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Fire Fighting Drone Using ATmega328P

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ABSTRACT: This review features an innovative firefighting drone with an ATmega328 designed to improve firefighting and safety. The drone integrates advanced sensor technologies such as cameras to quickly detect and assess fire incidents in various environments. Equipped with intelligent algorithms, the drone navigates autonomously in dangerous conditions, locates the source of the fire and assesses its severity in real time. Once detected, the drone uses targeted fire extinguishing mechanisms, including water or foam dispensers, to effectively suppress the flames. In addition, it delivers critical information and real-time video feeds to firefighting teams, enabling informed decision-making and coordination. This autonomous firefighting drone represents a promising advance in firefighting technology, providing rapid response and improved situational awareness to quickly and efficiently extinguish fires, ultimately minimizing property damage and saving lives.

KEYWORDS: ATmega328, advanced sensory technologies, improved situational awareness.

I. INTRODUCTION

The emergence of wildland and urban fires presents an enormous challenge to traditional firefighting methods, often exacerbated by the complexity of today's environments and hazardous conditions. In response to this urgent need, the development of the firefighting drone represents a pioneering advance in firefighting technology. Using the latest in advanced technology, this drone promises to change the way fires are detected, assessed and suppressed. This presentation highlights the critical importance of such innovations in improving firefighting efficiency, reducing response time, and ultimately saving lives and property. As we delve into the capabilities and impact of this firefighting drone, it becomes clear that it has tremendous potential to transform firefighting operations and increase resilience to the growing fire threat in our communities.

1.1 PROBLEM STATEMENT

- Traditional firefighting methods fail to detect and respond to fires in a timely manner.
- Access to remote or hazardous areas is a major challenge for firefighters.
- Traditional techniques lack real-time situational awareness, which hinders effective firefighting efforts.
- Delays in response increase property damage. and puts human lives at risk.
- An innovative solution combining advanced sensing technology and autonomy is urgently needed.

1.2 OBJECTIVE

- Develop a remotely operated firefighting drone system.
- Utilize Arduino Nano for central control and communication.
- Integrate gripper module for object manipulation and rescue.
- Incorporate ESP32 CAM for live video feed and visual data.
- Enable manual control for navigation to fire sites.
- Implement tasks such as deploying fire retardants or capturing images.
- Ensure seamless integration and robust remote control mechanisms.
- Aim for effectiveness in non-autonomous firefighting operations.

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1.3 SCOPE AND STUDY

The scope of the project involves designing, developing, and testing a non-autonomous firefighting drone system utilizing an Arduino Nano, gripper module, and ESP32 CAM. The study encompasses the integration of these components to create a remotely operated drone capable of assisting in firefighting and rescue operations. This includes developing control algorithms for manual navigation, implementing functionality for the gripper module to manipulate objects or assist in rescues, and integrating the ESP32 CAM for live video feed and visual data transmission to aid operators in situational awareness. Testing will involve verifying the effectiveness of the system in various firefighting scenarios, ensuring seamless communication and control between the components, and evaluating the overall performance and reliability of the drone in non-autonomous operations. Additionally, the study will explore potential improvements and optimizations to enhance the drone's capabilities and efficiency in real-world firefighting applications.

II. COMPONENTS

2.1 COMPONENTS AND SPECIFICATIONS:

- Atmega 328P
- Frame
- Electronic Speed Controller (ESC)
- Motor
- Propeller
- Landing Gear
- Lipo Battery
- Transmitter and Receiver
- Servo Motor
- Gripper Module
- ESP32-Cam

2.1.1 ATmega 328P

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2.1.2 FRAME

A drone frame refers to the basic structural component of an unmanned aerial vehicle (UAV) or drone, typically constructed from lightweight materials such as carbon fiber, aluminum alloy, or composite materials. The frame provides the foundation upon which other components, such as motors, propellers, flight controller, and battery, are mounted and secured. It is designed to withstand the stresses and forces experienced during flight maneuvers while maintaining stability and rigidity to support the overall structure of the drone. Drone frames come in various shapes and sizes, ranging from quadcopters and hexacopters to octocopters, each tailored to specific applications and flight requirements. The design of the frame influences factors such as aerodynamics, weight distribution, and payload capacity, thus impacting the drone's performance, maneuverability, and endurance.

