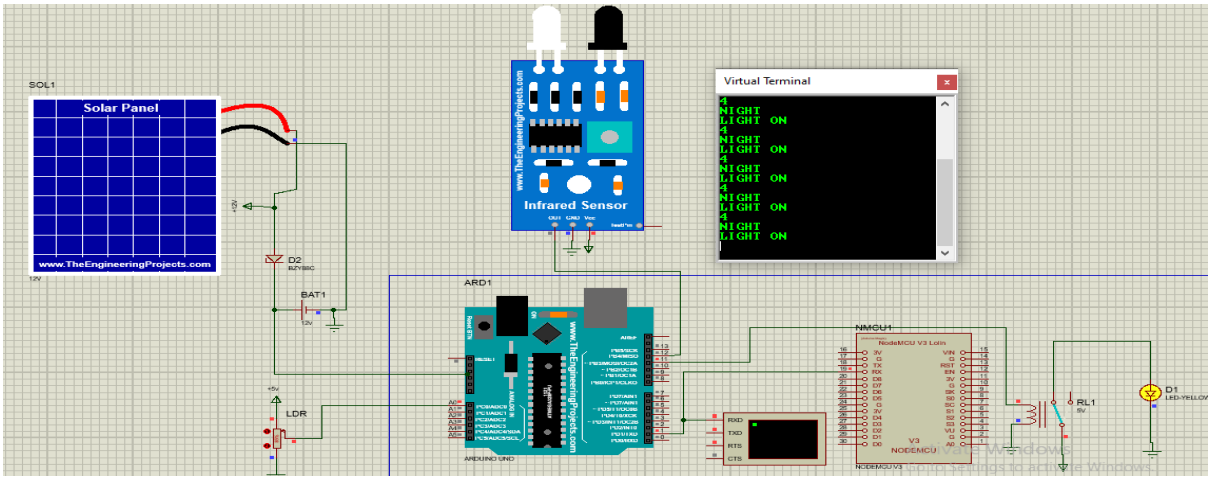

Fig. 6 Simulation of street light during night time

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- When there is enough natural light during morning time, the system monitors and controls the process and the street light is turned OFF automatically.

Fig. 7 Output during day time

- When there is no enough light and if there is any detection of vehicle or human crossing the road during night hours, then the street light turned ON automatically with the help of the system control.

Fig. 8 Output during night time

To run the Arduino Uno board, a source code is created to run the whole simulation. The source code used here is embedded C.

HARDWARE RESULTS:

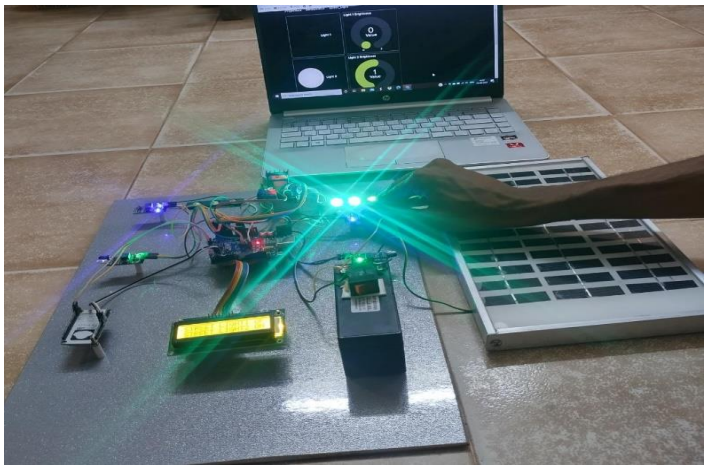

Fig. 9 Output when LDR detects

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In the abovefigure, when the LDR sensor detects darkness,the led light started to glow and the brightness level(value 1) is indicated in the IoT web page.

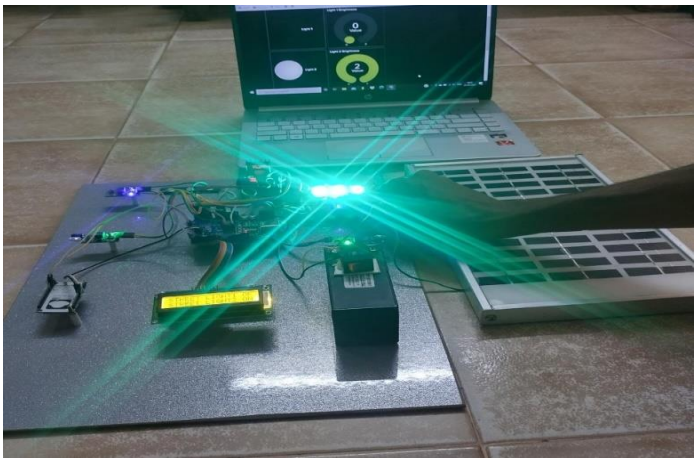

Fig.10 Output when both LDR and IR sensor detects

In the above figure, when the LDR sensor detects darkness and IR sensor detects the motion of human the led light started to glow and the brightness level(value 2) is indicated in the IoT web page.

