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The Effectiveness of Using Continuous Variable Transmission (CVT) in 2WD Buggy Vehicles

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Abstract

Continuous Variable Transmission (CVT) is a transmission system that does not have gears like in manual transmission cars or conventional automatic transmission cars. CVT has the advantage of being able to maintain the proper rotational speed at any time in terms of engine efficiency by changing the speed ratio flexibly and continuously. A continuously variable transmission (CVT) is a transmission that can change steplessly through an infinite effective gear ratio between maximum and minimum. This is in contrast to other mechanical transmissions which only allow a few different gear ratios to choose. The flexibility of the CVT allows the drive shaft to maintain a constant angular speed over the output speed range. Torque is transmitted from the drive to the pulley which is driven by friction acting between the belt and pulley surfaces. Tests were carried out using a dynotest to obtain wheel rotation data and the resulting torque. The loading is given from 3 kg, 5 kg, 7 kg and 8 kg, the engine rpm used is 5500 rpm, 6000 rpm, 6500 rpm, 7000 rpm and 8000 rpm. Rear wheel rotation is inversely proportional to the load, the greater the load the rotation will decrease. Load is directly proportional to torque, the greater the load given the torque will increase. The CVT system is still effective for use as a power successor. The power that can be transmitted is still greater than 50%, namely 68%.

Keywords: CVT, Rotation, Load, Effectivity.

1. Introduction

Power transfer (drive train) in the car is a number of mechanisms that transfer the power generated by the engine to move the wheels. Because the engine functions as the prime mover on a motorcycle or car, it has to do multilevel gearshifts. The car must be equipped with a system that is able to bridge between the engine output (power and engine torque) in stepped gearshift. This system is called the drive train or power transfer system. Power Transfer System can also be referred to as a power transfer system in a car (power train), is a mechanism that transfers power from the engine to the wheels. The power transfer system in a vehicle is very important in supporting vehicle performance. Because the power transfer system or power train is a series of mechanisms that function to transfer power from the engine to the wheels of a motorized vehicle [1].

A buggy car is a mini-sized vehicle that is carried by one to four passengers, with its small size this vehicle can answer the transportation needs in dense industrial areas [2]. CVT has been found in automotive and industrial applications such as machine tools since the early 20th century. CVT is a power transmission device, in which the speed ratio can be varied continuously between two limits [3]. CVT is the ideal transmission system design to transmit power from the engine to the wheels. CVT changes the transmission ratio continuously so it is named as an infinite ratio transmission. As a result, every time the system will choose the most appropriate ratio to optimize energy efficiency and performance. Some of the other advantages are low production costs, lighter weight than conventional gearboxes, more fuel efficient, changes in speed ratios that are smooth without jerking and are able to provide a better engine braking effect [4]. Continuous Variable Transmission (CVT) is a transmission

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system that does not have gears like in manual transmission cars or conventional automatic transmission cars [1]. CVT has the advantage of being able to maintain the proper rotational speed at any time in terms of engine efficiency by changing the speed ratio flexibly and continuously [5]. A continuously variable transmission (CVT) is a transmission that can change without a step through an infinite effective gear ratio between maximum and minimum. This is in contrast to other mechanical transmissions which only allow a few different gear ratios to choose from. The flexibility of the CVT allows the drive shaft to maintain a constant angular speed over the output speed range [6]. Torque is transmitted from the drive to the pulley which is driven by friction acting between the belt and pulley surfaces [7]. CVT (Continuously Variable Transmission) is a power distribution system automatically with the help of centrifugal force caused by rotation [8]. This CVT works through 2 pulleys (v-belt disc). The smaller the pulley diameter will form a wider distance and vice versa, the larger the pulley diameter will form a narrow distance. What is meant by distance is the distance that is on the sidelines of the primary pulley, namely the distributor of rotation from the crankshaft with the v-belt forwarded to the secondary pulley towards the rear axle.