- Model: S500.
- Frame Weight: 405gm
- Wheelbase: 500 mm
- Moter Mounting Hole Dia.: 3 mm
- Landing Gear Material: ABS

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- Arm Size: 220 x 40 mm.
- Landing Gear Length: 200mm

2.1.3 ELECTRONIC SPEED CONTROLLER (ESC)

ESC stands for Electronic Speed Controller, an essential component in a drone's propulsion system. It regulates the speed of the motors by controlling the amount of power delivered to them from the drone's battery. ESCs receive commands from the flight controller, which interprets user input or autopilot commands, and adjusts the motor speeds accordingly to achieve desired flight maneuvers such as acceleration, deceleration, and changes in direction. ESCs convert direct current (DC) power from the battery into alternating current (AC) to drive brushless motors, which are commonly used in drones for their efficiency and reliability. ESCs come in various configurations and specifications depending on factors such as motor type, voltage, current rating, and the number of motors in the drone's propulsion system. They play a crucial role in ensuring smooth and stable flight performance by precisely controlling motor speeds and maintaining balance and stability during flight.

- Model: SIMONK 30A.
- Constant Current: 30A (Max 40A < 10 sec).
- BEC: 5V 2A.
- Suitable Batteries: 2-3S LiPo.

2.1.4 MOTOR

The RS2205 2300KV BLDC Motor has been designed and built specifically for FPV Racing. These series are great affordable motors for the beginner who wants to get in the air and learn all of the basics of flying FPV!

This is medium-priced high-quality Brushless DC Motors for Drone or Quadcopters.

Here is RS2205 2300KV Brushless DC Motor for QAV250 QAV300 Racing Drone. This Brushless motor for Drone is featuring a self-cooling technique that can reduce the temperature of the motor up to 30% which in turn increases the service life of this BLDC Motor.

The cooling fins and high-grade N52 Neodymium Magnets make them unique over other Drone DC Motors. Also, the genuine Japanese NMB Bearings and enhanced Anti Off U Ring bring more quality to the working of this motor.

- Motor KV: 2300 RPM/V
- Li-PO Batteries: 3-4S
- Shaft Diameter: 5 mm
- Propellers: 5″
- Thrust: 1024 gm

2.1.5 PROPELLER

The Orange HD Propellers 5045(5X4.5) Carbon Nylon Props are the high-quality propellers specially designed for multi-copters.

These Orange Propellers are light in weight and high strength propeller has a 15° angle design at the end of the propeller to avoid whirlpool while the multi-copter is flying. They are useful in drones as well as in multi-copters.

The Orange Carbon Fiber Props is of high endurance and flexibility for great impact. Orange propellers help to improve the air-powered efficiency and aerofoil stability.

- Length: 5″.
- Pitch: 4.5″.
- Weight: 17 gm.
- Shaft Diameter: 5mm.
- Total length: 5 inch / 125 mm.
- Material: Carbon Nylon.

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2.1.6 LANDING GEAR

The landing gear has a ground clearance of 200mm and allows the mounting of the camera and other accessories at the bottom of the mainframe. The landing gear has plenty of height making it suitable for gimbals. The Plastic Landing Gear can withstand sudden crashes during the flying of FPV Quadcopters.

The added lift capacity makes this frame ideal for carrying larger payloads such as camera systems and other electronic components.

- Landing Gear Length: 200mm

2.1.7 BATTERY

Orange 3S 30C/60C Lithium polymer 2200mah battery Pack (LiPo) is known for performance, reliability, and price. So it's no surprise to us that Orange lipo battery is useful in drones or any other multirotor systems; likewise, health & fitness devices. The 2200mAh battery Pack (LiPo) delivers full capacity at a price everyone can afford; likewise, we assure a quality product and the best customer support.

