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Relative Study of Inconsistent Size P&O based Maximum Power Point Tracking (MPPT) for PV systems

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ABSTRACT: Maximum Power Point Tracking (MPPT) techniques are used in photovoltaic (PV) systems to maximize the output power of the photovoltaic field, incessantly monitoring the Maximum Power Point (MPP) that depends on the temperature of the panels and the radiation circumstances. The MPPT problem has been addressed in dissimilar ways in the literature, but, especially for low-cost implementations, the algorithm for tracking the point of maximum disturbed and observed power (P&O) is the method most used for its ease of use. implementation. A disadvantage of P&O is that, in a stable state, the operating point fluctuates around the MPP resulting in the waste of a certain amount of available energy; Furthermore, it is known that the P&O algorithm can be confused throughout those time intervals characterized by rapidly evolving atmospheric conditions. This paper shows that, The performance of the developed model is tested under different Load conditions. Our Proposed PV model controlling a motor and battery with control architecture. Rapid Time is reduced from 10-20 second to 0.05 second. Using PID controller along with MPPT algorithm produce stable power with less transient time and also improve quality of supply for sensitive industries.

KEYWORDS : Maximum power point tracking (MPPT), photovoltaic (PV) systems, Perturbation and Observation (P & O)

I.INTRODUCTION

Renewable energy is energy that is collected from non- depleting resources, which are naturally replenished, such as sunlight, wind, tidal waves. This energy consumption is sub-divided as 8.9% from traditional biomass, 4.2% as heat energy,3.9% hydroelectricity and 2.2% is electricity from solar energy, wind, geothermal, and biomass. Globally fund invested in renewable technologies is more than US$286 billion in 2015, with China and the United States diverting funds heavily in wind, hydro, solar and bio fuels. Universally, about 7.7 million jobs linked with the renewable energy industries, with solar photo voltaic' being the largest employer. As of 2015 globally, about half of all new electricity capacity installed was renewable.

Different type of renewal energy sources

A). Wind power: Air pressures used to run wind turbines. Modern wind turbines range from around 600 kW to 5 MW, however turbines with rated output of 1.5–3 MW have become the most common for commercial use. The largest generator capacity of a single installed wind turbine reached 7.5 MW in 2015.

B). Hydro power: hydropower generated 16.6% of the world total electricity and 70% of all renewable electricity till 2015. Since water is about eight hundred times denser than air, even a slow flowing stream of water, or light sea swell, can yield considerable amounts of energy. There are many forms of water energy.

C). Solar energy: Solar energy, radiated light and heat from the sun, is harvested using a range of various technologies such as solar heating, photovoltaic cell, concentrated solar power (CSP), concentrator photovoltaic (CPV), solar architecture and artificial photo synthesis.

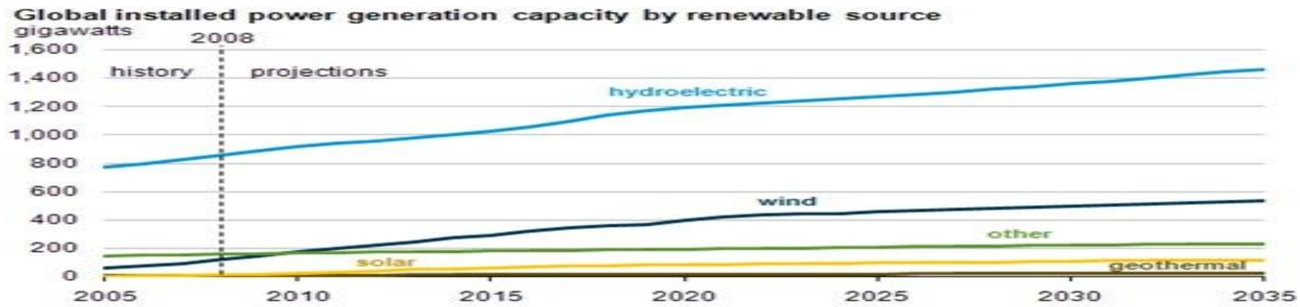

Fig. 1: - Comparison Power generation in different source.