Continuously Variable Transmission (CVT) is increasingly being used by the automotive industry, because the CVT system can transmit power from the engine to the vehicle wheels which has continuity and no interruption, so that ratio changes are progressively unlimited between the minimum-maximum ratio prices. This progressive system provides more ability to select a gear ratio. CVT is a gearless transmission system whose principle works by utilizing a change in diameter between the driver pulley and the driven pulley. With this change in diameter, the ratio also changes continuously. following changes in the two pulley diameters. This system produces an automatic reduction ratio and an automatic torque change from the engine to the rear wheels, with a very precise ratio. This CVT system uses a V-belt, this is what distinguishes it from other vehicles. The V-belt on this CVT system can last a long time, this is due to the V-belt mechanism stored in a room equipped with a cooling system to reduce heat generated caused by friction. This is also supported by the existence of a cooling flow system that is made in such a way that it is free from dirt/dust and water. The cooling air intake hole is installed higher than the axle, aiming to prevent water from entering when the motorcycle crosses the flood area. Although the automatic transmission was invented as well as the conventional one, today engineers use a steel belt whose diameter can be changed by means of a uniquely shaped pulley [9]. This means that the CVT drive system has become a development of the automatic transmission. Vehicles that transmit CVT make motorcycles grow by the largest number compared to other types of motorized vehicles and make vehicles increasingly popular.

Based on several studies, the CVT system is effectively used to transmit power to the rear wheels. This system has the advantage that power can be transmitted continuously and the transmitted torque can be adjusted to the existing load. The torque distributed to the rear wheels can change according to the load because the CVT uses a roller and spring system that works according to engine rotation. If the load increases, the engine speed will increase, which will affect the CVT system to tighten the belt so that more torque is distributed to the rear wheels. Based on the background of the problem, the problem is formulated as follows: is the CVT system applied as a power successor to the rear-wheel drive buggy effective for continuing power from the driving engine. This CVT system is expected to be able to transmit torque from the engine effectively to the rear wheels continuously and in accordance with the load given.

2. Method

The method used in this research is an experimental study by analyzing data displayed in graphical form. The graphs obtained will be analyzed using descriptive methods. Descriptive analysis is a type of research carried out to obtain a description or description of the characteristics of data through the results of data analysis that is as is without making general conclusions [10]. Descriptive analysis or deductive analysis is part of statistics, studying how to collect data and present data so that it is easy to understand. Descriptive statistics only relate to describing or providing information about data or circumstances or phenomena. Descriptive analysis functions to explain conditions, symptoms or problems only aimed at existing data collections [11]. Analysis was carried out on the rotation of the rear wheels due to the applied load and the torque that can be distributed to the rear wheels with the CVT system.

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2.1 Design

The application of this CVT power successor to the rear - wheel drive buggy vehicles. The CVT model was chosen because it does not use conventional gears to make it easier to operate the vehicle. Another advantage is that the driving engine power can be forwarded according to the load requirements of the wheels. It is hoped that this buggy will later become an all-terrain operational vehicle that can be applied by adding various additional tools as needed. Figure 1 is an installation of the CVT design in this research.

