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Automotive Mechanical Vehicle Starter

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Abstract. This research is used to crank start automotive vehicle. There are many different system used in order to start-up vehicles using electric starter, in the time of battery low-power or totally drained. The purpose of this research is to help the driver to get out of this difficulty. Nowadays there are many people that have experienced such a bad moment, where they are stranded at road side due to malfunction starter in their car because of battery problem. Most of the vehicle electric starter failure is because of battery corrosion or battery undercharged. The importance of this research is to solve this problem. Starter is a vital part of the vehicle, without it no automotive vehicles able to operate. These starters will rotate an internal-combustion engine to initiate the engine's operation under its own power. Starters also can be malfunction too due to corroded electrical connections or an undercharged battery. This system can be used to solve this problem. This system used human energy by using mechanical parts in order to produce electrical power. In order to produce electrical current, workforce will be applied by rotating the wheel that already linked by belt and from that rotations will trigger a magnetic force and it will produce an electrical current and supply it into battery. This system is divided into two development; hardware development and software development. The hardware development involved, mechanical device which is used and electrical device such as monitor. For software development, Fritzing is used to construct circuit.

1. Introduction

A starter also known as self-starter, cranking motor, or starter motor is a device used to rotate the crank, an internal-combustion engine so as to initiate the engine's operation under its own power. Starters can be electric, pneumatic, or hydraulic. In the case of very large engines, the starter can even be another internal-combustion engine.

Internal combustion engines are feedback systems, which, once started, rely on the inertia from each cycle to initiate the next cycle. In a four-stroke engine, the third stroke releases energy from the fuel, powering the exhaust stroke and also the intake, compression strokes of the next cycle, as well as powering the engine's external load. To start the first cycle at the beginning of any particular session, the first two strokes must be powered in some other way than from the engine itself. The starter motor



is used for this purpose and it is not required once the engine starts running and its feedback loop becomes self-sustaining.

2. Theoretical Framework

2.1 Concepts of vehicle starter

This research is about the design and development of an automotive mechanical vehicle starter. Starter is a vital part of automotive vehicle. Kettering's key-operated electric self-starting ignition system, introduced on Cadillac vehicles in 1912 and patented three years later, made automobiles far easier and safer to operate than they had been previously, when the ignition process had been powered by iron hand cranks. By the 1920s, electric self-starters would come standard on nearly every new automobile [1]. These starters will rotate an internal-combustion engine to initiate the engine's operation under its own power. Starters also can be malfunction too due to corroded electrical connections or an undercharged battery. Automotive mechanical vehicle starter can be used to solved this problem. There are some refinements based on this method [2].

This system used human energy by using mechanical parts in order to produce electrical power. In order to produce electrical current, work force applied by rotating the wheel that already linked by belt and from that rotations will trigger a magnetic force and produce an electrical current and supply it into battery. This system is divided into two development; hardware development and software development. For hardware development, mechanical device is used and electrical device such as monitor. For software development, Proteus Design Suite is used to construct circuit. Lastly, the final aim of this research is to develop the mechanical system that can produce electrical energy directly to starter.

2.2 Hardware selection

Therefore, this research on automotive mechanical vehicle starter has been created in order to make life easy. This is capable to supply sufficient amount of power to provide for engine to start. The use of mini pedal exerciser and DC motor will act as medium between DC generators is proposed in this research. This will help the user in trouble due their battery undercharged. High torque motors also will be used in this research to gain a constant and high output power. Voltmeter sensors also used as 'display' of this research to determine the output that has been produced.

3. Methodology

3.1 DC generator

DC generator is a machine that converts mechanical energy to electrical energy by using the principle of magnetic induction [3]. This principle is designated by rotation of conductor within a magnetic field. During this process the conductor will cuts magnetic lines of flux and voltage will generated within conductor [4]. The amount of voltage generated will determined by on the strength of the magnetic field, the angle of conductor during cuts the magnetic field process [5]. The polarity of the voltage depends on the direction of the magnetic lines of flux and the direction of movement of the conductor [6]. To determine the direction of current, the left-hand rule for generators used as shown in Figure 1.

