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Solar Powered Pwm Controlled -Controller Based Electric Hybrid Vechile

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ABSTRACT: The increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies. The second most important feature is it is pollution free, eco – friendly and noiseless in operation. For offsetting environmental pollution using of on – board Electric Bike is the most viable solution. It can be charged with the help of AC adapter if there is an emergency. The Operating cost per/ km is very less and with the help of solar panel it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

KEYWORDS: e-bike,solar panel,

I. INTRODUCTION

A solar bicycle is a bicycle which runs using the electrical energy of battery to run the hub motor which ultimately runs the bicycle. Solar energy is used to charge the battery. Two or more Photovoltaic cells may be used to harness solar energy to generate voltage to charge the battery. Battery gives the required voltage to the hub motor mounted on the rear wheel to run the bicycle. Solar bicycle are not sold generally in our everyday life but there manufacturing can be increased to prevent environmental pollution. These are primarily used as practical projects and are also sometimes sponsored by government agencies. There have been many patents on electrical vehicles in different countries and thus electric vehicles are not a very new concept. Utilizing solar energy to charge the battery and combining this concept with the concept of electricity generation pedaling is a new concept and there have been very less research in this regard.

There are two types of solar panels that are generally used that is, polycrystalline panels and microcrystalline solar panels. The polycrystalline panels are having less efficiency as compared to microcrystalline panels. Polycrystalline panels have efficiency of approximately 15 – 20% while microcrystalline panels have efficiency of 50 -60%. There are different types of batteries used in electric vehicles like lead acid batteries, lithium ion batteries, Nickel cadmium batteries, etc. Different batteries they have their different advantages for different applications. As far as solar bicycles are concerned lead acid and lithium ion batteries are most commonly used. Lead acid batteries have lower cost, higher current carrying capacity but have smaller life and are heavier. While lithium ion batteries have lower weight, but have higher cost and there are chances of explosion.

Slowly solar bicycle have gathered attention from all over the world and there have been many projects being done on this topic. The motor used is a permanent magnet Hub motor which will be mounted on the rear wheel. Bicycles and motorcycles are the two important form of two-wheeler transport in India. Bicycle has an advantage of very low running cost but has a drawback that, its range is mainly dependent on the physical fitness of the rider. On the other hand motorcycle has a very high range as compared to the bicycle but its running cost is very high. With increasing oil price the running cost of motorcycles will go up further in coming years. So the present need is to develop an alternate

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means of transport which has the advantages of both bicycle and motorcycle. Due to the increasing oil price this alternate means of transport should be powered by sources of energy like solar, wind etc that are freely available in nature and also free from pollution. Motorized bicycle powered by solar energy is an answer to all the above present needs. The work "solar bicycle" aims at:

1. Developing an alternate mode of transport, which has an advantage of low running and long range.

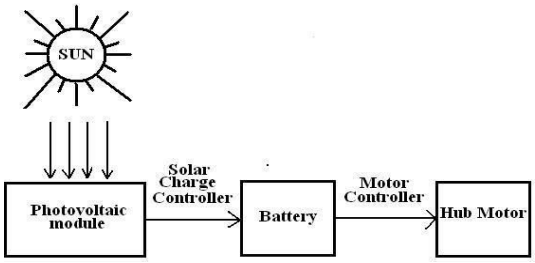
2. Developing environmentally sustainable zero emission vehicle.