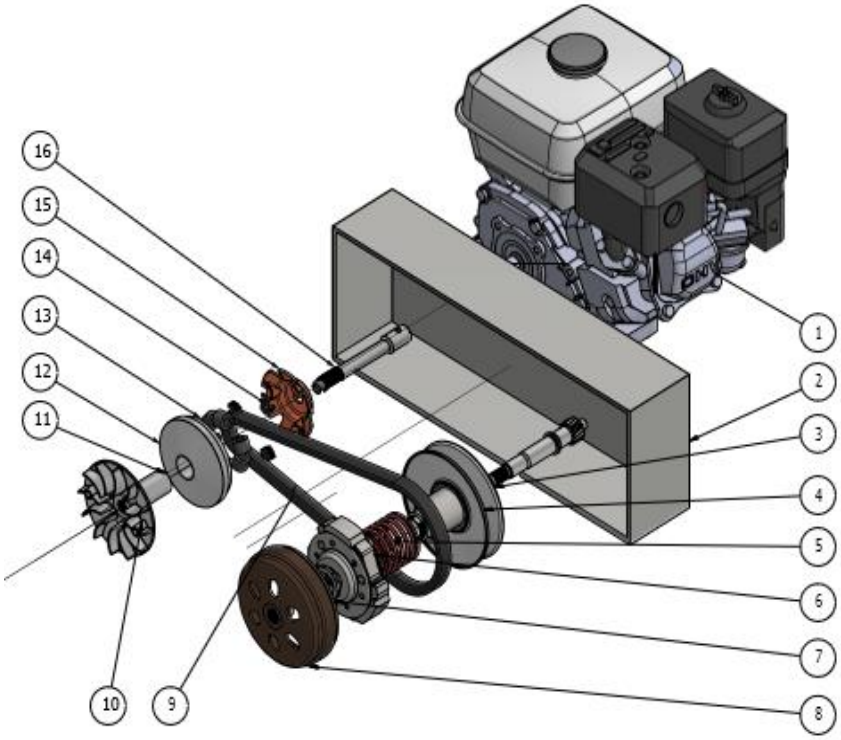

Figure information
1. Engine
2. CVT box
3. Axle-rear pulley
4. Rear pulley
5. CVT spring
6. Clutch
7. Clutch nut
8. CVT clutch bowl
9. V belt
10. Front pulley CVT
11. Boshing pulley
12. Roller base
13. Roller
14. Piece slide
15. Cup roller
16. Axle to engine

Figure 1. CVT Installation Plan

2.2 Research Instrument

Power is the result of work done within a certain time limit. This power is applied to the piston which works back and forth in the engine cylinder [12]. Therefore, in the engine cylinder there is a change of energy from the chemical energy of the fuel to the mechanical energy of the piston. The combustion process in the combustion engine is assisted by the ignition system so that combustion can work continuously. Delay in the ignition of the ignition system that occurs several strokes, will cause a decrease in power. Indicator power is a source of power per unit of engine operating time to overcome all engine loads [13]. During work the machine has components that are interrelated with one another to form a compact unit. The indicator power also overcomes the load from the components owned by the machine [14]. Some of the components include a water pump for the cooling system, oil pump for the lubricating system, radiator fan and others, these components are referred to as engine accessories. This accessory is considered parasitic for the engine because it draws power from the indicator power. The following is the formulation of each power, the power unit uses HP (Horse Power).

The instruments used in the study entitled Effective Use of CVT in 2WD Buggy Vehicles are a dyno test to measure power and torque and a tachometer to measure RPM. The fixed variables in this study are the rotation (rpm) of the driving engine and the loading on the rear wheels, while the independent variables are the torque and power measured on the wheels. The speed variables (rpm) are set at 5500 rpm, 6000 rpm, 6500 rpm, 7000 rpm and 8000 rpm. Variable loads are set at 3 kg, 5 kg, 7 kg and 8 kg.

The test is carried out by connecting the propulsion system with the dyno test as show in Figure 2. The power successor uses a sprocket chain system with a ratio of 14:34. This chain system is used to

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make it easier to apply to buggy vehicles. Gear 14 is placed on the CVT output while gear 34 is installed on the rear axle.

