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Design of a Fingerprint–Based Identification System for UMAT Examination Centres

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ABSTRACT:Examination at the end of every academic system has been the way of testing students' level of knowledge in a particular field of study. The need to avoid impersonation and examination malpractice has led many institutions to require a form of identification from students before sitting for the exam. The University of Mines and Technology requires a student ID for identification which is not only time consuming but also an inconvenient way of identifying students before examination. This paper seeks to design and implement a student identification using fingerprints that would replace the current system in place. Fingerprint identification systems are not only user friendly but an efficient way of checking for student identity in this fast-growing world. This design involves the use of an AVR Microcontroller, Arduino platform and a PCB Board. The results show that it was easy and faster for students to be identified using this method. This design also helped with the easy identification and monitoring of students who sat for the examination

KEYWORDS: Student Identification, AVR Microcontroller, Fingerprint sensor

I.INTRODUCTION

The University of Mines and Technology (UMaT) is among the high-ranking Universities in Ghana noted for the training of engineering professionals who are serving the country in various disciplines. Examinations are conducted at the end of every semester to monitor the academic progress of students and examine what the students have learnt during the semester. In this light, the University takes issues regarding examination very seriously. Before the start of every examination, students register and identify themselves with their student identification (ID) card to prevent impersonation. Over the years, students who misplace their identification cards or forget to carry them must go for an authorisation note from their respective departments before they would be allowed to take the examination. This process is not only frustrating but could also take a toll on the academic performance of the students. Therefore, a fingerprint-based student identification system is needed to check student identity in UMaT before they enter the examination room. This paper solves the problem of delay due to misplacement of ID cards and other factors. It also prevents the stress invigilators go through to check every student's ID card during examination time.

II.BIOMETRIC IDENTIFICATION

Identification has been a matter of concern to many law enforcement agencies, countries, and other institutions at large. The increase in crime and the need for identification of culprits, the need to identify a traveller's data or citizenship, the need to identify students in a particular institution with the easiest possible means and the increase in the world's strict measures for security have all made scientists and engineers around the globe, to think deeply about very secure ways of making human identification and authentication stress-free.This has however led to many research works involving biometric data acquisition and identification[1]. There are basically two types of biometric methods namely the physiological biometrics and the behavioural biometrics. Physiological biometrics areused for identification based on the person's unique physical characteristics such as the face, fingerprint, iris, veins in the finger, the hand, etc. Behavioural biometrics on the other hand is used for verification purposes[2]. Verification simply involves determining the authenticity of a person to prevent impersonation. This method looks at patterns of how certain activities are performed by an individual. For example, the way a person walks or the way aperson types using the keyboard, how a person's voice sounds or how a person signs his or her signature. The way biometrics are classified according to physical and behavioural traits are shown in figure 1. The solution to replacing the usage of ID cards before examination falls under physiological biometrics which would be the focus of this study. Physiological biometrics are concerned with identifying a person using his or her unique characteristics which makes it an ideal case to be applied in UMaT. [3]

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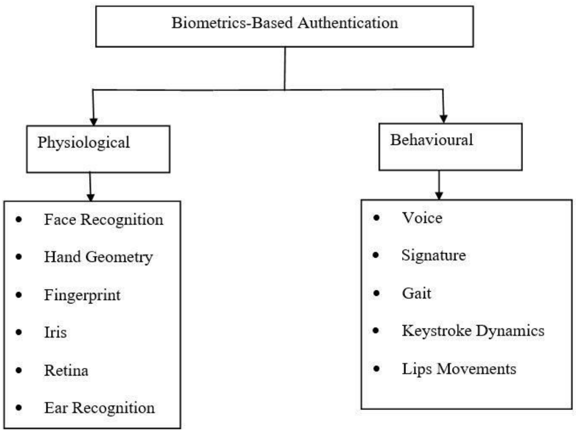

Fig. 1 Classification of Biometric Technique

Physiological biometrics

There are several categories of physiological biometrics which are commonly used in the various industries in Ghana. The most common types of physiological biometrics are as follows:

1. Hand Geometry

Hand geometry systems produce estimates of certain measurements of the hand such as the length and the width of fingers[4]. Various methods are used to measure the hand. These methods are mostly based either on mechanical or optical principles with the latter are much more common today.