3. Effective utilization of solar power

4. Reaching grass root level population of India to make a common man's daily commutation affordable

II. METHODOLOGY OF SOLAR-ELECTRIC BICYCLE

The solar hybrid bicycle consists of following components - hub motor, solar panel, lead acid battery, motor controller, accelerator, bicycle



Block diagram of solar Bicycle

Block diagram shows the methodology incorporated for the construction of solar powered bicycle as compared to any other motor driven vehicles. Photovoltaic cells of 24V, 10W each are mounted suitably in front and back end of the bicycle. The PV cells are connected in series to deliver a voltage of 48V. Charging of battery by PV cell is controlled by solar charge controller. This increases battery life, which would be otherwise less because of variation in solar radiations. The so generated electrical power is stored in battery. four 12V, 7AH sealed lead acid battery is connected in series to produce a voltage of 48V, 7AH. The motor used is 48V/250W Hub Motor mounted on the rear wheel of the bicycle. This motor is powered by battery. This motor has an advantage of high torque to weight ratio, low supply voltage and easily mounted on the rear wheel. Hence it is more suitably chosen. Motor controller is provided to control the speed of the cycle. Connections from the battery, motor and throttle are given to the motor controller. The motor is switched ON using throttle. It provides a variable speed control usingpotentiometer. Solar Bicycle gives an option to run motor whenever required and also manual pedaling.

HUB MOTOR

Most electric-powered vehicles (electric cars, electric bicycles, and wheelchairs) use onboard batteries and a single, fairly ordinary electric motor to power either two or four wheels. But some of the latest electric cars and electric bicycles work a different way. Instead of having one motor powering all the wheels using gears or chains, they build a motor directly into the hub of each wheel—so the motors and wheels are one and the same thing [10] . That's what we mean by a hub motor.

The permanent magnet DC hub motor is a conventional Dc motor. The stator is inside the rotor with the permanent magnets placed inside. The stator is fixed on the axle and the hub will be made to rotate by AC supplied by the batteries. It generates high torque at low speed, which is highly efficient and which doesn't need sprockets, brackets and drive chains. Thus they are very reliable and have a long life. Fig 4.2 shows a hub motor and Fig.4.3 shows a hub stator. The main feature of the Brushless DC Machines is that they can be controlled to give wide constant power speed ranges. The basic idea is just the same. In an ordinary motor, you have a hollow, outer, ring-

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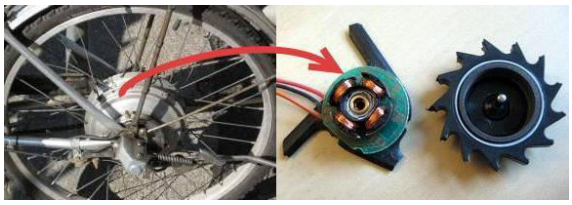
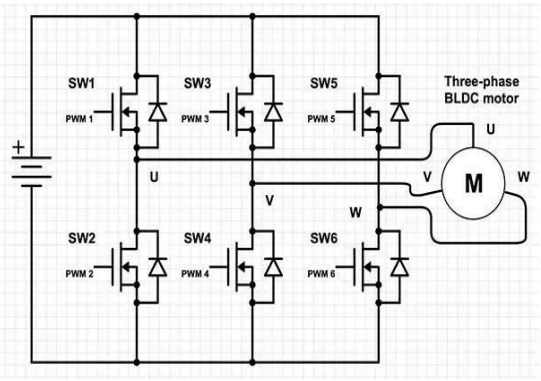
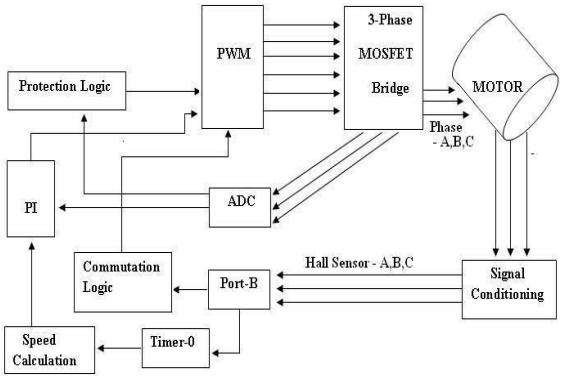
shaped permanent magnet that stays static (sometimes called the stator) and an inner metallic core that rotates inside it (called the rotor). The spinning rotor has an axle running through the middle that you use to drive a machine. But what if you hold the axle firmly so it can't rotate and switch on the motor? Then the rotor and the stator have no choice but to swap roles: the normally static rotor stays still while the stator spins around it. Try it with an electric toothbrush. Instead of holding the plastic case of your toothbrush (which, broadly speaking, connects to the static part of an electric motor), try holding only the bristles and then turn on the power. It's quite tricky to do, because the brush moves so fast, but if you do it right you'll find the handle slowly rocks back and forth. This is essentially what happens in a hub motor. When you switch on the power, the outer part of the motor rotates, becoming a wheel (or wheels) that powers the vehicle forward. Fig 4.4 shows the crossection of hubmotor.