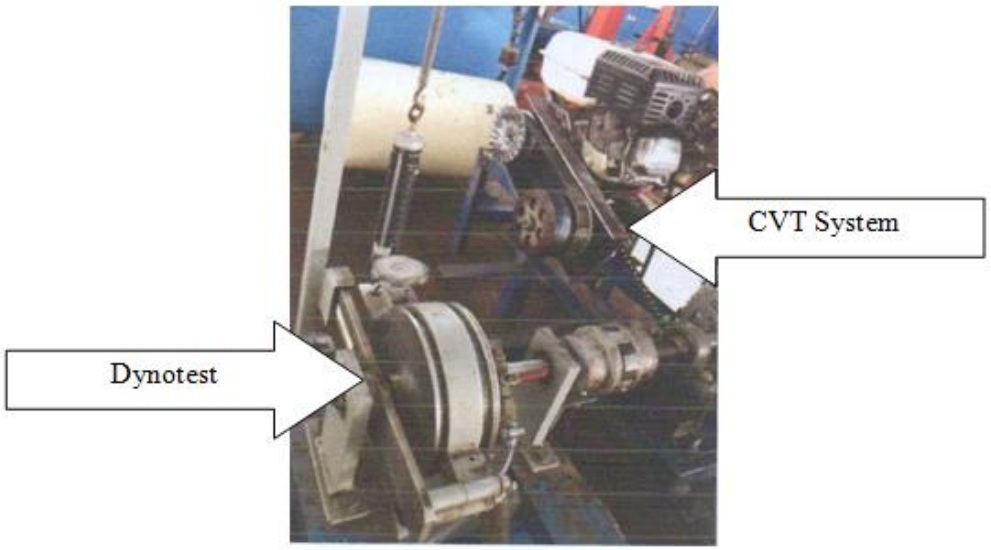

Figure 2. Testing with Dynotest

3. Result and Discussion

3.1 Rear Wheel Rotation

The test was carried out several times to get accurate data. Data collection is focused on the rotation generated on the rear wheels, the torque obtained is in accordance with the load so that the power transmitted to the rear wheels of the buggy can be calculated. The rotation cycle is very closely related to the stress of the test object, because the greater the stress, the smaller the number of rotation cycles, and vice versa [15]. This research shows that the load given to the plate bending test means that the greater the load given, the smaller the rotation cycle that occurs. The correlation between load and rotation is linear, if the load is greater the rotation will decrease and vice versa if the load given is smaller the rotation will increase.

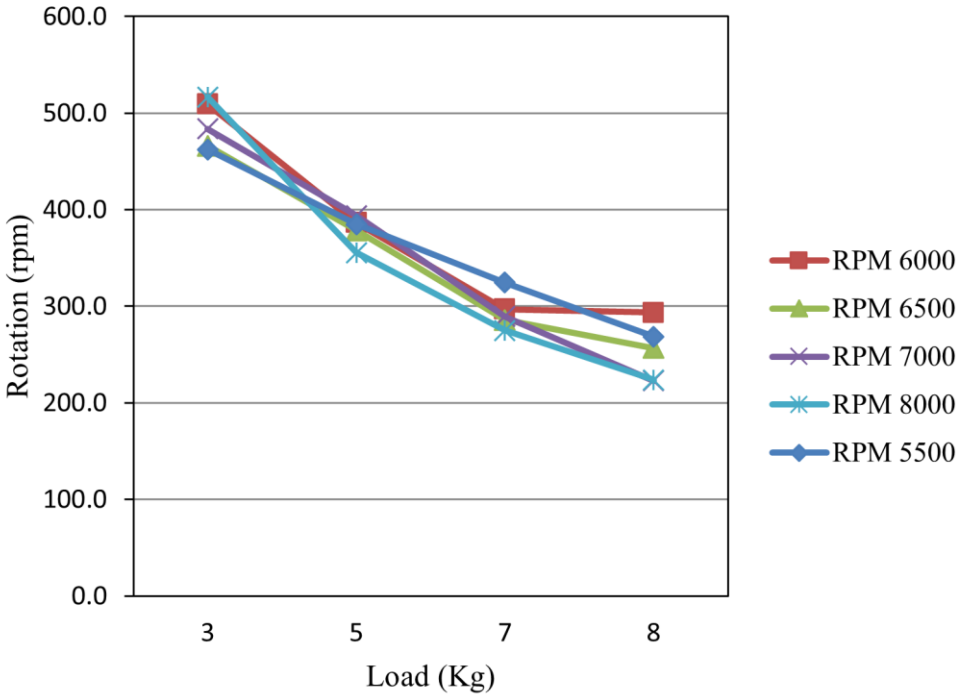

Figure 3. Rear Wheel Rotation (rpm)

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Figure 3 shows the results of the rotation measurements produced on the rear wheels according to the engine speed variable and the given load. At engine speed of 5500 rpm the rear wheels experience a decrease in rotation from 426.4 rpm to 268 rpm according to the given load. At a load of 3 kg the rear wheel spins to 426.4 rpm, a load of 5 kg the wheel spins to 384.8 rpm, at a load of 7 kg the wheel spins to 324.6 rpm and at a load of 8 kg the wheel spins to 268.4 rpm. The engine speed of 6000 rpm for the rear wheels has decreased from 466 rpm to 283.6 rpm according to the given load. At a load of 3 kg the rear wheel spins to 509.2 rpm, a load of 5 kg the wheel spins to 386.6 rpm, at a load of 7 kg the wheel spins to 297 rpm and at a load of 8 kg the wheel spins to 283.6 rpm.