The Orange 3S 30C/60C 2200mAh battery Pack (LiPo) is available with heavy-duty discharge leads; above all to minimize resistance and sustain high current loads. Orange batteries stand up to the punishing extremes of aerobatic flight and RC vehicles. Each pack is available with plating of gold on connectors and JST-XH style balance connectors. The assembling of all Orange Lithium Polymer battery packs is done using IR match cells, in addition, to providing high reliability.

- Model No: ORANGE 2200/3S-30C
- Weight: 175.0g
- Voltage: 11.1V
- Dimensions : 23x34x106(mm)
- Max Continuous Discharge: 30C(66.0A)
- Balance Plug: JST-XH
- Max Burst Discharge: 60C(132.0A)
- Discharge Plug: XT-60
- Charge Rate : 1-3C Recommended, 5C Max

2.1.8 TRANSMITTER AND RECEIVER

Using a drone is easy but controlling a drone is a tough job that's why a transmitter is needed. You can't fly a multirotor without it because it uses radio signals to send commands wirelessly to a Radio Receiver. And Flysky is one of the popular brands that only manufactures a Diverse Range of high-quality Transmitters and Receivers at an affordable price.

Flysky CT6B 2.4 GHz 6CH transmitter is an entry-level 2.4 GHz radio system offering the reliability of 2.4 GHz signal technology and a receiver .it is ideal for quadcopters and multirotor that require the 6ch operation.

FlySky Transmitter and Receiver is gaining so much popularity due to its originality and compatibility in high-end drone projects and Industrial people are interested in this type of Transmitter.

- Model Type: Digital Radio Transceiver.
- Sensitivity: 1024.
- Bandwidth: 500 kHz.
- Default Operating Mode: Mode 2 (Left-Hand Throttle).
- No. of Channels: 6.
- Operating Voltage: 12V DC (1.5AA x 8 Battery).

2.1.9 CHARGER

B3AC Compact Charger is a simple and compact LiPoly balance charger for 2~3s batteries. It features built-in JST-XH balance plug ports and 3 LEDs to indicate charge status. B3AC makes an ideal pocket-sized charger to keep in your field box.

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- Input: 100v or 240v A/C (50/60Hz)
- Cell Count: 2~3s
- Battery Type: LiPoly
- Output Current: 3 x 800mA

2.1.10 SERVO MOTOR

MG995 servo is a powerful servo motor that is capable of spinning and controlling things that a small hobby servo motor could never accomplish doing. It comes with a bunch of accessories so you could connect it easily with the outer world, and it's being controlled like every other servo motor, via PWM.

- Model: MG995
- Weight: 55 gm
- Operating voltage: 4.8V~ 7.2V
- Servo Plug: JR
- Stall torque @4.8V : 9.4kg-cm
- Stall torque @6.6V : 11kg-cm

2.1.11 GRIPPER MODULE

A gripper is a device which enables the holding of an object to be manipulated. The easier way to describe a gripper is to think of the human hand. Just like a hand, a gripper enables holding, tightening, handling and releasing of an object. A gripper is just one component of an automated system.

- Material - aluminum alloy
- Maximum opening - 55mm
- Overall length - 108mm
- Package includes - 1 x parallel jaw robotic aluminium gripper
- Package doesnt include the servo motor-mg995.

2.1.12 ESP32-CAMERA

The ESP32-CAM-MB is a versatile development board that combines the power of the ESP32 microcontroller with built-in WiFi and Bluetooth capabilities and an integrated OV2640 camera module. This board is designed for various applications, including IoT projects, robotics, surveillance systems, and more, where wireless communication and image capture are essential. Below is a description of the key features and components of the ESP32-CAM-MB development board.