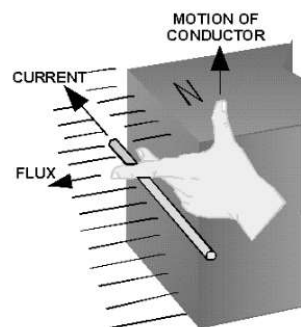


Figure 1. Left-hand rule for generators [5]

Illustration in Figure 2, from the image A through E, shows the component parts of DC generators. The Figure 2 shows the entire generator with the component parts installed and their physical relationship among other components [5] [7].

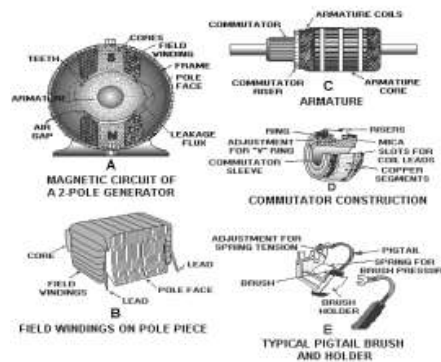


Figure 2. Components of DC generator [5]

3.3 Human Force Power Generator

Nowadays energy and power are the one of the basic needs in this modern world. Energy demand is grow rapidly day by day [8]. Proposal for utilization of human energy by using foot power is very relevant in populated countries like India where roads, railway stations, bus stands, temples are overcrowded with a million of people. The design and implementation of power generator by utilizing human as a source are divided by two parts electrical and mechanical [9].

3.4 Power needed for engine

Engine vehicles are required cranking power in order to start. The power needed will depends on many factors, such as engine type, engine size and temperature. Naturally, when a temperature drop it will require more power to start the engine [10]. Cold cranking amps (CCA) is a rating that measures a battery's cranking power [11]. It refers to the number of amps a 12 volts battery can deliver at 0°F for 30 seconds while maintaining a voltage of at least 7.2 volts [12] [13]. In the last ages the automotive industry has been investigating alternatives to conventional internal combustion engine in order to improve the efficiency of fuel and to reduce emissions gas [14]. During 2002 automotive manufacturers have announced plans to improve vehicle fuel with 25% or more by year 2005 [15].

3.5 Research Development

Research plan was developed to ensure that the research can be done with ease and without any problems. This research was done to find the gaps in the existing research and possible solutions to overcome these gaps in the future [16]. The plan is divided into several stages. Each stage is related and important to ensure the next stage to proceed smoothly. The reason for the hardware development and software development to be done at same time is the software is needed to be developed as the hardware to reduce time taken for this stage. The other reason is the hardware is needed as to test the efficiency of the software during testing stage after the integrating stage. After testing stage, the result gain and can be analyse for improvement.

3.6 Circuit Diagram Software

Fritzing is software that can be used for Printed Circuit Board (PCB) design, circuit schematic design and circuit simulation. This software is used to design an automotive mechanical vehicle starter circuit. These circuits also have been simulated to test if the circuits are able to fully functional. Figure 3 shows the automotive mechanical vehicle starter circuit layout.

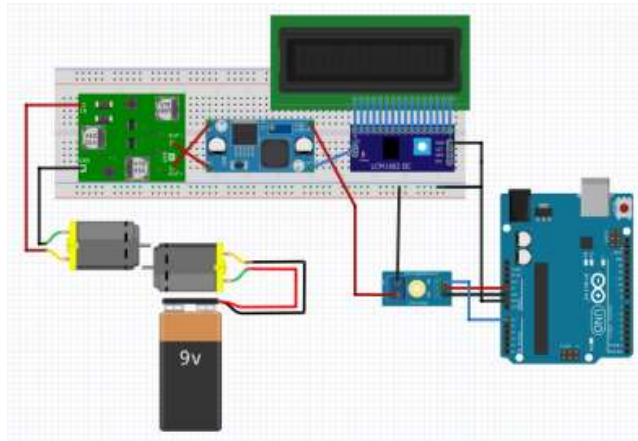


Figure 3. Voltage display circuit layout

The generator generated voltage and voltage sensor read the value received and display it. Figure 4 is the schematic circuit diagram [12] [13].

