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A Solar Powered Electric Bicycle (Bike or Cycle) System for a Two-Wheeler

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ABSTRACT: An attempt is made in the fabrication of a solar powered electric bicycle (bike or cycle) System for a two-wheeler.

There are so many vehicles that came to influence in the existing world. Their operating systems are based on the usual fossil fuel system. At the present sense the fossil fuel can exceed only for a certain period after that we have to go for a change to other methods. Thus we have made an attempt to design and fabricate an ultimate system (solar bicycle) which would produce the cheaper & effective result than the existing system. This will be very useful to the future needs of the world.

This works on electric power distributed by the DC electric motor receiving the current from a solar. The motor and the various parts are such as sprocket, chain assembly, bicycle and with easily available materials to serve and fulfill the purpose of the project.

KEYWORDS: solar powered electric bicycle, solar bicycle

I. INTRODUCTION

1. All vehicles that are in the market cause pollution and the fuel cost is also increasing day by day. In order to compensate the fluctuating fuel cost and reducing the pollution a good remedy is needed i.e. our transporting system.
2. Due to ignition of the hydrocarbon fuels, in the vehicle, some time difficulties such as wear and tear may be higher and more attention is needed for proper maintenance. Our vehicle is easy to handle and no fuel cost to the other existing vehicles. Hence a need for a change in the existing alternative system which can produce higher efficiency at minimum cost was thought about an attempt has been made to design and fabricate such an alternative system.
3. So this project "solar bicycle" is very much useful, since it is provided with good quality of power sources and simple operating mechanism. Hence "each and every drop of fuel saves our economy and meet the needs" is the saturation point that is to be attained as soon as possible. In order to achieve this saturation point we have to save and seek for some other source of power. This power, the alternate power must be much more convenient in availability and usage. The next important reason for the search of effective, unadulterated power are to save the surrounding environments, including men, machine and material of both the existing and the next forth generation of pollution, the cause for many harmful happenings and to reach the saturation point.
4. The most talented power against the natural resource is supposed to be the electric and solar energies that best suit the automobiles. The unadulterated zero emission electrical and solar power, is the only easily attainable alternate source. Hence we decided to incorporate the electric power in the field of automobile, the concept of many Multi National Companies (MNC) and to get relieved from the incorrigible air pollution.
5. This implementation concept is tried to the best two wheeler Bicycle. The various simple arrangements done for the good driving conditions of the SOLAR powered Bicycle with its most needed specifications was summarized in this report.

   This project is to design a solar capacitor bank powered vehicle with objective as follows:

   a) To design use photovoltaic source of power.
   b) To fabricate & assemble a working proto type model.

   This project is more focus on solar capacitor bank powered vehicle. The scope of this project is as follows:

   a) Selection of solar panel.
   b) Selection of capacitor bank.
   c) Selection of chassis, selection of motor etc.

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II. SOLAR BICYCLE

1. AN OVERVIEW

A solar bicycle is a vehicle, which is powered by sun's energy. A solar bicycle is a light weight, low power vehicle designed and built with a single purpose in mind – racing. They have limited seating (usually one, sometimes two people), they have very little cargo capacity, and they can only be driven during the day. It does, however, offer an excellent opportunity to develop future technologies that can be applied to practical applications.

Figure 1: Energy Flow Diagram of a Solar bicycle

The main component of a solar car is its solar array, consisting of photovoltaic cells, which collect the energy from the sun and converts it into usable electrical energy. The energy is passed either to the battery for storage, or to the motor to run the cycle, though a device called power tracker, which convert it into the required voltage. The decision on whether to transfer the power to the motor or battery is made by a small onboard computer called the motor controller. It is responsible for sending the electricity smoothly to the motor when the accelerator is depressed, controlling the torque that goes to the motor such that the car maintains the desired speed. Some bicycle also use a process called regenerative braking, which allows some of the kinetic energy stored in the vehicle's translating mass to be stored in the battery when the bicycle is slowing down.