MOTOR CONTROL

A motor controller is an important element of the solar hybrid bicycle or can be called as the brain of the vehicle. It controls the amount of power supplied to the hub motor and also to the lights and horn if required. The motor controller performs the function of conversion of the DC voltage from battery to an alternating voltage with variable amplitude and frequency that drive the hub motor at different speeds. It basically consists of MOSFET transistors and small microprocessor that vary from detecting any malfunctions with the motor hall sensors, the throttle, to protect functions against excessive current and under-voltage. The design involves running the BLDC motor in a closed loop, with speed as set by a potentiometer as seen in Fig.



Motor controller - Block diagram

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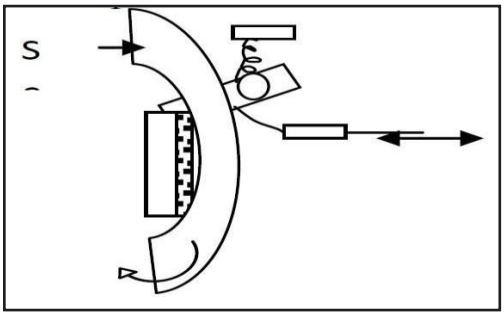
Once the motor starts running, the state of the three Hall sensors changes based on the rotor position. Voltage to each of the three motor phases is switched based on the state of the sensors. Hall sensor interrupt are counted to measure the motor speed. The commutation sequence by which windings get energized is shown in the Fig. Other peripheral functions are used to protect the system in case of overload, under-voltage and over temperature.



The three-phase MOSFET bridge as shown in Fig. is used to drive the three phases of the BLDC motor

Fig. Three phase MOSFET bridge

The DC bus is maintained at 48V, which is same as voltage rating of the BLDC motor. A separate Hi-Low gate driver is used for each high and low-side MOSFET phase pair, making the hardware design simpler and robust. The high-side MOSFET is driven by charging the bootstrap capacitor. The DC bus voltage is monitored by reducing it to suitable value using a potential divider. The DC bus current is monitored by putting a shunt in the DC return path. An NTC-type temperature sensor is mounted on the MOSFET heat sink, providing analog voltage output proportional to temperature.

The PWM module contains a six-channel configured to run in independent mode, The switching frequency is set to 10KHz because as a rule of thumb PWM frequency should be at least 10 times that of the maximum frequency of the motor. The output on the individual channelsiscontrolledaccordingtotheinputsfromtheHallsensorsasshowninfig.The inputs from the Hall sensors determine the sequence in which the three-phase bridge MOSFET is switched. The Duty cycle of the PWM is directly proportional to the accelerator potentiometer input. The change in the duty cycle of the PWM within the sequence reduces the average voltage supplied to the stator which in turn controls the current through the motor winding, thereby controlling motor torque and speed. Trapezoidal commutation is used for this application to make implementation simple.