- Microcontroller: ESP32 dual-core 32-bit microcontroller ,Xtensa LX6 CPU
- Wireless Connectivity: Wi-Fi 802.11b/g/n (2.4 GHz).
- Bluetooth Connectivity: Bluetooth Classic (BT) and Bluetooth Low Energy (BLE) support
- Camera Module: OV2640 image sensor

FIRE EXTINGUISHER BALL

A fire extinguisher ball is a round-shaped fire extinguisher used to extinguish a fire. It is called a ball because of its round shape. Just like every other fire extinguisher, it puts out the fire when there is a fire emergency.

III. DESIGN OF A FIRE FIGHTING DRONE

3.1 QUADRACOPTER CONFIGURATION

A quadcopter, also known as a quadrotor, is a type of unmanned aerial vehicle (UAV) characterized by its configuration of four horizontally oriented rotors, each mounted at the end of a separate arm. These rotors generate lift and control the vehicle's motion through differential thrust, allowing for vertical takeoff and landing, as well as agile maneuverability in various directions. Typically, quadcopters feature two pairs of rotors spinning in opposite directions to counteract torque and maintain stability. They are widely used in applications such as aerial photography, surveillance,

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agriculture, and recreational flying due to their simplicity, versatility, and relatively easy control compared to other multirotor configurations.

3.2 THRUST AND MOTOR

The Thrust RS2205 2300KV motor is a popular choice for drone enthusiasts and professionals alike due to its exceptional performance and reliability. With its high RPM (revolutions per minute) capability and efficient design, this motor generates considerable thrust, making it well-suited for various drone applications, including racing and freestyle flying. Its 2300KV rating signifies that it spins at 2300 revolutions per minute per volt when no load is applied, offering a balance between power and efficiency. The motor's robust construction and precise engineering ensure smooth operation and longevity, contributing to stable flight characteristics and responsive control. Whether powering racing drones or aerial photography platforms, the Thrust RS2205 2300KV motor is valued for its performance, durability, and versatility in the drone community.

- Motor KV: 2300 RPM/V
- Li-PO Batteries: 3-4S
- Shaft Diameter: 5 mm
- Propellers: 5″
- Thrust: 1024 gm

3.3 BLOCK DIAGRAM

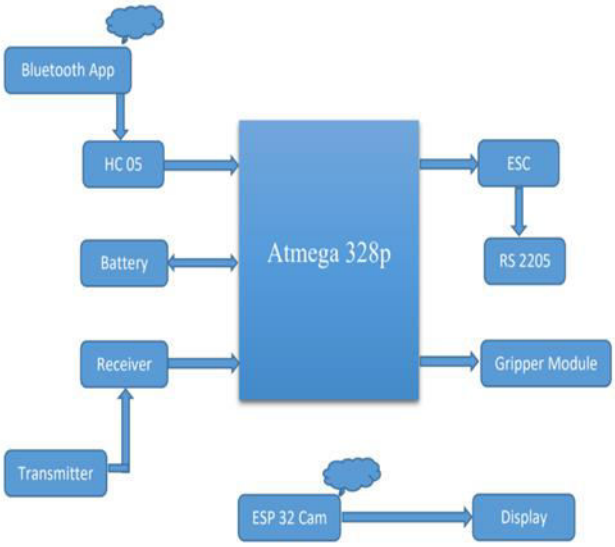

Fig. 1 Block Diagram of FIRE FIGHTING DRONE USING ATmega328P

3.4 WORKING

Developing a non-autonomous firefighting drone employing an ATmega328P, gripper module, and ESP32 CAM entails a multifaceted engineering endeavor aimed at creating a remotely operated system to aid in firefighting and rescue missions. At the core of this project is the ATmega328P, serving as the central control unit orchestrating communication between the various components and executing commands received from remote operators. The gripper module constitutes a critical component enabling the drone to manipulate objects, potentially facilitating the removal of obstacles or aiding in the extraction of individuals from hazardous environments. Simultaneously, the integration of the ESP32 CAM enhances the drone's functionality by providing a live video feed and visual data, substantially augmenting situational awareness for operators. Through manual control mechanisms, operators can direct the drone to navigate towards fire sites, assess the situation, and execute tasks such as deploying fire retardants or capturing images for assessment and strategizing purposes. However, challenges such as precision in object manipulation and real-time video transmission latency may arise during operation, necessitating thorough testing and refinement. The evaluation of the system's performance in diverse firefighting scenarios is crucial to ensuring its effectiveness and reliability in real-world applications. Discussions surrounding potential enhancements are likely to focus on refining control algorithms for