2. Iris Recognition

The iris begins to form in the third month of gestation and the structures creating its pattern are largely complete by the eighth month. Its complex pattern can contain many distinctive features such as arching ligaments, furrows, ridges, crypts, rings, corona, freckles, and a zigzag collaret. Iris scanning is less intrusive than retinal because the iris is easily visible from several meters away[5]. Responses of the iris to changes in light can provide an important secondary verification that the iris presented belongs to a live subject. Irises of identical twins are different, which is another advantage.

3. Facial Recognition

This is the most natural means of biometric identification. Since the time of human existence, the face has been a major and natural way of identifying a person. The approaches to face recognition are based on the shape of facial attributes, such as eyes, eyebrows, nose, lips, chin and the relationships of these attributes[6]. As this technique involves many facial elements, these systems have difficulty matching face images.

4. Fingerprints Recognition

Fingerprints are graphical patterns of ridges and valleys on the surface of fingertips. The ridge ending and ridge bifurcation is called minutiae.Fingerprints are graphical patterns of ridges and valleys on the surface of fingertips. The ridge ending and ridge bifurcation is called minutiae. Fingerprint recognition is receiving attention due to its accuracy and is widely used in banks and commerce operations [7].

The Fingerprint Identification

The fingerprint identification is based on two basic assumptions, which are invariance and singularity. Invariance means the fingerprint characteristics do not change throughout life. Singularity means the fingerprint is unique and no two persons have the same pattern of fingerprint. Fingerprints are classified into three patterns. The mostcommon type of fingerprint identification applicable in many industries are arches, loops and whorls[8].

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1. Arches
Fingerprint patterns where the ridges run from one side to the other side without any turn. Generally, there is no delta in an arch pattern whenever there is a delta point, no re-curving ridge intervenes between core and delta points. Delta can be any point upon a ridge nearest the centre.They are located between two diverging type lines and are located on or directly in front of their point of divergence. There are four types of arches namely, plain, radial tented and ulnar arches.

Fig. 2 An Arch Fingerprint Pattern

2. Loops
Patterns in which the ridges flow inwards and return in the direction of the origin. Ridges enter on either side of the impression, re-curve and terminate in the direction of the side where ridges entered. There are four types of loops. These are plain loop, lateral pocket loop, central pocket loop and twinned loop.

Fig. 3 A Loop Fingerprint Pattern

3. Whorls
Patterns in which ridges form circularly around a central point. Any pattern that contains two or more delta points is whorl patterns. There are four types of whorl patterns. These are plain whorls, central pocket loop whorls, double Pocket Loop whorls and accidental Whorls.

Fig. 4 Whorl Fingerprint Pattern

Fingerprint Recognition Methods

Many fingerprint recognition methods have been employed by scientists over the years to get the best in terms of identifying them. The various methods consider specific aspects or patterns and match those patterns for recognition[8].

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1. Minutia-Based Approach

In biometrics and forensic sciences, minutiae refer to specific points in a fingerprint. They are the major features which are used to compare one pattern with another. It includes ridge bifurcation or ridge ending on a fingerprint. Detected minutia in a fingerprint pattern is identified by a set of attributes such as minutia position, minutia direction and type such as bifurcation or ending[9]. Thus, a fingerprint is represented by a set of minutia present in the fingerprint pattern. Fingerprint can be verified by comparing minutiae points present in two images. Minutia is stored as the composition of attribute values such as minutia position in the fingerprint pattern. Minutia based fingerprint recognition systems are one of the most popular methods which achieve very high accuracy.