Materials used in PV cell

The materials used in Photovoltaic (PV) cells are as follows:

a) Single crystal silicon:

Single crystal silicon cells are most commonly used in the Photovoltaic (PV) industry. The main procedure for producing single-crystal silicon is the C Zochralski (CZ) method. High-purity polycrystalline is melted in a quartz crucible. A single-crystal silicon seed is dipped into this molten mass of polycrystalline. As the seed is pulled slowly from the melt, a single-crystal ingot is designed. The ingots are then sawed into thin wafers about 200-400 micrometers thick (1 micrometer = 1/1,000,000 meter). The thin wafers are then refined, doped, coated, interconnected and assembled into modules and arrays.

b) Polycrystalline silicon:

Consisting of small grains of single-crystal silicon, polycrystalline Photovoltaic (PV) cells are less energy efficient than single-crystalline silicon Photovoltaic (PV) cells. The grain boundaries in polycrystalline silicon hinder the flow of electrons and reduce the power output of the cell. A common approach to produce polycrystalline silicon Photovoltaic (PV) cells is to slice thin wafers from blocks of cast polycrystalline silicon. Another more advanced approach is the “ribbon growth” method in which silicon is grown directly as thin ribbons or sheets with the approach thickness for making Photovoltaic (PV) cells.

II. PROBLEMS IDENTIFICATIONS

As is clear from the review of the related literature a lot of problems like Power quality (voltage sag, voltage swell, Transients) are identified and studied. The photo voltaic system convert sunlight to direct current. The solar array is formed by connecting individual solar panel system together. The output current of solar array depends on the ambient temperature, solar radiation, the size and configuration of the PV array. In general, the larger area photo voltaic panels will generate more energy, and smaller photo voltaic panels generate less energy. From the simulation result, the PID controller has shown the better performance than other MPPT techniques. In study of literature we observed that if we did not use PID controller with MPPT then output power was low. It gets improved when we apply the PID controller along with MPPT complete control architecture and getting the output power is increased. After Appling MPPT and PID controller the output results of the current, voltages and power get improved. Previous Test results indicate that diesel generator can compensate PV power reduction relatively fast. The proposed method could be used to levelling PV output power fluctuation and reduce the frequency deviations and maintain resilience on the grid. “The three test results indicate that diesel generator can compensate for the rise and fall in solar active power in a relatively rapid time (10 to 20 seconds) and maintain the stability of grid frequency”.

III.OBJECTIVES

This thesis presents the MATLAB SIMULINK model of PV Grid with the control strategy needed for the improvement of power Quality at distribution end. The major objectives are as follows:

1. To analyse the effect of non-linear loads, linear loads and Motor loads on Distribution system.
2. To study, Design and simulate PV based power generation with battery controller.
3. To study and Present a systematic approach for designing PV Grid with various islanding faulty (LL-G)) loads.

4. Modelling of Indirect Current Control (vector control method) and VSC (Voltage source converter) theory.
5. To Study and Simulation of controllers like PID-PI And (Battery) Hysteresis controller.

IV.PERTURBATION AND OBSERVATION (P & O) METHOD

The P & O algorithm, as shown below in, operates by increasing or decreasing the array terminal voltage, or current, at regular intervals and then comparing the PV output power with that of the previous sample point. If the PV array operating voltage changes and power increases (dP/dV, PV > 0), the control system adjusts the PV array operating point in that direction; otherwise the operating point is moved in the opposite direction. At each perturbation point, the algorithm continues to operate in the same manner. The main advantage of this approach is the simplicity of the technique. Furthermore, previous knowledge of the PV panel characteristics is not required. In its simplest form, this method generally exhibits good performance provided the solar irradiation does not vary too quickly. At steady state, the operating point oscillates around the MPP voltage and usually fluctuates lightly. For this reason, the perturbation frequency should be low enough so

➢ P&O method Principle

In P&O method, the MPPT algorithm is based on the calculation of the PV output power and the power change by sampling both the PV current and voltage. The tracker operates by periodically increment or decrement the solar array voltage. If a given perturbation leads to an increase (decrease) in the output power of the PV, then the subsequent perturbation is generated in the same (opposite) direction. So, the duty cycle of the dc chopper is changed and the process is repeated until the maximum power point has been reached. Actually, the system oscillates about the MPP. Reducing the perturbation step size can minimize the oscillation. However, small step size slows down the MPPT. To solve this problem, a variable perturbation size that gets smaller towards the MPP.
However, the P&O method can fail under rapidly changing atmospheric conditions. Several research activities have been carried out to improve the traditional Hill-climbing and P&O Methods.