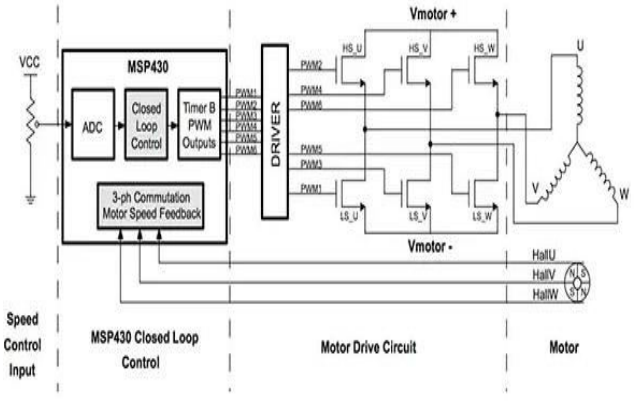


Fig. Detailed circuit diagram of motor controller

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SOLAR CHARGE CONTROLLER

Solar charge controller function is to regulate the power flowing from a photovoltaic panel into a rechargeable battery. Current limiting is provided by the solar panel –it is not a commonly understood fact that the solar panel tends to be a constant current device. For this reason, a solar panel can withstand a short circuit. Therefore, the control does not need current limiting.The circuit activation section uses a comparator to switch power on for the rest of the Solar Charge Controller. When the PV voltage is greater than the battery voltage, Comparator gives an output which turns on and sends power to voltage regulator. Voltage regulator produces a regulated power source (Vcc). This is used to power the Solar Charge Controller circuitry. The float voltage comparator compares the battery voltage to the referencevoltage

The output of float voltage comparator goes high (+Vcc) when the battery voltage is below the float voltage setting. The output goes low when the battery voltage is above the float voltage setting. This provides the charge/idle signal that controls the rest of the circuit. The charge/idle signal is sent to a pair of D-type flip-flops. The flip-flops are clocked by the clock oscillator. The clocking causes the flip-flop outputs to produce a square wave charge/idle signal that is synchronized with the frequency of the clock oscillator. The pair of D-Flip flops operate in synchronization, first flip-flop is used to drive the PV current switching circuitry, second flip- flop is used to drive the charging state indicator LED green (charging). The clocked charge/idle signal switches bipolar transistor on and off. This signal is used to switch power MOSFET, which switches the solar current on and off through the battery. Diode ZD prevents the battery from discharging through the solar panel at night. Fuse F1 prevents excessive battery current from flowing in the event of a shortcircuit

BRAKING SYSTEM

For the braking system it is convenient to use braking system used in band brake system which consist of spring loaded friction- shoe mechanism, which is driven with the help of hand lever as shown in fig

Fig. Braking system

III. DESIGN OF SOLAR-ELECTRIC HYBRID BICYCLE

Diameter of wheel (D)= 60cm

Weight of Bicycle= 40 kg

Weight of Rider= 70 kg

Speed(v)= 35 kmph

POWER CALCULATIONS

Normal reaction (N) on each tyre = W/2= 110/2= 55kg= 55*9.81=**539.55 N**

Friction Force (F) acting on each tyre :

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For Static Friction, u= 0.03

F= u*N= 0.03*539.55= 16.1865 N

For Dynamic friction u=0.004

F= u*N= 0.004*539.55= 2.1582 N

TORQUE REQUIREMENT (t)

For static Friction, T= F*R= 16.1865*0.305= 4.9368~5Nm

SPEEDCALCULATIONS

w= V/R= 15000/(0.305*3600) = 13.67 rad/sec

POWER REQUIREMENT (p)

On plainground

For Dynamic Friction, P= T* w = 9watt
For Static Friction, P= T* w = 68.35 watt

Overall power requirement= 68.35*2= 136.7watt

A) On Inclined Surface,a=2

B) total force required to move vehicle

F= u*mg*cos(a) + mg sin(a)
F= 70.013N
Therefore, power required = F* V = 291.72 W
By considering dynamic friction,
F= 0.004*110*9.81*cos(2) + 110 * 9.81*sin (2)
Power (P)= F*V= 174.611 W

BATTERY SELECTION

Since motor selected is of 48V hence battery voltage rating should also be 48. Therefore we select four batteries of 12V and 7.5 Ah in series combination of we get 48 V and 7.5 Ah

CHARGING TIME.

Time required to charge the battery by adapter 12 V 12Ah

T= (48*12) / 144 = 4 hrs.