III. ELECTRICAL SYSTEM

The heart of a solar bicycle is the electrical system, which is made up of batteries and power electronics. Power electronics include the peak power trackers, the motor controller, and the data acquisition system. The primary function of the power electronics is to monitor and control the electricity within the system.

3.1 BATTERIES:

A solar bicycle uses the battery pack to store energy, which will be at a later time. The battery pack is made up of several individual modules wired together to generate the required system voltage. The types of batteries used include:

- Lead-Acid
- Nickel-Metal Hydride (NiMH)
- Nickel-Cadmium (NiCad)
- Lithium Ion

The NiCad, NiMH, and Lithium batteries offer improved power to weight ratio over the more common Lead-Acid batteries, but are more costly to maintain.The battery pack is made up of several individual modules wired together to generate the required system voltage. Typically, teams use system voltages between 84 and 108 volts, depending on their electrical system. For example, Tesseract uses 512 li-ion batteries, broken down into twelve modules, which are each equivalent to a car battery, but only weigh 5 lbs each. Through an innovative pack design, the batteries are ventilated with even airflow to minimize temperature differences between the modules.

3.2 PEAK POWER TRACKERS:

The peak power trackers condition the electricity coming from the solar array to maximize the power and deliver it either to the batteries for storage or to the motor controller for propulsion. When the solar array is charging

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the batteries, the peak power trackers help to protect the batteries from being damaged by overcharging. Peak power trackers can be very lightweight and commonly reach efficiencies above 95%.

A maximum power point tracker (MPPT) is a DC-DC converter that matches the output of a PV string to the battery voltage in a way that maximises the power generated by the PV string.

The power generated by a PV string depends on the operating voltage. PV power increases steadily with operating voltage to a maximum, and then drops off rapidly as the voltage is increased further to the open-circuit voltage. A tracker allows the PV string to always operate at the most efficient point, independently of the battery voltage. For example, if your battery voltage is 100V and the ideal operating point for an array string is 2A x 120V = 240W, the tracker output will be 2.4A x 100V = 240W. In practice, there is always a small loss of 1-2% due to inefficiencies in the tracker electronics.

MPPTs are of three types:

- down (buck) converters, which convert the PV voltage to a lower battery voltage;
- up (boost) converters, which convert the PV voltage to a higher battery voltage; and

3.3 MOTOR CONTROLLERS:

This component performs the complex task of deciding how much current actually reaches the motor at a given time. This determination of current by the motor controller allows the car to accelerate, decelerate, or stay at a constant speed. The better motor controllers are up to 90% efficient.

3.4 TELEMETRY:

A team's telemetry system is used for data acquisition. A commercial or custom system monitors conditions such as speed, battery voltage, power collection and consumption, and motor temperature. The system then relays that information to the driver and team strategists. Most telemetry systems allow for two-way data transmissions and are based on microcontrollers and radio modems.

IV. DRIVE TRAIN

The drive train will consist of the electric motor and the means by which the motor's power is transmitted to the wheel causing the vehicle to move. Due to the low amount of power generated (less than 5 hp) usually only one wheel in the rear of the car is driven by the electric motor. The motor types that have been used in solar bicycle include

- brushed DC motors
- DC brushless motors
- induction motors

DC brushless motors are commonplace in solar car racing. Rare-earth, permanent magnets mounted on the rotor, reacts to magnetic fields produced by the motor's windings. Three-phase windings allow the rotor remain at constant torque. A motor controller sends signals to the windings, regulating the magnetic field around the rotor. The most common type of motor used in solar bicycle is the dual-winding DC brushless. It is fairly lightweight and can reach efficiencies of 98% at their rated rpm.

The dual-winding motor is sometimes used as an electronic transmission. Switching between the dual windings changes the speed rating of the motor. The low speed windings provide high torque for starting and passing, while the high speed windings have higher efficiencies and are best for cruising.

There are several variations of two basic types of transmissions used in solar bicycle.