Block Diagram of Perturb and Observe (P&O) method:-

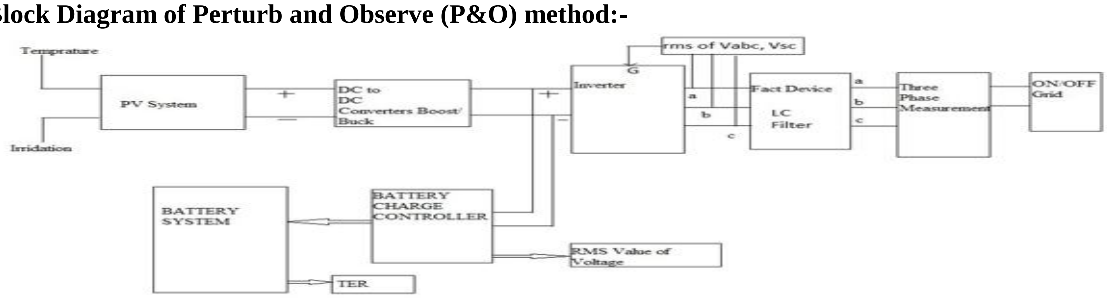

Fig. 2:-Block Diagram of Perturb and Observe (P&O)

➢ Perturb and Observe (P&O) method has the disadvantage

The classic perturbs and observe (P & O) method has the disadvantage of poor efficiency at low irradiation. For this reason, alternative solutions have been proposed. Combine a constant voltage (CV) algorithm with a modified P & O method to track the MPP with high efficiency under both low and high solar irradiation conditions. The algorithm operates by increasing the duty cycle until the PV output voltage is close to the open circuit voltage of the panel (VOC), this is then using the initial conditions for the MPP tracker. The algorithm then evaluates the current output; if the current is higher than (0.7 A) the algorithm adopts the P&O method; if it is lower it converts to the CV method. Simulation results demonstrate that overall greater energy can be extracted from the PV panel; efficiency levels of 95% to99% are quoted over a wide irradiation range. However, there is complication of combining the two methods.

The P & O method is also prone to erratic behavior under rapidly variation in light levels. This may result in slow, or incorrect, MPP tracking. Introduced a modified P&O (MP&O) method to solve this problem. The method adds an irradiance-changing estimate process in every perturb process to measure the amount of power variation caused by the change of conditions. Results show improved performance over the conventional P & O method. However, MP&O has a slow tracking speed which is approximately half of the conventional P & O method.

Model of PV cell:

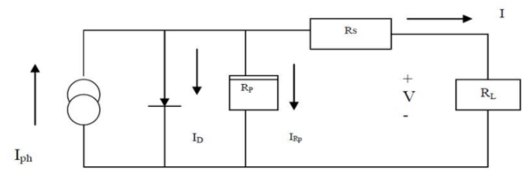

Fig. 3:- Equivalent circuit

An ideal solar cell is modeled by a current source in parallel with a diode. But no solar cell is ideal and therefore shunt and series resistances is added to the model as shown in the equivalent diagram shown in fig.

Here R_S= intrinsic series resistance whose value is very small and

R_P= equivalent shunt resistance has very high value.

$I=I_{ph}$-Id-IR_{sh}

$$I = I_{ph} - I_0\left(e^{\frac{q(v+IR_s)}{aKT}} - 1\right) - \left(\frac{V + IR_s}{R_{sh}}\right)$$

I = Cell current,

I_{ph}=photon current,

I_0= Reverse saturation Current of diode at T,

V = voltage across diode,

V_T= Thermal voltage,

K =Boltzmann constant,

T = Temperature in Kelvin,

q =Charge of an electron in coulombs

a=diode ideality factor, normally between 1 and 2

Structure of grid connection system

- This focuses on the overall design of a Photovoltaic (PV) system interfaced with a grid/stiff grid or utility.
- The description of each of the components of the Photovoltaic (PV) system, namely the Photovoltaic (PV) module, the boost converter, the inverter, and the grid. This description helps to understand the functionality of each component of the system, leading to its detailed mathematical design, the results of which are shown in the following chapters.
- A Glimpse of the architecture of the two-stage Photovoltaic (PV) system connected to a grid is shown in fig. 4. It is followed with sections describing the Photovoltaic (PV) cell, the MPPT controller, the DC-DC converter, the DC-AC converter, and finally the phase lock loop PLL.
- A parallel RLC load is connected to the system. P and Q represent the active and the reactive power, respectively, that is delivered from the Photovoltaic (PV) system to the grid, at Point of Common Connection (PCC). In different control aspects involved in a Photovoltaic (PV) system. Phase Locked Loop (PLL) is used to extract the phase angle (θ) and frequency (ω) at PCC. The current controller is used to control the AC side inverter currents. A DC-link voltage controller is used to maintain the Photovoltaic (PV) array voltage (V_{dc}or V_{pv}) at the reference value $V_{dcref\ which}$ is given by the MPPT controller.