The decrease in rotation on the rear wheels is associated with an increase in load [16]. The more the load is increased, the rpm will decrease which will affect the speed of the buggy.

3.2 Rear Wheel Torque

Based on the results of theoretical analysis and empirical tests, power and torque, it can be concluded that the higher the engine speed, the more power the vehicle has [17]. There was a decrease in power and torque after testing the rear wheels. The load is given to the rear wheels which affects the engine rotation. When the load increases on the rear wheels, the rotation decreases, but the engine speed will increase to be able to move the rear wheels. The calculated torque on the rear wheels that arises due to loading.

Torque can be calculated by multiplying several factors, namely the load given in kg, the force of gravity and the disc break radius of the dyno test tool used. Loads used from 3 kg, 5 kg, 7 kg and 8 kg. The disc break radius of the dyno test is 20 cm. Torque results are obtained according to Figure 4.

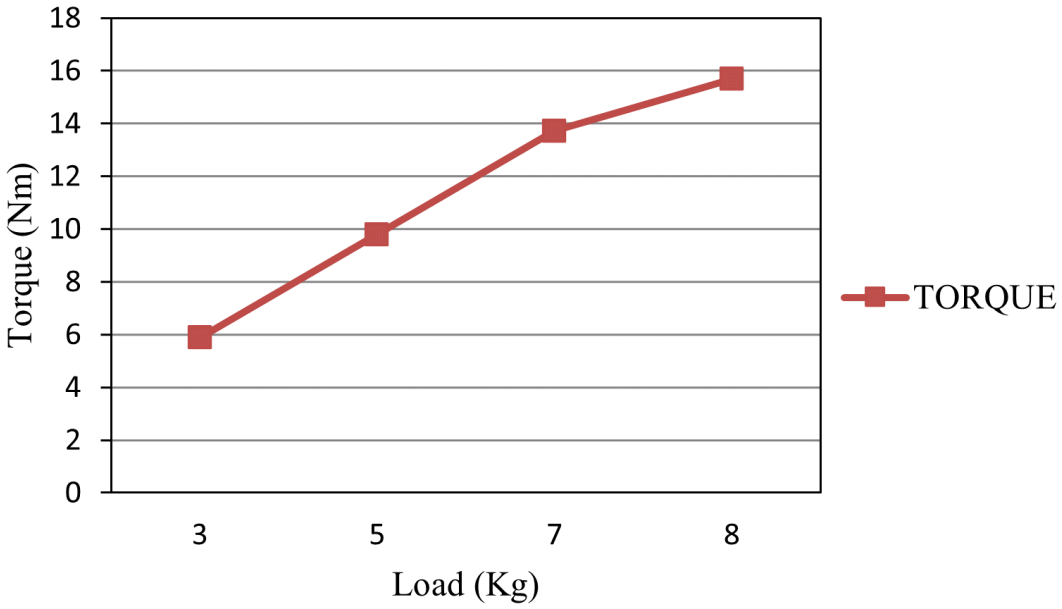

Figure 4. Rear Wheel Torque

The relationship between load and torque is directly proportional where as the load is increased, the torque that occurs will be greater [17]. The relationship between torque and rotation is inversely proportional where the greater the torque generated, the rotation will decrease. When a load of 3 kg, the torque at the rear wheels is 5.88 Nm. At a load of 5 kg the torque that occurs is 9.8 Nm. Torque of 13.72 Nm occurs at a load of 7 kg. The largest torque occurs when the load is 8 kg where the torque is 15.68 Nm.

3.3 Effectiveness

Effectiveness is activeness, usability, compatibility in an activity that carries out tasks with the intended target. Effectiveness is basically focused on the level of achievement of results, often or always associated with the notion of efficiency, even though there are actually differences between the two [18]. Effectiveness is how well the work is done, the extent to which people produce output as expected. The

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effectiveness is obtained from the ratio of the power of the propulsion engine to the power that occurs at the rear wheels which is forwarded by the CVT system. Effectiveness is also affected by the load given to the rear wheels. The effectiveness of the CVT system used as a power source can be seen in Figure 5.