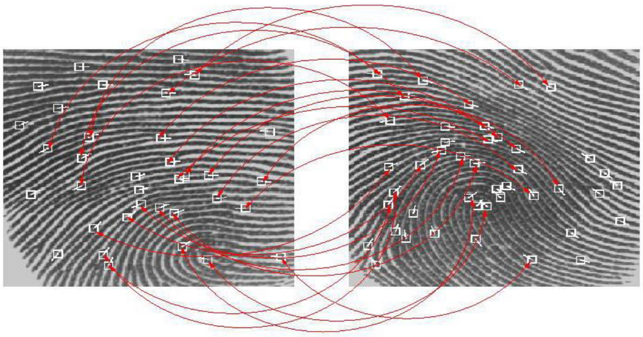

Fig. 5 Minutiae Matching Approach

2. Pattern Recognition Approach

Fingerprint contains composition of ridges and valleys called patterns. Pattern recognition methods use patterns for authentication. Pattern recognition is imposing identities of input data by recognising patterns it contains and relationships it maintains. Pattern recognition approaches are broadly classified as decision theoretic and structural. Quantitative descriptors such as area, length and textures are used to describe a pattern under decision theoretic approach. Relationships of several descriptors are used to describe a pattern under structural approach[10]. The important requirement in this type of fingerprint recognition system is to find the best descriptors that can represent a pattern in the best way.Pattern based fingerprint recognition system works by generating the data, where input is generated. Pre-processing is done so that the image becomes clean and free from noise. Next, features are extracted and stored as feature vector. Whenever input parameters are supplied, they are matched with feature vector database and based on the outcome, authentication is granted or rejected

3. Wavelet-Based Approach

Wavelet transforms can be used on fingerprint patterns to provide authentication. Wavelets cut data into different frequency components and each component is studied with a resolution matched to its scale. In this type of approach, fingerprint images are decomposed using Discrete Wavelet transform. Three levels of decomposition of fingerprint images are performed for training[11]. Mathematical tools like mean and standard deviation are also used during the decomposition process. For fingerprint classification, patterns are rotated from 0 to 360 degrees and 10 degrees are increased in each step. Set of wavelet statistical values and co-occurrence matrix features are extracted. Moreover, wavelet-based fingerprint recognition systems do not require fingerprint image pre-processing or post-processing. Hence, they are fast when compared to minutiae-based approaches

III.METHODOLOGY

Many research works and designs with respect to fingerprint identification systems have been done. While some of these works only paid much attention to proper ways of extracting the fingerprint, others also concentrated on building systems that were very simple without paying much attention to the after effects of certain methods used.This chapter exposes the methods that were employed to design and implement a system that is meant to stand the test of time, in terms of solid-state components and in-depth explanation of certain blocks of circuitry that come together to obtain this system.

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Components Used

The components selected for the system's design were carefully chosen, such that the system could stand the test of time and serve the purpose for the implementation. Some of the components employed are;

Fingerprint Sensor:The fingerprint sensor incorporated in the system was an optical fingerprint module which captures digital image of the fingerprint pattern. It has a Digital Signal Processing (DSP) chip that allows for the image rendering, calculation and feature finding.

Microcontroller: Microcontrollers are used to automatically control devices through coding. The microcontroller employed in this design is the AVR32. It is a 32-bit microcontroller produced by Atmel. It operates on 20 MHz and has 28 pins that are for input and output of commands.

The 555 timer: The 555 timer is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor.

The LM 7805 Voltage Regulator: The LM 7805 Voltage Regulator is a three terminal device that produces an output positive voltage for the system, that is, 5 V. This voltage is normally a regulated voltage. The input and output pins are at the extreme ends while the central pin is for grounding.

16 × 2 Liquid Crystal Display: This is a screen that displays the output of the system. All the instructions carried out by the system and the actions which the system takes are displayed on this screen. This 16 × 2 means it can display 16 characters, and 2 means there are two of such 16-character lines. It operates on two registers namely, command and data. That is, it takes command from the microcontroller and the data register stores the data to be displayed on the screen

Circuit Designs

The system consists of several circuit blocks that were brought together for its proper functioning. Some of the blocks are for the system's protection, switching the system on and off, lower battery indication, etc.