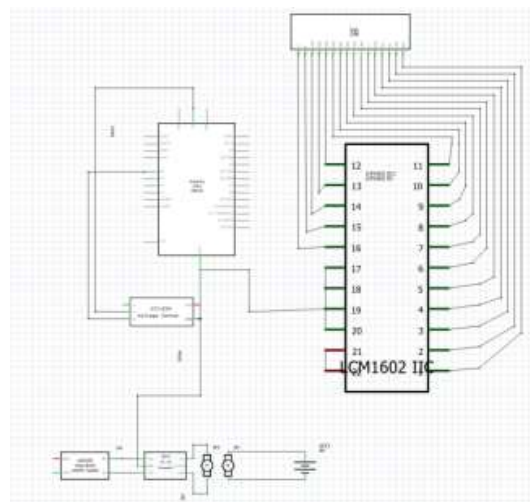


Figure 4. Circuit Schematic Diagram

3.7 Mechanical Design Software

In designing part, Solidworks software is used to create a Three-Dimensional (3D) drawing of the product. Solidworks is a CAD system for macro-scale parts designing and unable produce mask-layouts and process files. In this software, 3D drawing of the control system model was drawn for better understand and planning where to put microcontroller Arduino, DC generator and Liquid Crystal Display (LCD). The drawing must take account for easy troubleshooting and assembly.

3.8 Programming Software

Arduino software is used to program the circuit in this research. This programming are able to test after the hardware of this research is done. For this part, it is essential for both Arduino Uno microcontrollers are capable to communicate with each other to achieve better results in this research [17]. The idea of this research is to take an exact value for voltage output before connect it to car battery.

3.9 Hardware Development

Hardware development is stages where all hardware of these research is been assemble. This system is controlled by Arduino microcontroller [18]. The hardware components like Arduino microcontroller, Direct Current (DC) Generator, Voltage Sensor, DC Booster, Voltmeter Display, and Dimmer was used in this research. In this research, Arduino Uno will act as the voltage display for the DC motor generator.

4. Results and Discussions

Discussion on the results and analysis made from the achieved result of the research developed are found in this chapter. The data was taken based on the automotive mechanical vehicle starter performance in simulation. This method may seriously affect the diagnostic process and its outcome, especially if an automatic computer-based procedure is used to derive diagnostic parameters [19].

The average constant speed simulation shows the result of a better performance while the output of the product is recorded in output voltages and rotational speed of the human force. This chapter contains results that acquire during completing this research. For this research, the DC generator should be able to generate 12.6 volt. Human force also needed to be constantly operated DC generator in order to get a high voltage output. Constant rotation that produced to DC generator will supply a higher output voltage, when the higher voltage become the whole system can be operate smoothly.

4.1 Results of Voltage Generate Without DC Booster

The voltage produced by DC generator roughly maximized at 12.6V. In order to make engine start will need more than 12.6V. The DC booster will act as medium to booster the voltage to 24.6V. Therefore, with DC booster this research can produce a desired voltage. The result gained have been recorded successfully in table 1 and Figure 5.

Table 1. Voltage produced by experiment.

Average Speed (RPM)	Without DC Booster (V)	With DC Booster (V)
50	23.56	11.6
70	34.64	14.7
85	23.76	18.6
120	27.9	24.6

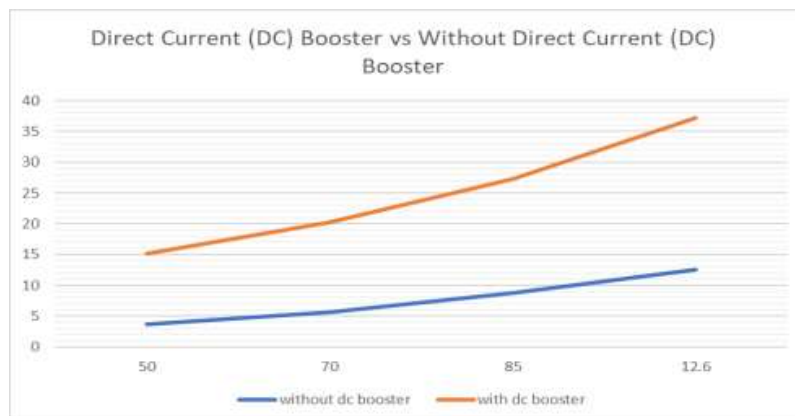


Figure 5. Graph result shows the voltage output

4.2 Results of Voltage Generate by Rotation Speed from Human Force

Results Human force is being used as a medium for this research in order to get the result. The reason for using this method is because human energy is free and can be used anywhere and anytime. Other than that, the devices that have been used in this research in order to get desired voltage is by using DC generator. This research can ensure that the average speed can produce a desired voltage. The result has been collected and recorded in Table 2 and Figure 6.