V.CONCLUSION

The use of power electronics is growing at an exponential rate in many areas of human life. The project's components, such as Arduino and sensors, are gradually becoming an indispensible part of our daily lives. As a result, it's only natural that we employ them to boost efficiency in all areas of life. SolarSmart Street Light System with IoT is an outstanding and effective option, keeping in mind the pressing need for energy saving. It blends safelighting protocols with power consumption that is as low as possible. As previously said, the energy savings are amazing. The project's future scope will include speed sensing and a programmable area of illumination. The introduction of LED bulbs would be an additional component that would improve the concept's functionality.

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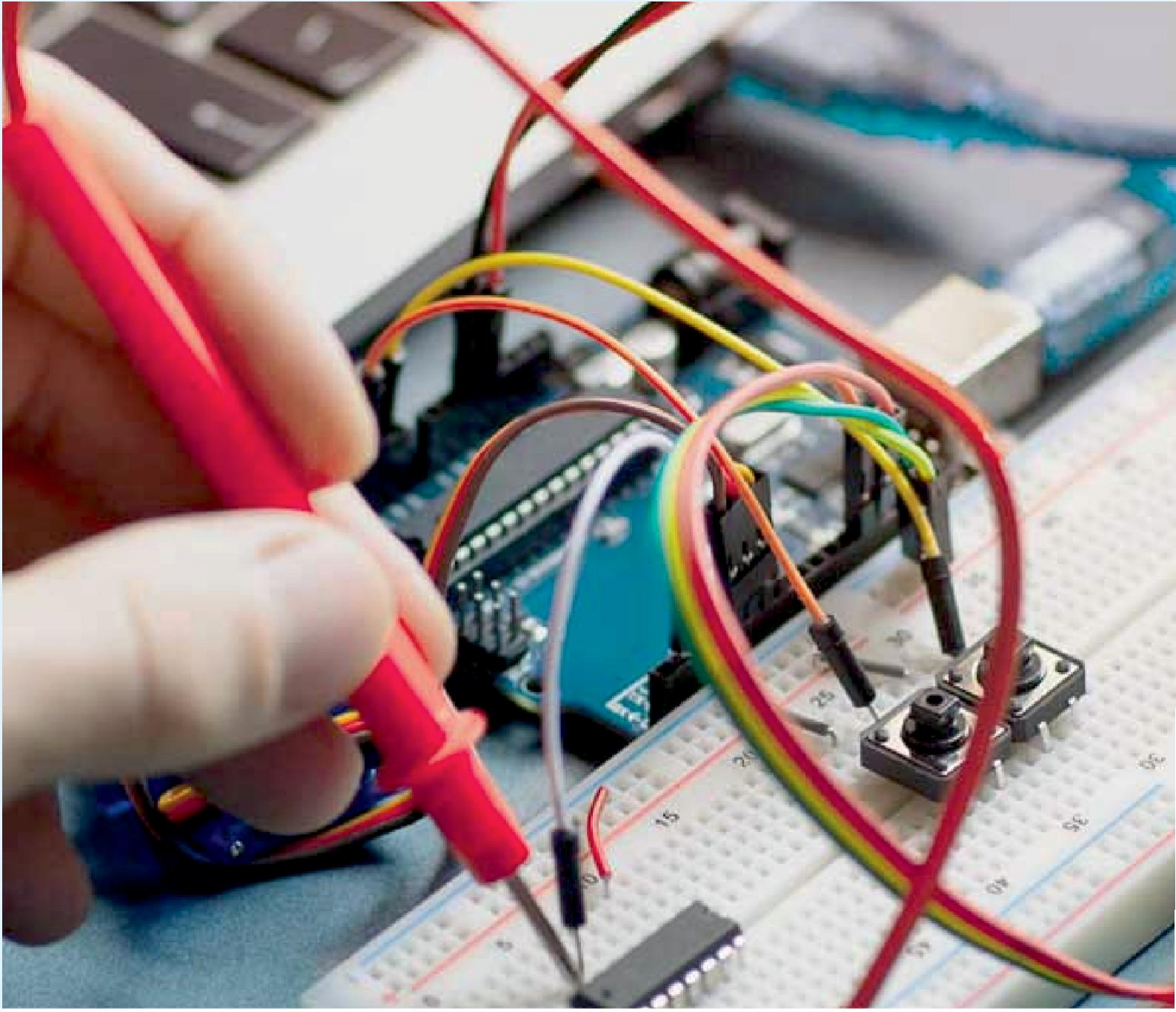

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