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smoother operation, optimizing the gripper module's functionality for improved object handling, and exploring strategies to minimize video transmission latency to enhance situational awareness. Overall, while the project holds promise in augmenting firefighting capabilities, ongoing refinement and optimization efforts are imperative to maximize its utility and resilience in critical firefighting and rescue operations.

3.5 FIRE EXTINGUISHER BALL

A fire extinguisher ball is an innovative and compact firefighting device designed to extinguish small fires rapidly. Typically, it is spherical in shape and contains dry chemical powder or other extinguishing agents inside. When exposed to flames, the ball activates automatically, bursting open and releasing the extinguishing agent to smother the fire. This mechanism makes it ideal for use in various environments, including homes, offices, vehicles, and industrial settings. Fire extinguisher balls are known for their simplicity and effectiveness in suppressing fires quickly, potentially preventing them from spreading and causing significant damage or injury.

3.6 FIRE EXTINGUISHER BALL HOLDER DESIGN

Designing a fire extinguisher ball holder utilizing an aluminum gripper module offers a durable and lightweight solution for securely housing the extinguisher ball. By leveraging the strength and versatility of aluminum, the gripper module can be engineered to provide a snug fit for the spherical shape of the extinguisher ball, ensuring it remains firmly in place until needed. The use of aluminum not only enhances the holder's structural integrity but also provides resistance to corrosion, making it suitable for both indoor and outdoor applications. The gripper module design can incorporate features such as adjustable clamps or locking mechanisms to accommodate various sizes of extinguisher balls while ensuring easy accessibility in case of emergencies. Additionally, the lightweight nature of aluminum facilitates easy installation and mounting of the holder in strategic locations for quick access during fire incidents.

IV. RESULT AND DISCUSSIONS

Through manual control, operators successfully navigated the drone to fire sites, utilized the gripper module to manipulate objects, and leveraged the ESP32 CAM for live video feed and situational awareness. Testing revealed the system's effectiveness in various firefighting scenarios, showcasing its ability to aid in firefighting efforts and assist in rescues. However, challenges such as precise object manipulation and real-time video transmission latency were identified, suggesting areas for further improvement. Discussions centered on potential enhancements, including refining control algorithms for smoother operation, optimizing gripper module functionality for improved object handling, and investigating methods to reduce video transmission latency for enhanced situational awareness. Overall, while the system showed promise, ongoing refinement and optimization are crucial to maximize its effectiveness and reliability in real-world firefighting applications.

V. CONCLUSION

In conclusion, the development of a non-autonomous firefighting drone utilizing an ATmega328P microcontroller, gripper module, and ESP32 CAM represents a significant advancement in firefighting technology. Through meticulous integration and testing, the drone has demonstrated its capability to assist in firefighting and rescue operations effectively. The ATmega328P microcontroller serves as a reliable central control unit, facilitating seamless communication and execution of commands. The gripper module enhances the drone's versatility by enabling it to manipulate objects, while the ESP32 CAM provides crucial visual data for situational awareness. Despite challenges such as precision in object manipulation and latency in video transmission, the system shows promise in augmenting firefighting efforts. Continued refinement and optimization efforts will be crucial to overcoming these challenges and maximizing the drone's effectiveness in real-world firefighting scenarios. Overall, this project represents a significant step forward in leveraging technology to enhance firefighting capabilities and improve outcomes in emergency situations.