1. single reduction direct drive
2. variable ratio belt drive
3. hub motor

In the past, the most common type was the direct drive transmission where the motor is connected to the wheel through a chain or belt with a single gear reduction. This is a reliable and easily maintained transmission if special care is taken when aligning the components. Efficiencies above 75% can be achieved when designed properly.

For a variable ratio belt drive, gear ratio changes as the speed of the motor increases. This gives the motor more starting torque at lower speeds, but still allows the car to run efficiently at higher speeds. Variable belt drives require precise alignment and careful setup to work efficiently.

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A hub motor eliminates the need for any external transmission because the motor shaft is connected directly to the wheel hub. This greatly increases the efficiency of the drive train and reduces the number of moving parts necessary to drive the wheel. A hub motor uses low rpm to account for the lack of gear reduction, which tends to drop their efficiency slightly, but they still can achieve efficiencies in excess of 95%.

V. SOLAR INSOLATION

The energy from the sun strikes the earth throughout the entire day. However, the amount of energy changes due to the time of day, weather conditions and geographic location. The amount of available solar energy is known as the solar insolation or irradiance and is most commonly measured in watts per meter squared or W / m^2.

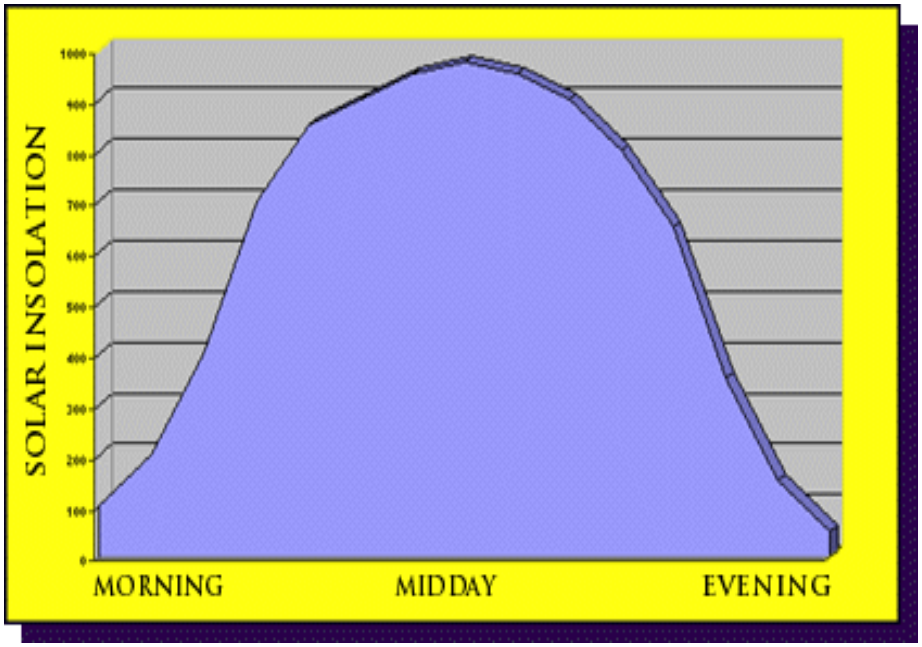

Figure 3: Typical solar insolation for a sunny day.

Solar irradiance is generally modelled as having three components:

- direct beam irradiance,
- diffuse irradiance, from the sky, and
- reflected irradiance, from the ground.

The sum of these components is called global irradiance. The irradiance that will fall on a surface depends on the many factors, including:

- the day of the year
- the position of the sun in the sky
- the inclination of the surface
- cloud cover.

These factors should be taken into account while designing the solar array.

VI. SOLAR ARRAY

Solar cells or photovoltaics collect the energy from the sun and converts it into usable electrical energy. They are made from silicon by joining an n-type and a p-type silicon semiconductor, creating an electron rich and an electron poor layer. When sunlight strikes the cell, photons cause atoms of the semiconductor to free electrons, leaving behind positive charges. The flow of electrons thus created constitutes an electromotive force that drives the current to charge a battery or power a motor.