MAXIMUM CARRYINGCAPACITY

The total weight of the cycle is 30kg

Weight of the cycle (without any assembly) = 20kg

Weight of the battery=2.5 kg

Weight of motor= 2.5 kg

Total weight of the cycle (20+5+2.5+2.5) kg= 30 kg

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IV. IMPLEMENTATION AND RESULT

Time management is an important factor which is to be given serious concern at every engineering level and the same is to be applied at this moment so as to give a better and maximum efficient project. The product so designed is to be done before the dead line and should be in working condition as the feasibility and availability requirements have to fulfilled before the dead line, so that we can work on designing of the project which is to be completed before the end of 7th semester so as to purchase the required project. After the completion of the designing of the project the main thing left to do was the fabrication process which has been done in this semester including the testing and checking of the project manufactured

Maximum Speed : 35 km/hr

Range : 10 km

Charging Time : 4 hours

Battery Life : 2 years

Running Cost : Nil

V. CONCLUSION

It is an attempt by us to make developing India aware about the other non conventional ways of utilizing the renewable energy in our day to day life. We also want to represent INDIA shoulder to shoulder with the other developed/developing nations of the world and to test the technology on the biggest possible platform. It was indeed a small drop in ocean to decrease the global warming. With the increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies. The second most important feature is it is pollution free, eco – friendly and noiseless in operation. For offsetting environmental pollution using of on – board Electric Bike is the most viable solution. It can be charged with the help of AC adapter if there is an emergency. The Operating cost per/ km is very less and with the help of solar panel it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

REFERENCES

[1] Ajit B. Bachche , N. S. Hanapure 'Design and Development of Solar assisted bicycle' volume 2 , issue 2, December 2012, IJ

[2] HeneryGannon , 'Electric and pedal driven bicycle with solar charging', patent no. 5316101, May 31 1994

[3] Glenn C. Streif', 25052 Campo Rojo, - Lake Fomst' Calif- 92630, 'Solar powered Two wheeled vehicle with Energy intensifying Solar Collector'

[4] V.B. Bhandari, Design of machine elements, The McGraw. Hill Companies, Second Edition

[5] S.S. Ratan; Theory of Machine, the McGraw. Hill Companies, Second Edition.

[6] F. Boico, B. Lehman, K. Shuj

aee, "Solar Battery chargers for NiMH Batteries" *IEEE*

[7] E. Radziemska, E. Klugmann, "Photovoltaic maximum power point varying with illumination and temperature," Journal of Solar Energy Engineering, Vol. 128, Issue 1, February 2006, pp.: 34-39

[8] Zilog Electric bike BLDC hub motor control,Z8 Encore MC

[9] Aikenhead, G. S.,"Bicycle Applications for On-Board Solar Power Generation", pp. 9-10, 2011

[10] Barve, D. S.,"Design and Development of Solar Hybrid Bicycle", International Journal of Current Engineering and Technology, pp. 378-379, 2016.

[11] Barve, D. S.,"Design and Development of Solar Hybrid Bicycle", International Journal of Current Engineering and Technology, pp. 380, 2016

. [12] FOGELBERG, F.,"Solar Powered Bike Sharing System", Goteberg,Sweden: Viktoria Swedish ICT, 2014.

[13] F. ASHOK ,"Solar Powered Bike", Goteborg, sweden: Viktoria Swedish ICT, 2014.

