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Research paper

Development of Energy Harvesting Method Using Shock Absorber

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Abstract

An alternative of power source need to be discovered in order to reduce the dependency on general power source such as fuel by making use of the waste energy. Power bump technology is one of the alternative power sources by using pressure. The conversion of the pressure from the external force is exerted by using process of transfer one form of energy to another. The term of free of charge energy coming from the force where it is converted to the potential energy force and that energy is being used. The generated free energy can increase efficiency and the output of productivity. This paper provides a full picture of the force utilization created from the effect of shock absorber of motorcycle bump an alternative power source. This paper also analyzes the pressure and force principle of Energy Harvesting in contributing to a new energy recovery technology. A model of shock absorber is utilized in order to harness energy from its upward and downward movement which create force that rotates the generator connected to the absorber. The application of the generator motor into the shock absorber will not affect the suspension system. It transforms the applied force into electrical energy. Mechanical parts are used for the harnessing process and conversion process. The harvested electrical energy can be either used directly to charge the battery or directly light up the bulb of the motorcycle.

Keywords: *Pressure, Force, Renewable energy, Shock absorber, Power bump technology*

1. Introduction

The quantity of vehicles out and about increments definitely throughout the years. As indicated by the Malaysian Institute of Road Safety Research 5,849 to 6,872 individuals have died every year on Malaysian streets and expressways every year somewhere in the range of 2001 and 2010; a generally high figure thinking about the nation's populace of just 28 million [1]. Suspensions are without a doubt the most imperative and compulsory units of any vehicle like car and motorbike. These guarantee the vehicle execution, for example, road handling as well as comfortable ride and so on. The inconsistencies behavior, increasing speed and braking which is empowered the suspension to contract and extend. This energy is clearly a sufficient sum since neither it can stay away from the street inconsistencies nor speeding up and braking. Along these lines, the basic inquiry "Why not fuse this vitality back to the framework to improve the effectiveness" still comes up short on a definitive answer. Consequently, the best possible route is to expand the framework to saddle electrical vitality utilizing the info wellspring of mechanical/vibration vitality from the suspension. Keeping in mind the end-goal to accomplish the future power needs without hurting the earth, it is important to concentrate further on the sources of sustainable energy for electricity production [2]. Road vehicles create potential and kinetic energies from forces of its weight and speed whenever hitting the diverse level of street condition, for example, uneven surface road. In this paper, the electricity is generated by the electro-mechanical devices that harness wasted potential and kinetic energies from the shock absorber. The impact between vehicles and road causes the absorber to move, thus acting as suspension to vehicle. The significant of the power bump technique applied on the shock absorber which effected by the surface of the road will produce electricity. The increase of population people in a city will lead to the increase of transportation. People will use motorcycle to go to work place to prevent traffic jam. By using application of renewable energy, the human can get free energy sources instead of electrical energy while riding the bike. Indirectly, this can reduce healthcare cost with healthy environment [3]. The study of harvesting technique helps to increase the energy of the battery motorcycle using electrical power from generator. This work firstly, aims to simulate the circuit and make full use of available excessive energy via power suspension as a new option for the source of power. Secondly, to develop a model and analyze by using mechanical principle as a tool for energy harvesting technology by applying the power bump technique as energy generation. The scope of this research is to make a simulation of the shock absorber module using hardware testing, experiment on the shock absorber module and testing shock absorber module on pressure from effect of vehicle wheel on the road. Thus, this study will investigate the ability of power hump concept as a harvesting mechanism for shock absorber that can be used in every vehicle that using suspension system. This research is to produce electrical power from the moving and bumping of motorcycle. Basically, the bumping of the motorcycle and kinetic energy from the environment will rotate the generator to produce electrical power [4]. A thorough research will be done to fully understand the concept and theory regarding the development of voltage circuit by using PROTEUS software to step up and convert from around DC 14V to charge the battery 12V and the model of shock absorber will be done to obtain the result.

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In general, the scopes of work that have been carried out including:

1) Understand the principle, function, characteristic and concepts of power bump and excessive force.
2) Research on excessive force as an alternative way to generate energy.
3) Research based on excessive force technology using fork suspension concept.
4) Testing of shock absorber concept using simple hardware design.
5) Experiment and testing on producing power using fork suspension concept.
6) Utilizing force and testing on force from every damping that shock absorber absorb in every vehicle.
7) Analyze the results from simulation and testing.