1. Power Input to Switch Block

This system was designed using a 555 timer configured to serve as momentary toggle, using the flip flop internal circuitry. By the help of the 555 timer and per the manufacturer's specifications, signals are input to the triggering pin while output is through the Pin 3. The block works such that at one point only one input signal, say ON is able to function at a time, such that the system cannot be instructed to be ON when it is already in the ON state and vice versa.

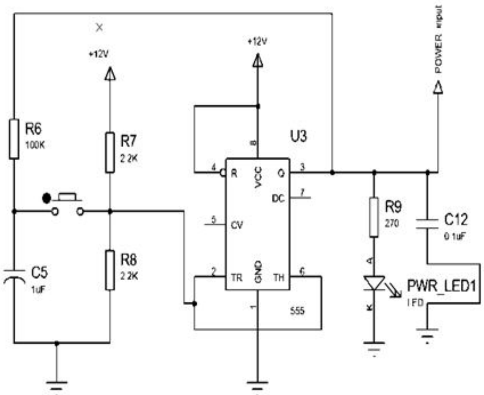

Fig.6The Power to Input Switch Circuit

2. Power Regulation Circuit

The power regulation circuit of the system is made of an LM 7805 regulator that is supposed to produce a positive linear regulated voltage to the microcontroller. This is becausethe microcontroller is only able to work with 5 V.

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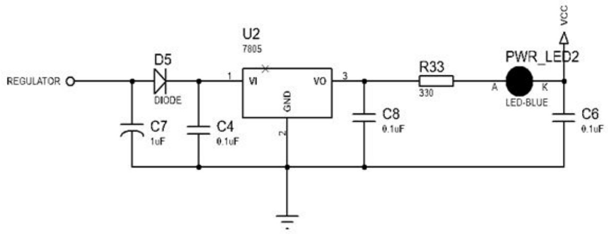

Fig. 7Power Regulation Circuit

Internal Circuitry

The system was carefully built by mounting the required solid-state components on the printed circuit board. Prior to this, the connections were done on a bread board to check the systems working state before it was transferred to the printed circuit board. Fig. 8 shows the arrangement of all the components and their connections for the system.

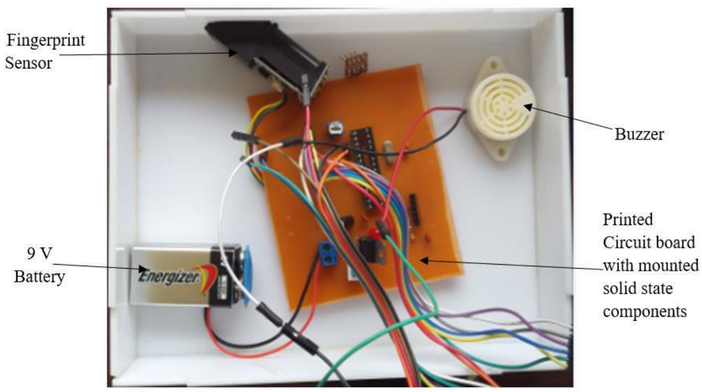

Fig. 8System Design

System Operation

The system operates by employing two major stages, which are the enrolment and identification stages.The enrolment stage involves hitting the enrolment button. The system displays “scan finger”, such that the fingerprint sensor takes the image of any finger it senses. This is kept in the system’s database for later identification. The image taken can be assigned an identification using coding, whereby the name and index number of the bearer of the fingerprint are stored in the database.The identification stage involves hitting the identification button of the system, such that the system displays ‘‘place finger’’ on its 16 × 2 LCD screen. If the system senses a finger placed on the fingerprint module, it proceeds to look for a match of the fingerprint in its database. If it does not find a match, it displays “match not found” on the screen.On the other hand, if the system is able to find a match of the fingerprint requested, it displays the person’s details and the buzzer beeps as depicted in the flow chart in Fig. 9.

