PROTOTYPE DEVELOPMENT OF WIRELESS PNEUMATIC GEAR SHIFTER

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ABSTRACT

Conventional design of transmission gear shifter is basically consists of mechanical linkage of gear lever attached on the side of motorcycle engine with pivot directly connected to the gear shifting mechanism. Shifting up and down of gear positions are performed by moving foot or toe upward and downward on the lever respectively. For disable rider (rider requires special need), shifting gear for manual transmission type of motorcycle with or without clutch system is difficult. In this research, a pneumatic gear shifter is designed and fabricated. It consists of pneumatic circuit with actuator, tanks and air compressor. The movement of gear lever is performed by the pneumatic actuator. Pneumatic tanks are installed to achieve optimum pressure. It also controlled by wireless system for convenient purpose and buttons installed at the handle. Simple experiment is performed to measure the force for each gear position.

KEYWORDS*: Pneumatic gear shifter, Wireless gear shifter, Gear changer, Gear mechanism, Gear leve*

1.0 INTRODUCTION

The transmission of a light vehicle is determined by the number of force applied to the gearshift. Most motorcycle gearshift assemblies in recent years have been fabricated with a foot pedal that is shifted upwardly and downwardly by the bottom and top surfaces of the toe or foot. The heel portion of the rider's foot normally rests on the stationary stirrup of foot rest which bears most of the weight of the leg and foot of the rider, while the pedal mounted on the end of a foot rest at a location where the rider could merely depress or lift the toe portion of his foot with pivotal movement about his ankle joint to shift the gears of the motorcycle (Herbert, 2005)(Bosch, 1975). In transmission system, conventionally, it has a mechanical linkage that connects the gear lever

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to the gear switching mechanism. The mechanism for gear changing of the transmission still remains the same that is the reliance towards the gear lever situated on the left leg of the rider (Cengel et al. 2009). A normal healthy person would not have any problem to carry out this action but the situation is vice versa for the elderly and leg disable people. Hence, the research hopes to give the data and a new light so that people that fall into the previously mentioned category could also enjoy the pleasure of riding this economical means of transport (Steve, 2007). The transmission system size, weight and type are varied from one manufacturer to another. Nevertheless, its basic principle on how the system works remain constant although it is produced by different manufacturers. For the simplest form of this system, it will only contain a centrifugal clutch attached to the crankshaft and then redirected to the sprocket via chain. As the engine speed increases, the clutch activates and propels the rear wheel (Jaap, 2000),(Molly and Pautot, 1992). This is a perfect example for a single speed transmission system which is consider to be the most efficient system available nowadays (Lin and Costello,1983),(Salonidis, 2001).

A solenoid gear shifter or an electric solenoid shifter is an invention that is equipped onto motorcycle or car for the gear changing process (Lee, 1995). This technology, mainly for motorcycle, is only used for clutch-less shifting of the motorcycle by only pressing or pushing a button that is mounted on the handlebars of the selected motorcycle. It also includes with a solenoid mounting plate for ensuring that the solenoid is fasten securely to the motorcycle and a micro-switch which is used to be operable linked to the solenoid and the mounted motorcycles (Kevin, 2007). Solenoid gear shifting mechanism uses magnet to move upwardly and downwardly (Gerald, 1996). This movement depends on the magnetic field that is produce by the magnet when power is supply through it. This paper is meant to provide a better understanding of motorcycle transmission system and how the system could be simply or improve in order to ensure that elderly and leg disable people could ride the vehicle. The component relation to the human safety is given extra attention in order to avoid unnecessary expenditure in the maintenance and repair works of the vehicle, This is due mechanical failure during the test of this technology could means fatality if no contingency plan present

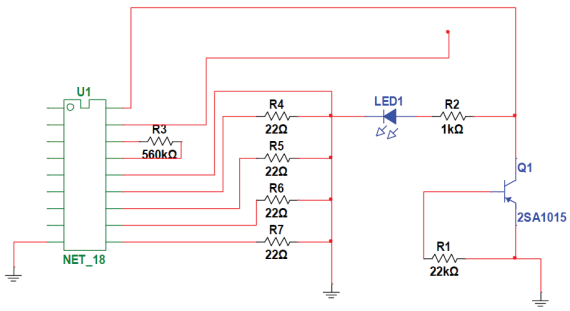
2.0 METHODOLOGY

The pneumatic gear changer requires a very precise precision and accuracy so that it will not fail during the real working condition. Each of the specification used in this phase will be taken serious consideration and any flaw in the system during this phase will be enhance or otherwise change by a new part. Theoretical calculation also will be taken into consideration as it will help to further understand how the system actually works and it flaw was detected, it can be solve in a fast pace. The pneumatic gear changer owns novelty which is the wireless system, requires two main components which is the transmitter which will relay any information that the user input and the receiver. The receiver is the most vital component for the wireless system as all the information transmitted by the transmitter via radio frequency will be translated by this component and it will signal the information towards the related parts for operation.