The cell's positive contact is on the bottom while the negative contact, or bus bar, is located on the top of the cell. Each cell produces approximately .5 volts and 3 amps of current. Connecting the cells in series, i.e., positive to

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negative, increases voltage. Parallel connections, i.e., negative to negative and positive to positive, increase current. Therefore, connecting the cells in various series and parallel configurations produces modules of different voltages and currents.

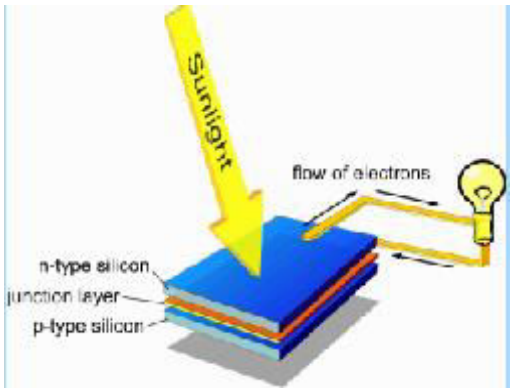

Figure 4: Schematic Diagram of a Solar

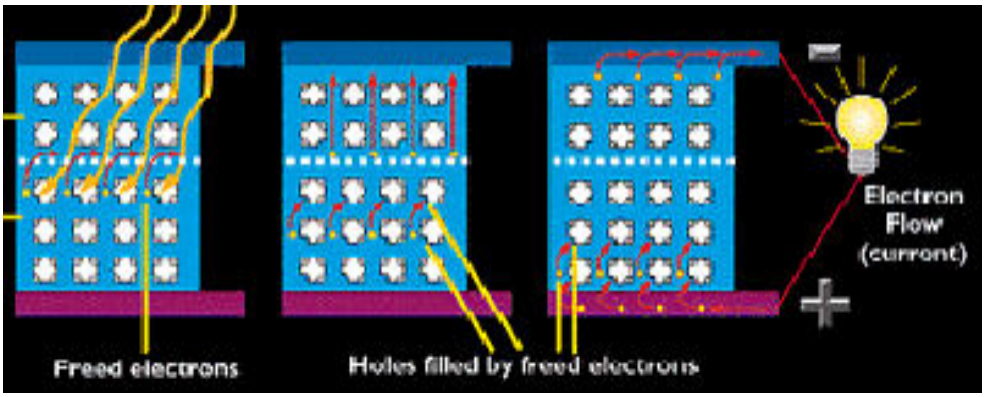

Figure 5: Solar Cell Diagram

Cells can be grouped into space grade and terrestrial grade categories:

- Space grade cells are up to 29% efficient, and are used mainly in satellite production due to their high cost. These high efficiency cells cost in excess of $500 per square inch.
- Terrestrial grade cells having a efficiency of 14%, are much cheaper causing them to be the cells of choice for solar bicycle. Each cell measures 10cm x 10cm, costs approximately $6.00, and produces 1.5 watts of power.

A large number of solar cells are wired together to form a solar array. The entire solar cells together form the solar array. Solar cells should also be divided into several zones. For example, if you have 750 solar cells, you might want to wire 3 sets of 250 cells, each zone producing about 125 volts. If one zone fails, two other zones are still producing power. SUNRUNNER'S array consisted of 14,057 razor blade sized, 16% efficient space grade cells.

The cells are extremely fragile. So many engineers put them through a process called **encapsulation**. Doing so strengthens solar cell durability, but decreases the efficiency. Encapsulation is the process of coating the cells with a tougher material like resins or sandwiching it between two sheets of fibre glass, which prevents the cells from being damaged. For cells 14% efficient, encapsulation would reduce the overall efficiency to12.5%.

VII. MATERIALS USED

A composite material is the combination of a filler material sandwiched between layers of a structural material. Carbon fibre, Kevlar and fibreglass are common composite structural materials. Honeycomb and foam are common composite filler materials. These materials are bonded together using epoxy resins and in the cases of Kevlar and carbon fibre, can obtain impressive strengths (equal to steel) but remain very lightweight. SUNRUNNER used Kevlar as the fabric with a Nomex honeycomb spacer while MAIZE& BLUE used carbon fibre fabric.