2. Research Methods

A. Designing of the shock absorber energy harvesting system

Figure 1 shows the block diagram of the overall system in which the excessive energy from the wheel of vehicle is captured by the shock absorber as an energy potential that is converted to mechanical energy via the primary shaft to the gear concept. The mechanical parts are attached to the DC motor to convert the mechanical energy to electrical energy. The block diagram in Figure 1 shows the methods of operation on the mechanism of shock absorber system to produce electricity. The impact of the vehicle to the shock absorber from the rough road condition will generate a force that is known as the power bump [5]. The power bump receives transfer to the shock absorber will then activates the rotational mechanical part movement. The motor is attached to the mechanical part and act as the mechanical part is receives kinetic power from power bump and hence the motor will generate electricity. The electrical generated are used to charge a battery or boost up the voltage will then be utilized for any connected load of the vehicle.

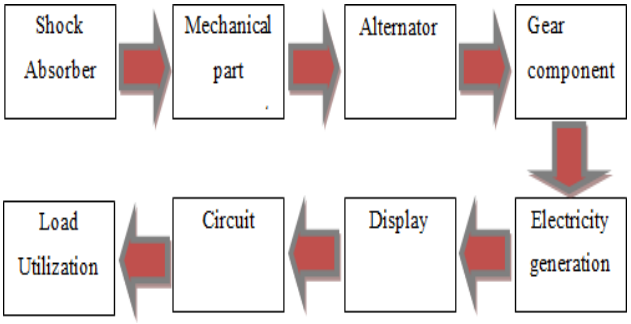


Figure 1: Block diagram of the whole system

The systems utilizing the shock absorber technique as shown in Figure 2. The main part which is the shock absorber where the concept starts by the wheel hit a bump from the difference surface of road will compress the suspension. The spring temporarily stores up this energy but it will release it as soon as possible, so it tries to extend or rebound using the front wheel away from the bike [6]. Any movement created by the absorber will produce mechanical movement. This mechanical movement is expressed by the gear which is connected to a primary shaft of a motor installed with this, electricity is generated.



Figure 2: Shock absorber design

Figure 3 shows the gear connection where different sizes of the gear being used in order to get higher efficiency of the conservation of energy from primary shaft to the motor shaft. The transmission system consists of different kinds of gear namely the speed-reducer, gear-head and gear-reducer which are being mounted by factory using enclosed together with lubricated housing consists of a set of gears, shafts and bearings [7]. In addition to that, the gear ratio system is made of a pair of gear that is used for the input driver and driven using the chain.



Figure 3: Gear connection design

The DC motor 12V as shown in Figure 4 is chosen to generate the voltage and current based on the moving of shock absorber in up and down connected to shaft of the motor. This kind of motor can generate higher voltage with low speed of the motor shaft



Figure 4: 12 V DC motor

The CN6009 as illustrated in the Figure 5 is the voltage booster that can raise the voltage from 5V to 9V DC or 7.4V DC. However, from the input part, 5V DC power source cannot be lowered from 3V DC with tools CN6009 as the function of the circuit is to increase the voltage, and not to lower the DC voltage. This board will act as booster to boost up the voltage output from the motor.

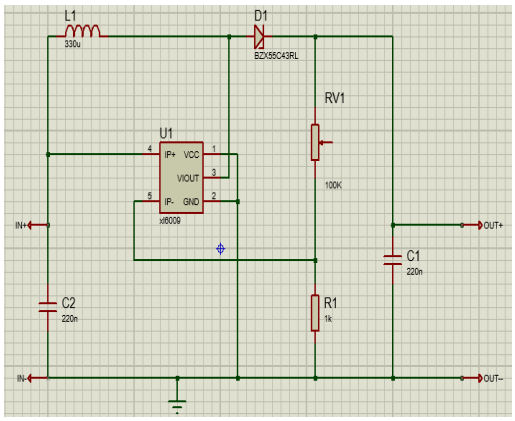


Figure 5: The circuit of CN6009 booster

Arduino UNO is an open source hardware which consists of 14 digital pins and 6 analog pins. For digital pins, a few are used as PMW pins. It also has built-in led aligned with 13th pin of the Arduino UNO. The proposed system used 1N5819 schottky diode as shown in Figure 6. The operating voltage of Arduino UNO is +5V [8].



Figure 6: Arduino Uno

One of the simple way to regulate and display the output voltage from the motor and booster is shown in Figure 7.