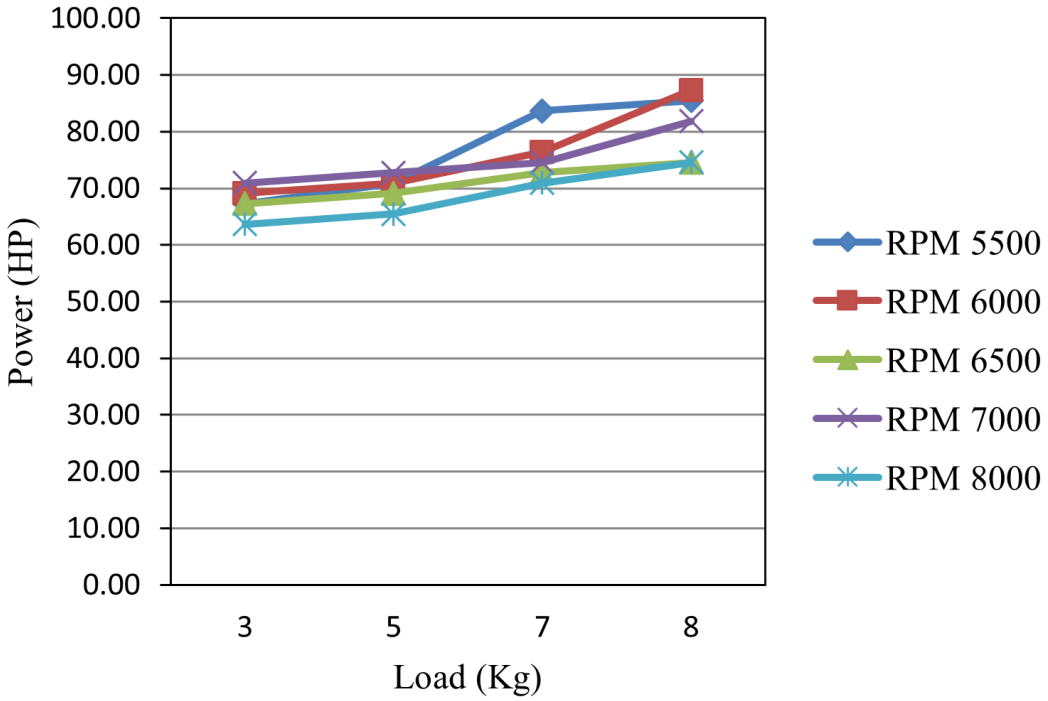

Figure 5. Effectiveness

Power effectiveness is the amount of power that can be transmitted from the main mover to the object being moved [19]. Effectiveness here is greatly influenced by the load given to the object being moved. The effectiveness measured is in the CVT system which is used to transmit power from the main mover to the object being moved. The effectiveness of the power transmitted at 5500 rpm is 70.6%, at 6000 rpm is 72.1%, at 6500 rpm is 67.1%, at 7000 rpm is 66% and at 8000 rpm is 64.3%. The average effectiveness of the overall power that is transmitted is 68%, meaning that from the 5.5 hp driving engine power that can be transmitted by the CVT system to the rear wheels of 3.74 hp.

4. Conclusion

Based on the test results of the CVT system which is used as a successor to the driving engine power to the rear wheels of the buggy, it can be concluded is:

- The rotation of the rear wheels is inversely proportional to the load, the greater the load, the rotation will decrease, a decrease of 40% occurs at 5500 to 6500 rpm and at 8000 rpm there is a decrease of 60% according to the load given.
- The load is directly proportional to the torque, the greater the load given, the more the torque will increase, the torque is 5.88 Nm at a loading of 3 kg and the largest torque at a loading of 8 kg is 15.68 Nm.
- The CVT system is still effective for use as a power successor. The power that can be transmitted is still greater than 50%, namely 68%.

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