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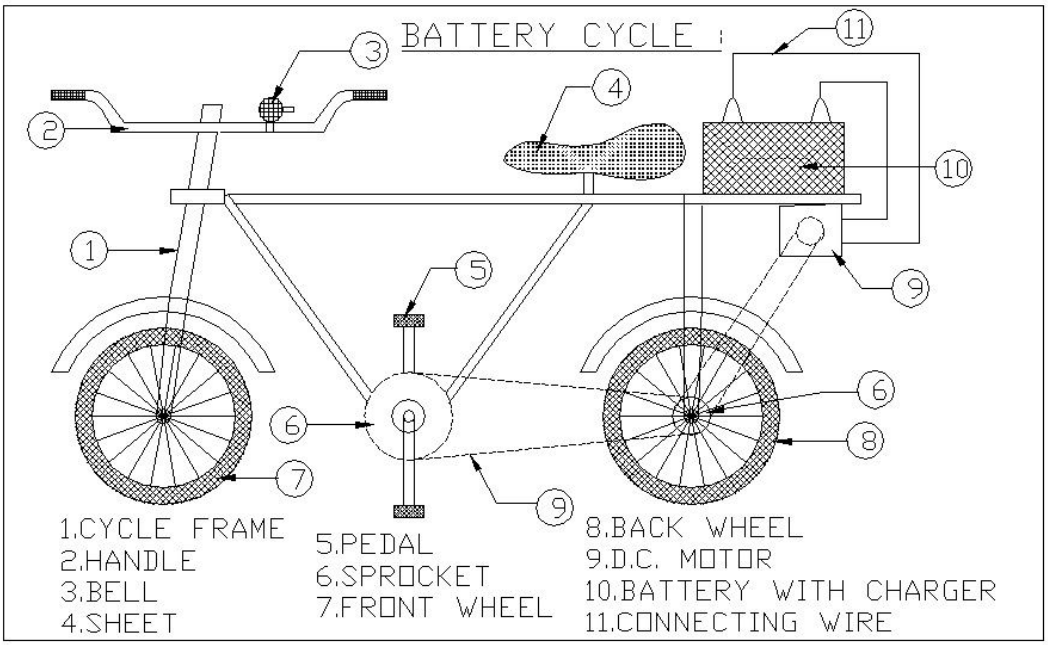

VIII. FALLING SHORT

There are several characteristics that a commercially viable car must have. Commercial bicycle typical can hold at least 4 passengers. It must be extremely reliable, comfortable, and be able to function on its own. It must also be able to maintain the required speed. In addition, commercial bicycle typically have amenities such as air conditioning, radio, and power locks and windows. Solar vehicles when driven on highways, experienced many flat tires and often were incapable of maintaining highway speeds of fifty-five miles per hour. With the energy available to solar bicycle, the type of amenities described above is impossible. The car is also a very cramped one. Hence it failed to break into the commercial car market as of now

IX. CONCLUSION

The solar bicycle are used exclusively for racing in tournaments, at present. Though they have been around for about twenty five years now, the technology is still in the developmental stages. Hence they can not be used as a practical means of transport. The challenge lies in making it a viable means of transport. Further research is needed in this regard to improve solar panels, reduce weight, to improve reliability and to reduce the cost. Research is being carried out on many semi-conductors and their alloys to develop more efficient solar cells. It can be safely assumed that with the advent of mass production there would be greatly reduced. Thus this technology will definitely live up to its potential some time in the future.

X. FUTURE SCOPE

In solar vehicle project, the main component is capacitor bank and as we know it needs to be charged periodically it is done using the solar panel but the problem is when the sun will disappear no charging will take place and vehicle will get stopped on the spot, but it can be overcome by using the latest technology.

The revolution in capacitor manufacturing and technological advancement lead to new type of capacitors called gold plated capacitors; they have the special feature of retaining the charge for longer period, if we use these types of capacitors the problem of charge loss can be overcome easily.