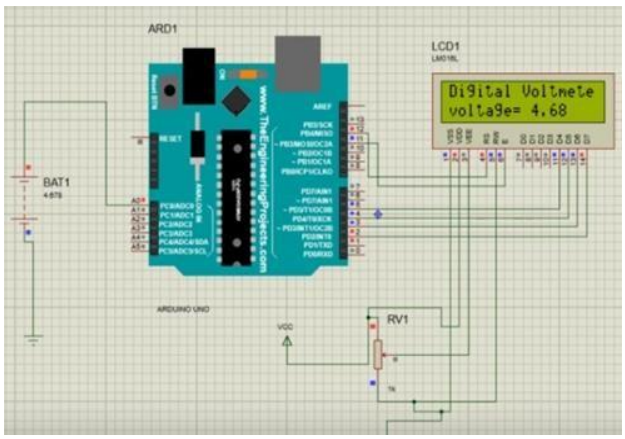


Figure 7: Circuit of Arduino Uno

B. General flow chart to obtain power of shock absorber energy harvesting

Figure 8 shows the detail of the process and operation of the shock absorber energy harvesting. The guideline of the methodology for this research is required to be followed from the starting of the project till the objective is achieved. A general literature studies is made regarding the development of energy harvesting using shock absorber based on the experiment and research done by other researcher. Then, details understanding on the absorber concept and applying the concept to produce electricity are carried out. The mechanical movement is one of the basic concepts in order to find the way to produce electricity. This is done in order to select the method of mechanical movement that can be applied to the shock absorber. After the mechanical movement concept is selected, it is then developed and tested for energy generation. By understanding the principle and concept, the method of mechanical movement will be selected until the most suitable concept method to produce electricity is obtained. The concept is then designed to be utilized with a load for testing requirements until it reaches the target output voltage of 5 V. After that, the circuitry for the display is prepared to display the output of the designed concept. Finally, the prototype is implemented to fully complete the research.

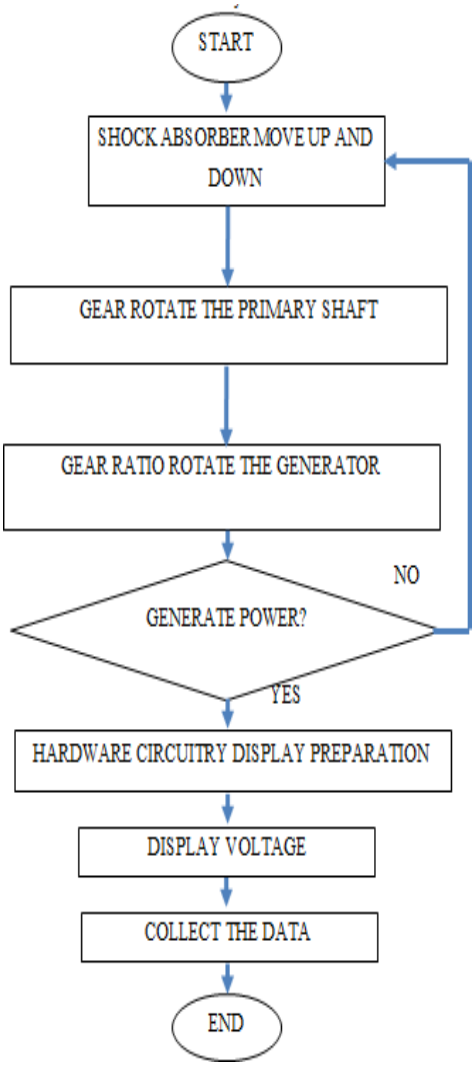


Figure 8: Flowchart of shock absorber energy harvesting

3. Results and Discussions

Due to the nature of the road, each of the power bump of the shock absorber causes a different length of effect to the absorber. The length of absorber effect from the bump is being push will calculate using different length and same number of bumps. The force from the shock absorber power bump is converted into rotational energy that is received from the primary shaft of the DC motor which acts as generator will provide around 5 V to 23 V. Table 1 presents set of data for minimum and maximum voltages measured from the different length of absorber affected by force of the wheel at the shock absorber and different number of bumps that produced by the generator. Several forces of bumps from 0 until 7 were applied to the shock absorber in order to put the constructed prototype in test. During the test, a constant force was used to function as a passing by wheel that is applied on the absorber whilst the voltage was recorded.

Table 1: Shock absorber power bump results

Length (mm)	Number of bumps					
	0-2		3-4		5-7	
	Minimum voltage (V)	Maximum voltage (V)	Minimum voltage (V)	Maximum voltage (V)	Minimum voltage (V)	Maximum voltage (V)
5	3.23	4.01	4.79	5.67	4.88	5.79
10	5.32	6.93	7.02	8.39	7.44	8.66
15	7.32	7.82	8.66	9.54	8.75	9.74
20	8.06	9.42	9.76	10.61	9.86	10.68
25	9.31	10.41	11.13	13.51	11.13	13.55
30	11.11	12.40	16.11	17.40	16.33	17.52
35	15.41	16.603	17.50	18.90	17.75	19.07
40	17.33	18.32	20.03	22.32	20.66	22.72
45	19.22	20.33	22.45	23.33	22.53	23.43