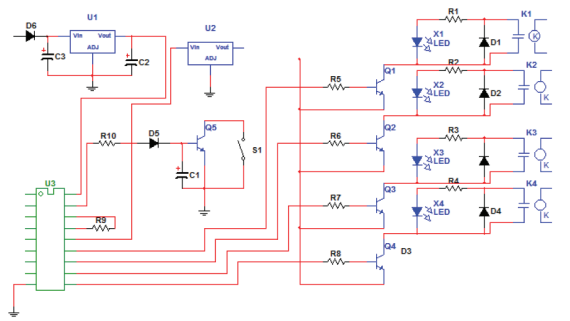
2.1 Prototype Design

Figure 1 shows the image for the final configuration of the circuit board for both the transmitter and the receiver. The schematic diagram was later then used as a guideline in order to produce the actual wireless communication system. A jig is a type of custom made tool used to control the location and motion of another tool. Its primary purpose is to provide repeatability, accuracy and interchangeability in the manufacturing process. In addition it also used for conducting experiment that used the same material over and over without changing any part of the system. As a result it enabled the user to conduct a controlled experiment without any further delay for to production or creating a place to hold the same material or apparatus over and over again. Since the jig will be used for the testing of a pneumatic actuator; it will be made from plywood with thickness of 15 mm. Figure 2 (a) was used as the base guideline for designing of the jig. The design parameter is quite different with the actual product as there has been difficulty in obtaining the most suitable material during the production process. Figure 2 (a) shows the CAD file for the design that will be used for creating the most suitable for the pneumatic actuator experiment. The gimmick box is manipulating all the moving part of the research project which is the movement of the gear lever for engaging and disengaging gear so that it will attract and at the same time make the audience to get better understanding of what being explained to them. It also served as a storage compartment which will house the entire vital component for this project. Figure 2 (b) shows the setup of the gimmick in one of exhibition that this project took part in. Component such as gas tank,

circuit board and even wiring is placed inside the gimmick box in order to remove most of the nuisance from the audience vision. By having the gear lever stick outside of the box, explanation could be done more easier as both side of the box is pasted with picture depicting the actual positioning of the pneumatic gear changer on a light vehicle.

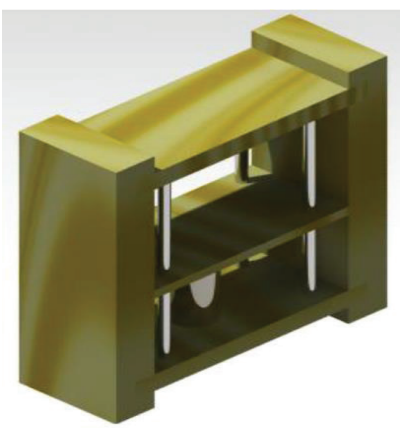


(a)

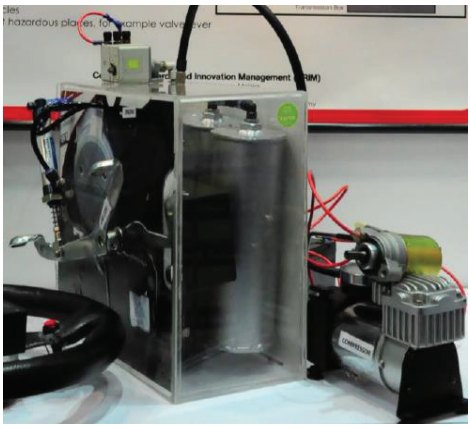


(b)

Figure 1. Transmitter (a) and receiver schematic diagrams (b)



(a)



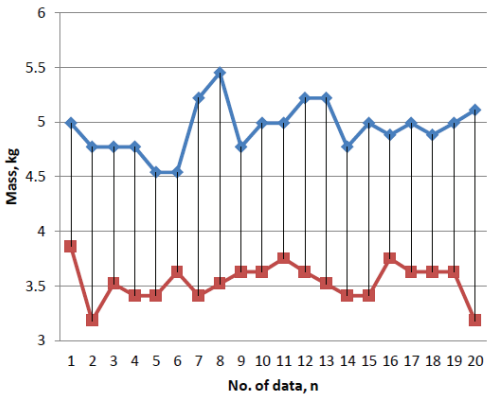
(b)

Figure 2. Test jig (a) and prototype box (b)