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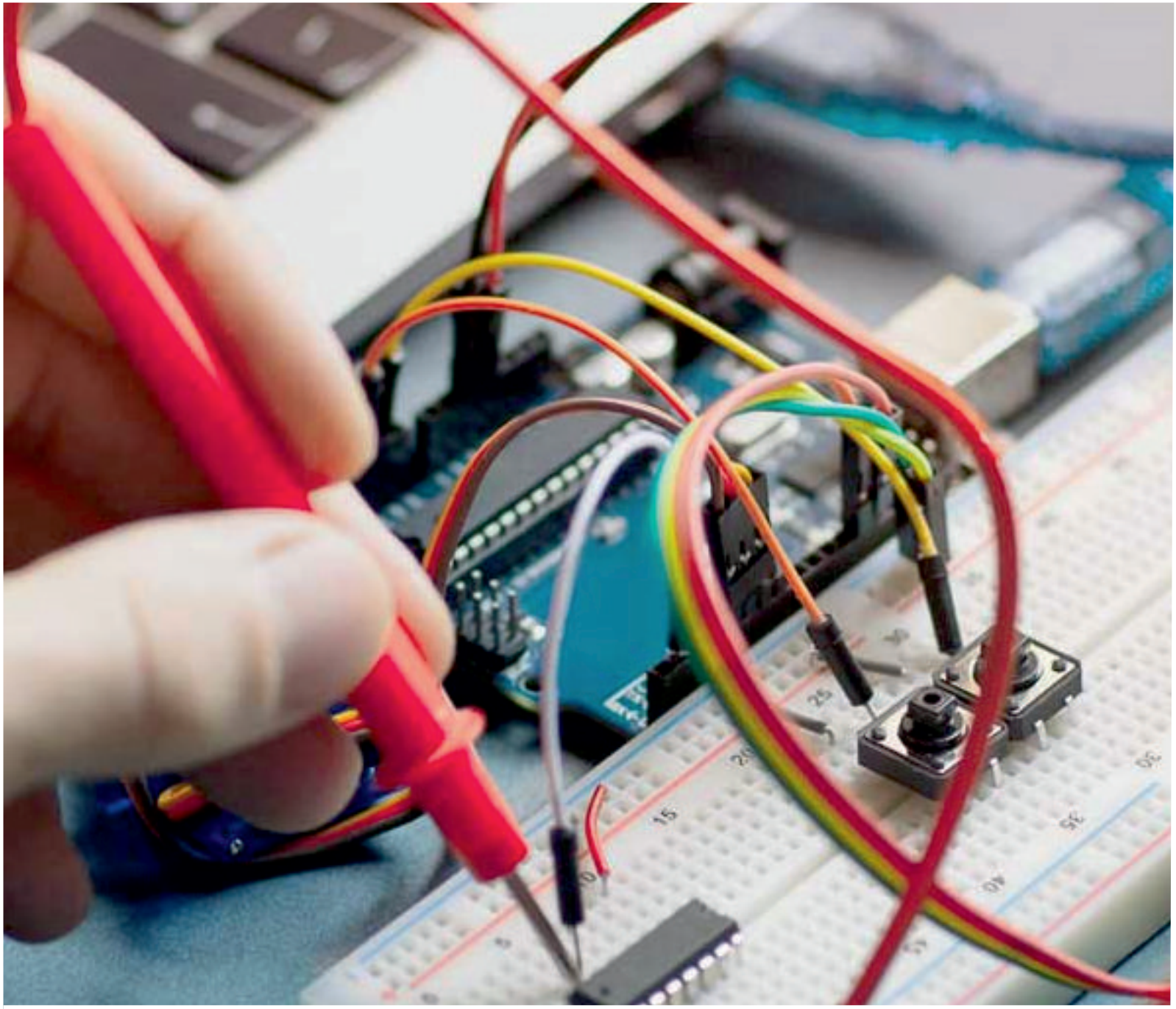
[14] GOODMAN, J. D.,"An Electric Boost for Bicyclists", The New York Times, 2010.
[15] Prof. Palak Desai, P. D.,"Design And Fabrication Of Solar TRI Cycle", International Journal of Engineering Sciences & Research, pp. 664, 2016.
[16] T.Bhavani,"Novel Design of Solar Electric Bicycle with Pedal", International Journal & Magazine of Engineering, pp. 108, 2015.
[17] BLDC motor fundamentals- Padmaraja Yedamale, AN885, Microchip Technology Inc.



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