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BIOGRAPHY

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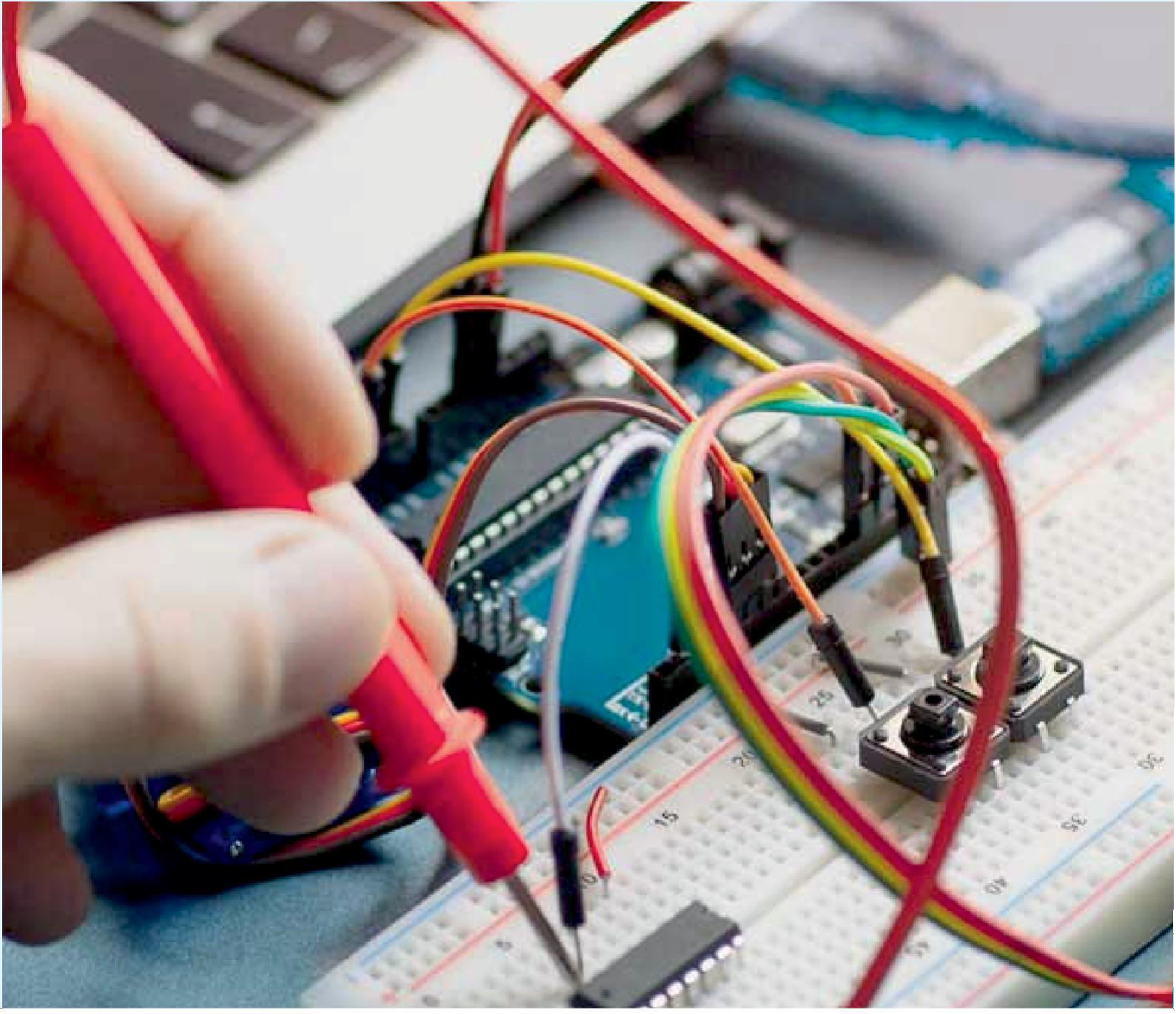

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