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Interfacing of the PV Array with Boost Converter

The Photovoltaic (PV) array has been interfaced with the boost converter using a controlled voltage source as shown in the circuit diagram below.

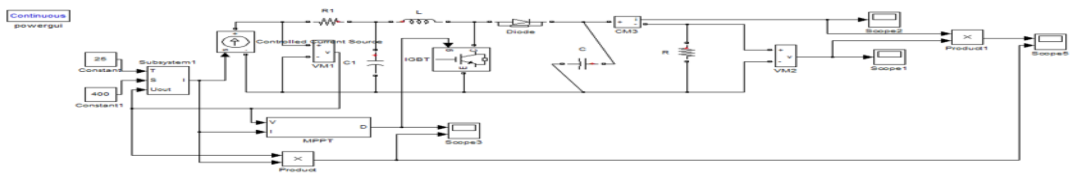

Fig.4 :- Simulink model of PV array with the boost converter

The detailed internal circuit of the Photovoltaic (PV) array showing the design is given below:

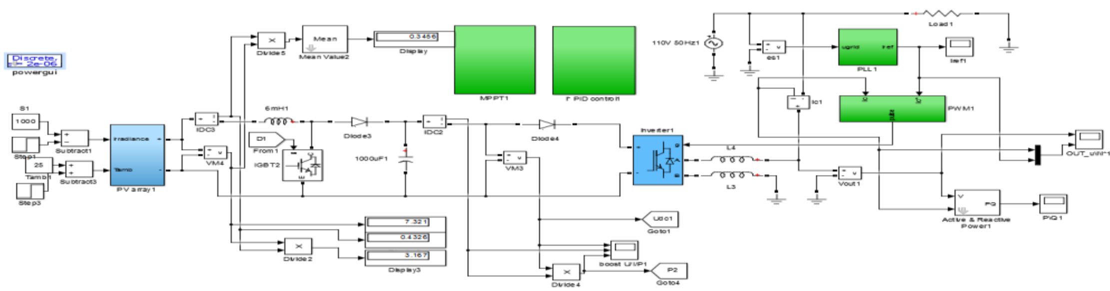

Fig. 5 :- Modeling of MPPT with PID controller.

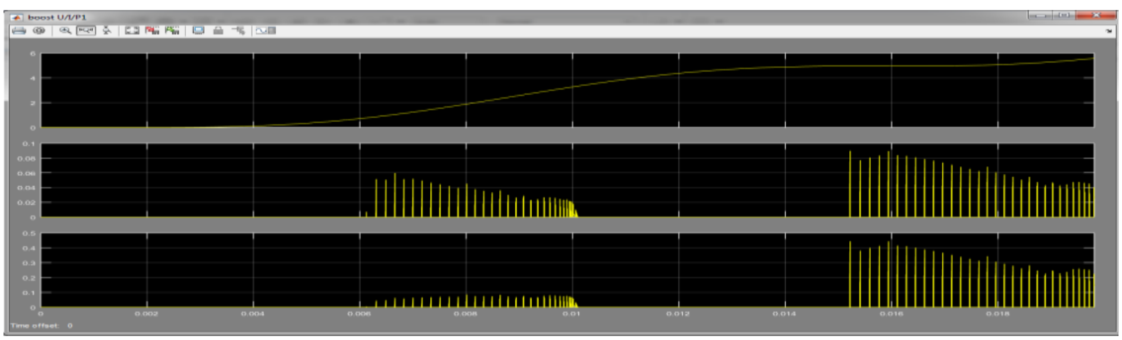

Fig.6:- Voltage, current and power variations.