Table 2. Results taken from simulation

Time Taken (minutes)	Average Speed (RPM)	Voltage (Volt)
5	70	5.6
5	85	8.7
5	111	11.3
5	120	12.6

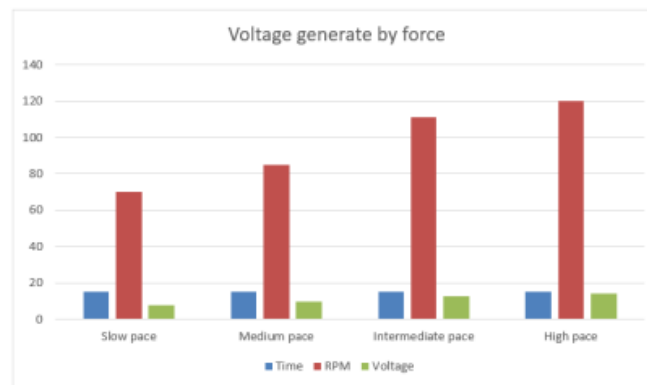


Figure 6. Graph of voltage generated from human force

4.3 Casing durability

Casing is being used as a medium to protect device from damaged. Material selection mainly depends on how easily they can be shaped [20]. This casing has been created by acrylic box. The size diameter on side box is 8mm. This box been through drop test experiment in order to maximize the safety for automotive mechanical vehicle starter inner component. This drop test has been repeated many times.

4.4 Automotive Mechanical Vehicle Starter

Since engineering is a practicing profession; a profession devoted to harnessing and modifying the three fundamental resources humankind has available for the creation of all technology: energy, materials and information [21]. The automotive mechanical vehicle starter has been designed and developed based on the criteria needed, obtained from the tests above as shown in Figure 7.

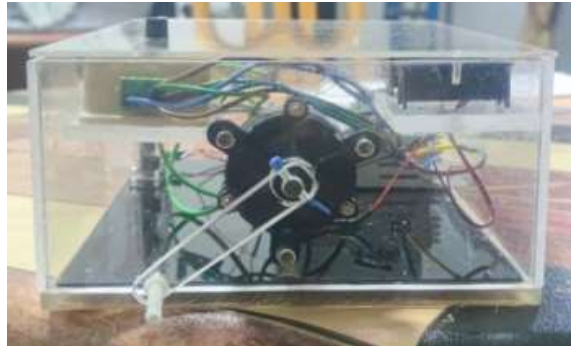


Figure 7. Automotive mechanical vehicle starter

From the results above, the automotive mechanical vehicle starter prototype consists of a modified DC generator, voltage sensor, LCD display, potentiometer, and DC booster.

5. Conclusions

Automotive mechanical vehicle starter may sound like an easy research. However, the concept of high voltage using human force to be solved. In this research, the concept of generate a high voltage by using human force brought out an idea on integration of human energy and voltage generator. This research used the idea of using DC generator to produce voltage output before supply it to car battery.

The value of rotation per minute from human energy is used to determine the value of voltage that has been generated. If the rotation value per minute is too slow, the voltage output produced low and cannot supply to car battery. After determine the ideal speed for DC generator, the output voltage can be easily achieved by using step-up transformer to amplify the output voltage. After the output voltage already amplified, step-down transformer needed. Since the car battery need 12.6 volts, step-down transformer adjust the output voltage until reached 12.6 volt before supply it to car battery.

Therefore, by completing the objectives, the research is declared as success. The objectives are creating a system which is safe, affordable and can be used by many people. Overall, the research prototype has been developed and functioning properly.

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