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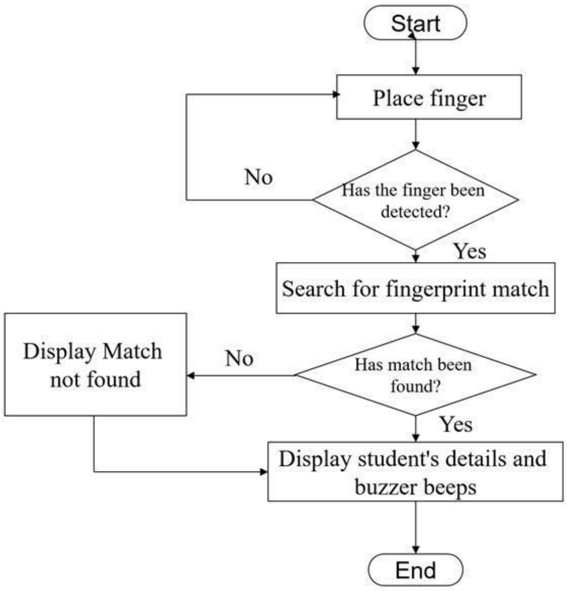

Fig. 9Flowchart of System

System Setup

The design of the fingerprint identification system involved the use of software and hardware. The main software used as the programming environment was the Arduino 1.0.5 which was compatible with the fingerprint module for giving commands. The following were some of the cases involved with the actions taken and the results obtained from the actions.

Programming the AVR Microcontroller

The commands were carefully written and loaded into the Arduino software. The Arduino software has a preburned bootloader that allows codes to be uploaded on it without employing any external hardware programmer. Fig.10 shows a picture of the codes uploaded into the Arduino software, for the fingerprint module and microcontroller's usage. Appendix A shows the codes used to programme the microcontroller in the Arduino software.

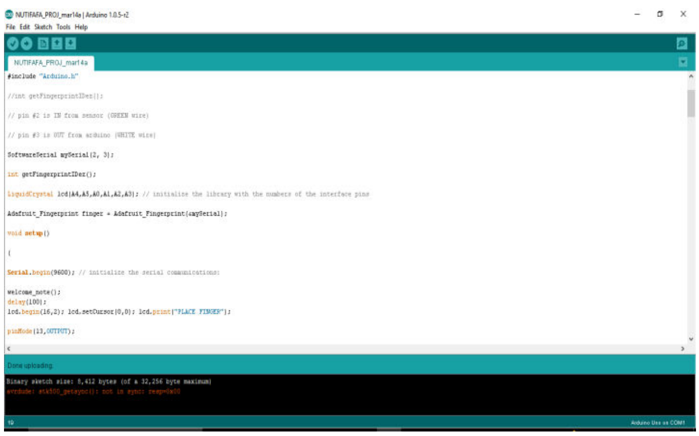

Fig. 10Programming Codes for System

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IV. RESULTS

Successful testing of the designed system confirms the success of the design. The commands written for the system indicated the results wanted

Fig. 11Display of Instructions

Discussions

During the practical operation of the system, some results and observations made are discussed as follows. During the enrolment stage, after the enrolment button was hit, the system displayed “scan finger” on its screen. When a candidate placed the finger on the fingerprint module, the image of the candidate’s fingerprint was taken and stored in the system’s database. The system continued to display “scan finger” until it had the right fingerprint pattern of the individual.During the system’s identification stage, the system displayed “place finger”. When a candidate with the fingerprint in the database placed the finger on the fingerprint sensor, the system displayed the number with which the candidate enrolled. This number was accompanied by a confidence level. The confidence level is a number range from 0 to 250 that indicates the level of trust the system gives to the fingerprint being identified. This is to indicate how close the match is with the one stored in the system’s memory. The system also displayed the person’s details and “match found” on its screen coupled with the sounding of the buzzer, to a recognition of the fingerprint in its database. It rather displayed “match not found” coupled with no buzzer sound, to indicate the absence of a fingerprint in its database.

VI.CONCLUSION

This design effectively identifies students that are enrolled in the system’s database taking relatively less time (less than 0.5 seconds) for the fingerprint module to capture the image. This means the system takes less time during enrolment for examination and hence less time during the identification stage. The design will eliminate the stress students and invigilators pass through to check identification.