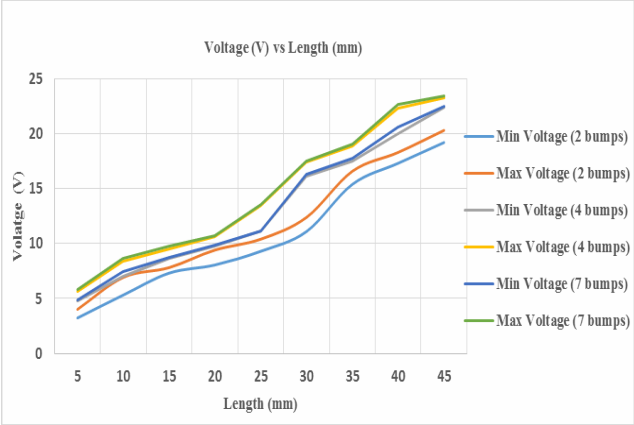


Figure 9 : Voltage (V) vs. Length (mm)

Figure 9 shows the relationship between the length affected by shock absorber and voltage produced by the generator. It shows that as the length increases, the voltage produce also rises. The continuous force of the shock absorber causes the shaft motor to rotate to keep increasing until 7 bumps and generate voltage. The increase of length from the 5 mm until 45 mm shows the result of voltage increases drastically. The maximum voltage generated by generator is 23.43V where condition of shock absorber at maximum point and the highest number of bumps. Every line in the graph shows the different effect of number of bumps. There is a small increasing of voltage from 2 bumps until 7 bumps at the same length.

Figure 9 also shows the relationship between the heights affected by shock absorber is directly proportional to the voltage generated. In the real condition of the road is far different from the force given in this research. The number of bumps from the road condition will increase and the reaction on the shock absorber even faster. This will give more continuous voltages because when the wheel of vehicle moving, the effect from the weight and the speed of the vehicle will increase the number of bumps and the length of the affected of shock absorber.

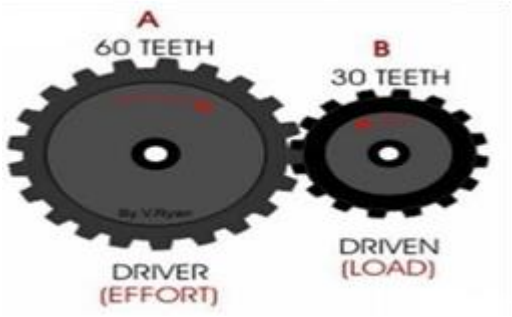


Figure 10: Gear ratio

$$\text{Gear Ratio} = \frac{\text{Out}}{\text{In}} = \frac{30}{60} = \frac{1}{2} = 1:2 \quad (1)$$

$$\text{Speed (New)(RPM)} = \frac{\text{Speed Input}}{\text{Gear Ratio}} = \frac{\text{Speed Input}}{\frac{1}{2}} \quad (2)$$

4. Conclusion

The shock absorber with energy harvesting concept is suitable for every vehicle or moving thing that uses any shock absorber. There are no roads in the world that have very smooth surface. Without wasting the excessive force resulted from the road bumps, this shock absorber research will benefit every vehicle user. The electricical energy will be produced whenever the vehicle starts to move. It can be observed from the experiment that with the amount of at least 5mm with 2 bumps continuous vehicles moving shock absorber with power bump can produce the maximum amount of 4.0V. In this research, the simulation circuit that make full use of excessive force through power suspension as a new source of power is achieved. The development of a model by using the mechanical principle as a tool for energy harvesting technology also have been accomplished. To obtain more available output voltage produced by the generator, high speed of primary shaft is required. The join of primary shaft to the motor shaft will affect the generated voltage because the is a direct relationship between the rotation of the primary shaft and generated voltage. Therefore, there are methods that can be applied to maximize speed of the rotation of the shaft motor from the shock absorber to obtain high output voltage. One way is from the gear ratio system. The speed reducer is made of gear head and its reducer which consists of a set of gears, shafts and bearings that are assembled together originally from the factory [9]. The gear ratio system generally consists of a set of gear which combined the driver for the input and driven as the output or deliver as shown in Figure 10. Furthermore, the correct calculation between driver and driven is crucial to get the desired output speed. The design of final gear ratio plays a significant role in order to obtain a very high acceleration and highest achievable speed [7].

The gear ratio system is possible to be utilized and integrated into the shock absorber design between the primary shaft and the motor shaft to achieve a higher speed of the motor rotation and to prevent from higher mechanical loss. To obtain a higher speed, the ratio of the gear is required to be big too small or with the ratio of 1 to 2 in which rotation of the output will be two times than the input rotation as shown in (1). As a result, it will not only give rise to the flywheel rotational speed as shown in (2) but also lower the output torque.

Acknowledgement

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