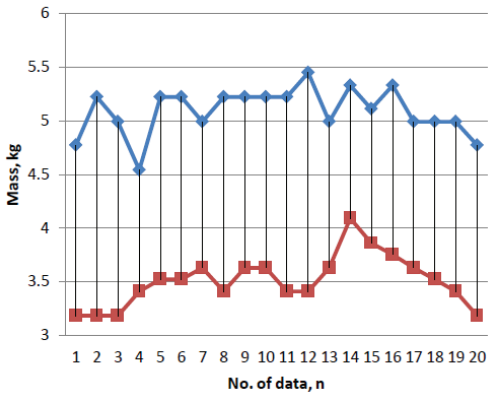
3.0 RESULTS AND DISCUSSIONS

Gear lever is the main or the most vital part for the transmission of a light vehicle. It helps the vehicle to translate the movement of up and down of the rider's leg into kinetic energy which will then either engage or disengage a gear. An experiment was conducted in order to find out the exact value of pressure and force required to be exerted by any rider in order to change gear of the light vehicle itself. In addition, the data obtained also will help this research with giving an insight for how much pressure does an actuator need to be able carry out the same task as the rider does. Table 1 shows the result acquired from test done in order to find out the amount of force required in order to engage and disengage the transmission of a light vehicle. The test was conducted by an analog scale as shown in Figure 3. The result of the test was done been double checked with a spring balance in order to ensure the accuracy and the reliability of the data. In addition, each of the data was taken 20 times in order to eliminate human error during the data reading through the usage of average data. The data for each of the gear transmission have been translated into graphical view which can be seen below. Figure 3 (a) shows line graph for the data of the first gear, Figure 3 (b) represent the graphical translation of the tabulated data for the second gear. Figure 3 (c) and (d) show the representation of the tabulated data for the third and the last gear of the light vehicle. the average value of mass needed for engaging and disengaging is around 6 kg and 4 kg respectively. Do take note that, the experiment was conducted by using light vehicle which still using the default part obtain from the manufacturer. In addition, the data might

be varying slightly for different light vehicle as it might use different type of configuration in its transmission system. All the result obtained from this task was then tabulated into Table 1 where the value will then be compare with the value of pneumatic actuator. The system used a gear lever that helps to translate the human input into mechanical movement which will then engaging or disengaging the light vehicle transmission depending on the human input. Upward movement is for shifting while downward movement is for downshifting. The amount of force required to be exerted by the riders depend on the speed of his leg; experiment result as tabulated in Table 1 shows the trend of force required for shifting on a light vehicle which is Honda Wave 110. The engagement and disengagement of gear n mean shifting from gear n-1 to gear n or from gear n+1 to gear n. From the table, it can be seen that based on all 20 data taken for each gear shifting, the amount of force required remain in the range of 45 N to 55 N. This value change significantly depending on how fast the user exerted the force onto the gear lever. The faster the movement of the rider leg, the less amount of force required to engage and disengage the transmission system. Yet, different light vehicle uses different kind of tools for the construction of the transmission system; the stiffness of the transmission spring inside the system will be different for different vehicle.



(a)



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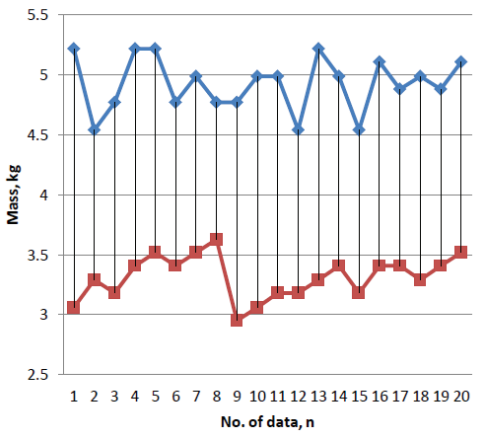

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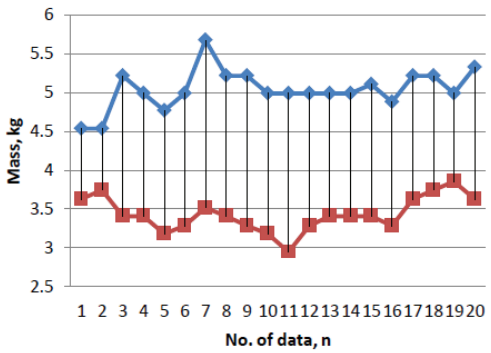

(d)

Figure 3. Load during gears' engage (♦) and disengage (■) for first gear (a), second gear(b), third gear(c) and fourth gear (d).

Table 1: Pressure and force for all gears

Gear *n*	Gear 1		Gear 2		Gear 3		Gear 4	
Action	Engage	Disengage	Engage	Disengage	Engage	Disengage	Engage	Disengage
Average (kg)	4.94	3.54	5.09	3.51	4.93	3.32	5.04	3.44
Force (N)	48.46	34.73	49.93	34.43	48.36	32.57	49.44	33.75
Pressure (Pa)	5.19	3.72	5.35	4.01	5.18	3.49	5.30	3.61

4.0 CONCLUSIONS

The prototype of wireless pneumatic gear changer has been developed. The prototype has proven experimentally produced suitable amount of force and pressure to engage and disengage gears using pneumatic actuator on the gear lever. The prototype can be used by elder riders and special need riders who cannot shift the gear ordinarily using foot. The prototype is available for future improvement and installation on actual motorcycle.

ACKNOWLEDGEMENT

The authors gratefully acknowledged the Advanced Vehicle Technology (AcTiVe) research group of Centre for Advanced Research on Energy (CARe), the financial support from Universiti Teknikal Malaysia Melaka and The Ministry of Education, Malaysia (MOE) under Fundamental Research Grant Scheme (FRGS), grant no.: FRGS/2013/FKM/TK06/02/2/F00165.

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