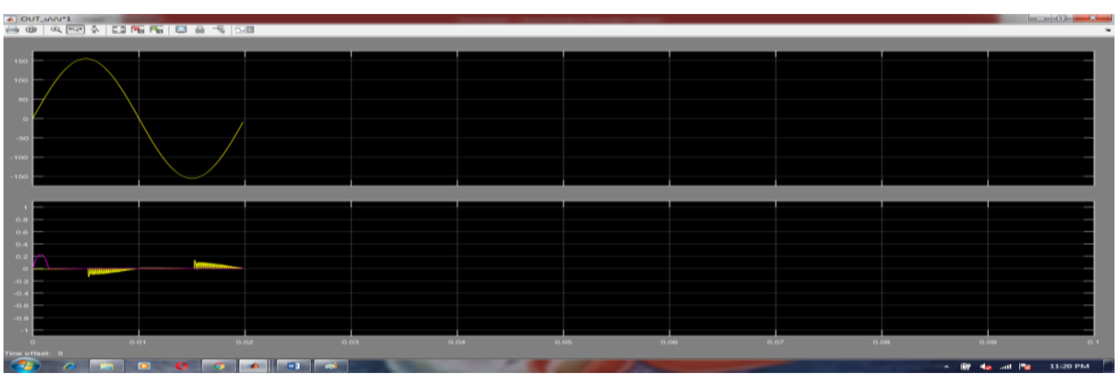

Fig. 7:- Single phase voltage and power.

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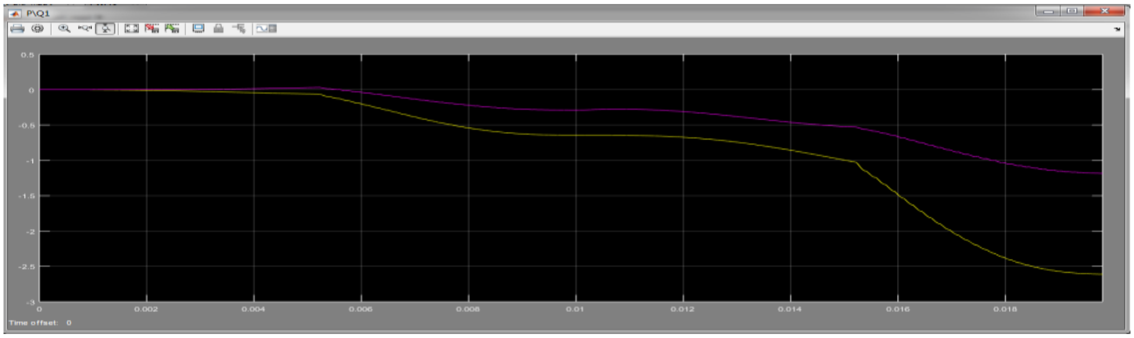

Fig.8 :- Active power deviations.

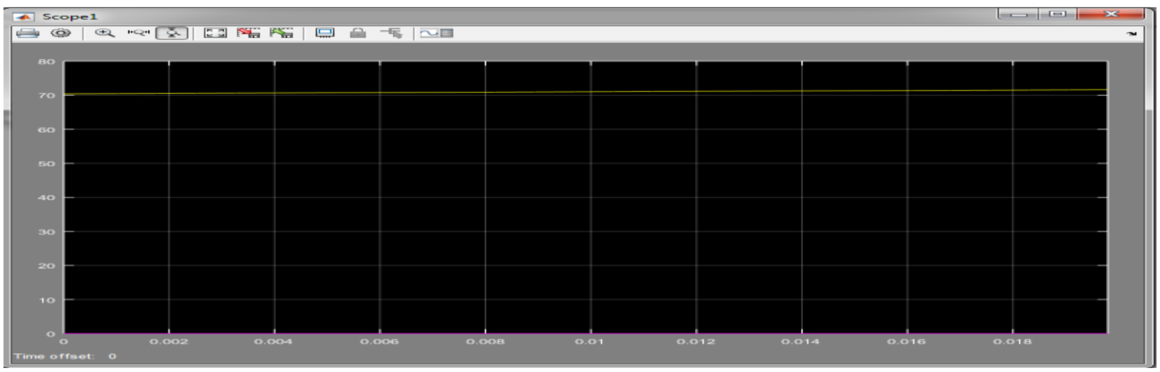

Fig . 9:- MPPT reference power.

PARAMETERS TABLE

1. without boost converter PV output:

Irms	**0.3456A**
V_{pv}	**0.4326V**
P_{pv}	**3.167Watt**
Temperature	**25^0C**
Irridation	**1000**

2. With Boost converter output:

Irms	**0.3456A**
V_{Total}	**150V(With Exponential Increase)**
PQ	**-2.61Watt,-1.183**
Kp	**0.00001**
Ki	**0.000015**
Kd	**0.000015**

V.CONCLUSIONS

The Performance of the developed model is tested under different Load conditions.