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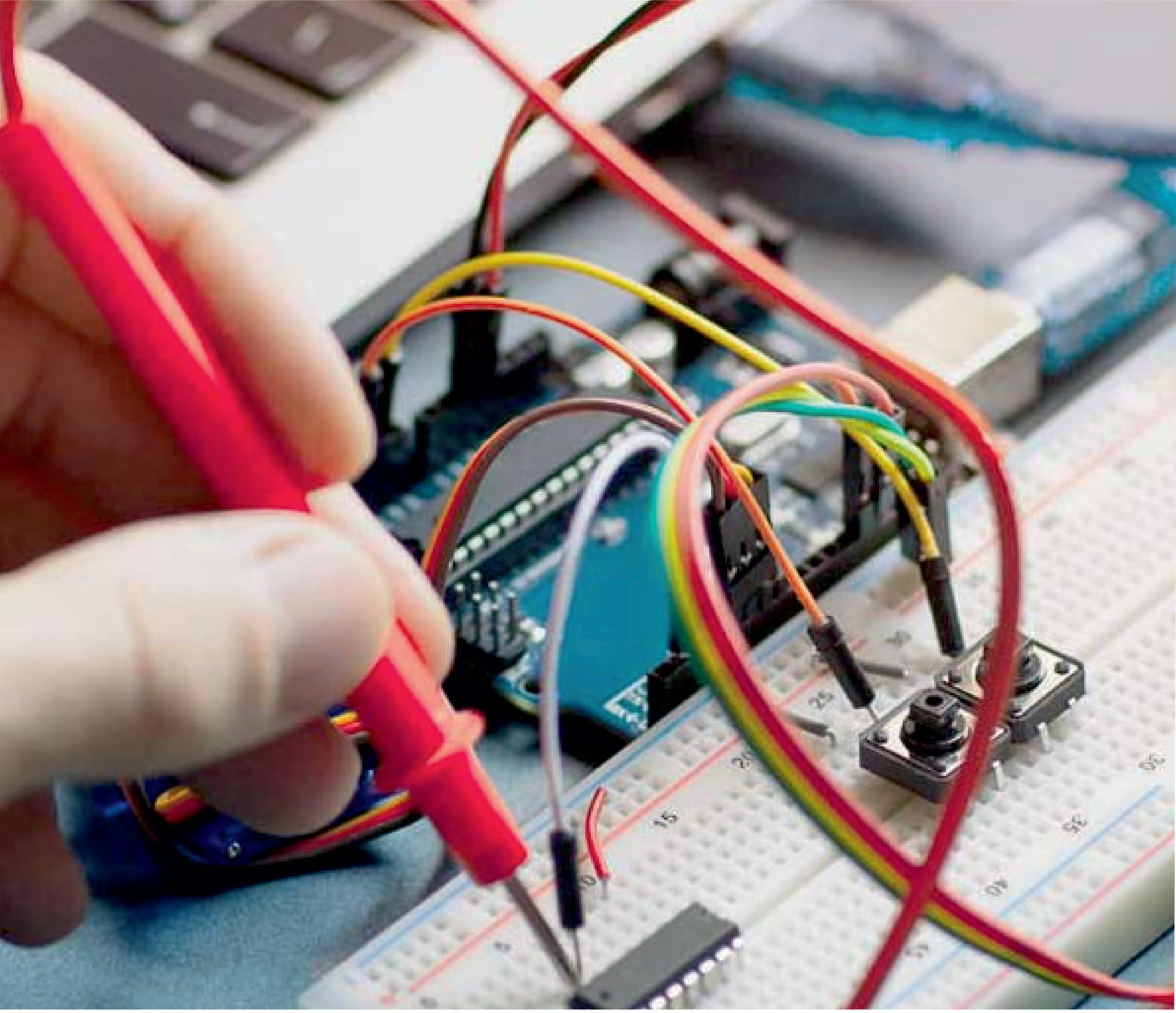

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