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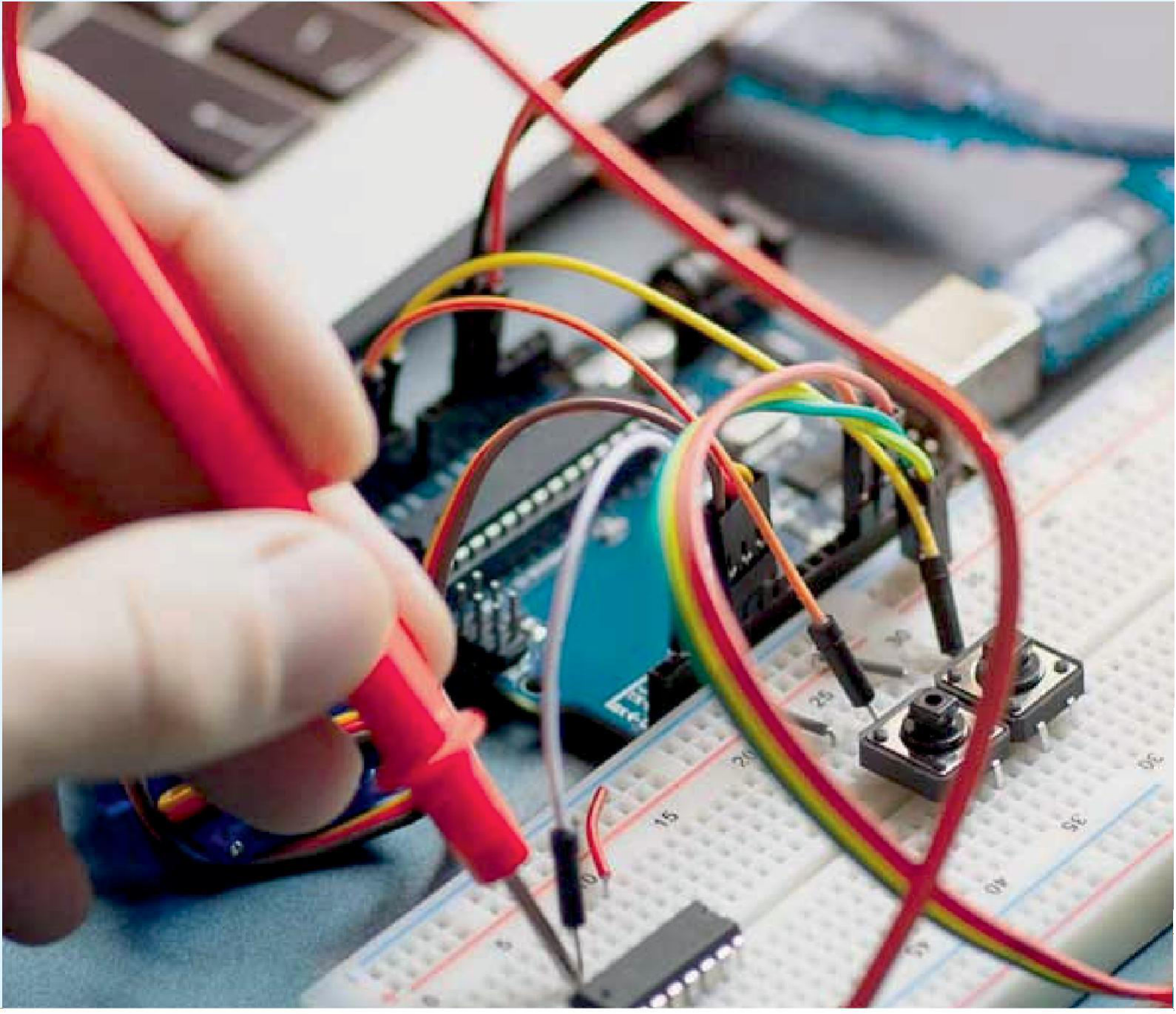

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