- Our Proposed PV model controlling a motor and battery with control architecture.
- Rapid Time is reduced from 10-20 second to 0.05 second.
- Using PID controller along with MPPT algorithm produce stable power with less transient time and also improve quality of supply for sensitive industries.
- Results of Perturb and observe algorithm produce good result mean to say able to obtain maximum power point in comparison with other algorithms.
- Our model using FACTS devices and PLL system improve voltage stability and minimizes Harmonics.
- Our model present best controlling Techniques for small to high load systems.

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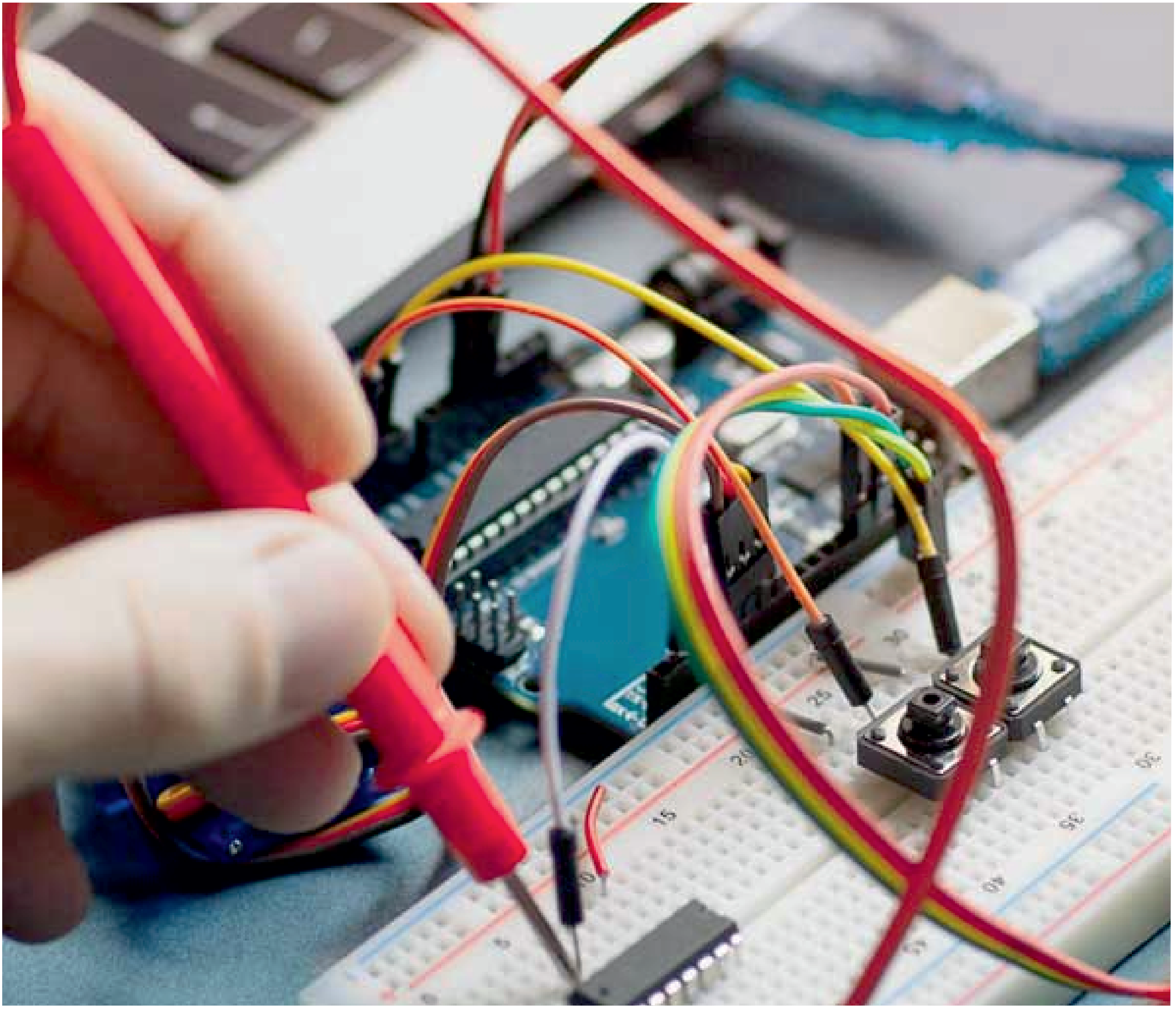

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