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Transmission System of Electric Go-Kart

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Abstract: The aim of this report is to highlight the final design of team hornets of lord's go-kart vehicle Transmission in automobiles is a unit which supplies the power from the clutch to the differential. The simplest transmissions are manual transmissions which consist of a set of gears which are in mesh when transmitting power. Manual transmission requires frequent shift between gears especially while driving in cities. Each time it requires engaging and disengaging clutch while shifting gears.

Keywords: Go-kart, transmission, gears, motor, clutch

I. INTRODUCTION

A transmission is a device or machine that consists of power source and power transmission system, which provides controlled application of the power. Often the term transmission refers simply to the gear box that uses gears and gear trains to provide speed and torque conversion from a rotating power source to another machine device.

The dynamics of a car vary with speed: at low speeds, acceleration is limited by the inertia of vehicular gross mass; while at cruising or maximum speeds wind resistance is the dominant barrier. When changing gear, the engine torque is transferred from one gear to the other continuously, so providing gentle, smooth gear changes without either losing power or jerking the vehicle.

II. LITERATURE REVIEW

Being a new team we required a clear idea of basic requirements, parameters and design of Go Kart. We made a detailed study on Go Kart and visited Runway9, Hyderabad a Famous Go Karting Spot. We gained more knowledge during our field study and our basic doubts on design were cleared.

III. DESIGN METHODOLOGY

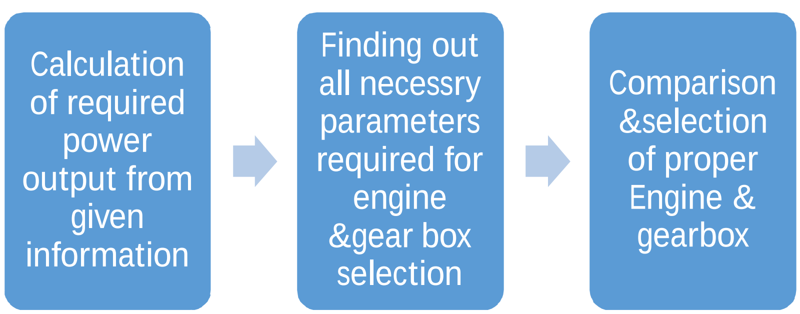

Fig.1 Design methodology of transmission system

IV. MAIN SECTION

A. Goals

The main function of a transmission system is to ensure uninterrupted movement of the wheels with help of motor. The hope for the transmission system to be design was

To achieve maximum possible speed using gears.

To achieve maximum torque at the starting and continues.

With a possible extent, to reduce the major and minor power losses.

Selecting of components carefully to avoid the power losses and to overcome the above view.

To achieve high torque at low rpm.

To achieve high efficiency.

B. Motor

The motor used in the experiment is a brushless DC electric motor. Brushless DC electric motor also known as electronically commutated motors are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context alternating current (AC), does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude and waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed). The rotor part of a brushless motor is often a permanent magnet synchronous motor, but can also be a switched reluctance motor, or induction motor.

The working can be understood of this motor by given animation.

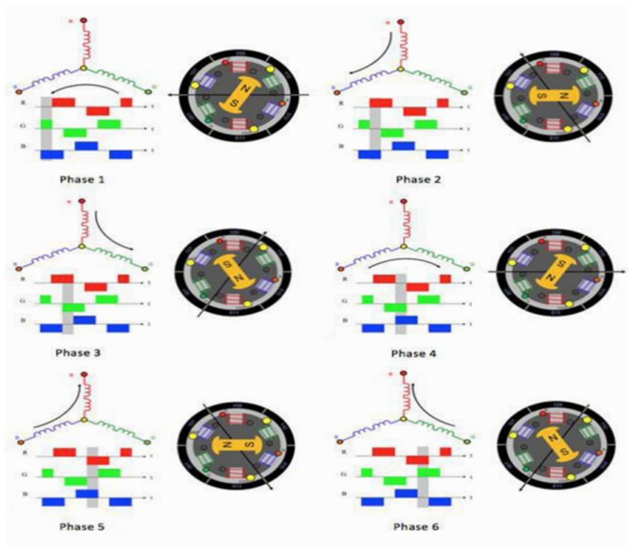

Fig.2 Motor Indications

C. Gear

Most manual transmission two-wheelers use a sequential gearbox. Most modern motorcycles (except scooters) change gears (of which they increasingly have five or six) by foot lever. On a typical motorcycle either first or second gear can be directly selected from neutral, but higher gears may only be accessed in order – it is not possible to shift from second gear to fourth gear without shifting through third gear. A five-speed of this configuration would be known as "one down, four up" because of the placement of the gears with relation to neutral. Neutral is to be found "half a Click" away from first and second gears, so shifting directly between the two gears can be made in a single

The required power switching system is designed on PROE and manufactured in our university mechanical workshop and given below.

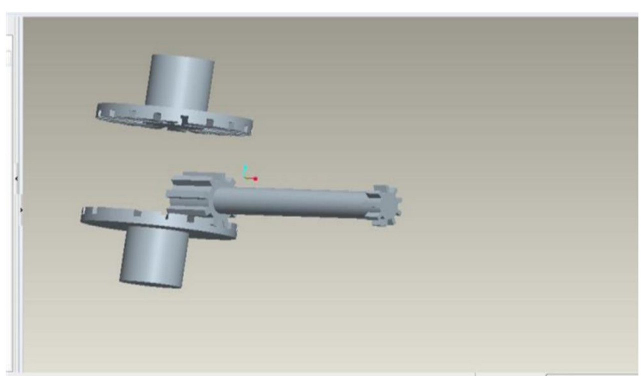

Fig.3 Power switching system design in PRO-E

D. Clutch

Multiple-disc clutches can be used to hold members to the case instead of using bands but in most transmissions, they couple

Volume 5 Issue I, January 2017
ISSN: 2321-9653
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planetary gear members and shafts together. A servo-operated band can only hold a member Stationary, but multiple-disc clutches can hold or drive individual members. They have a set of driving plates, and a set of driven plates, collectively called a clutch pack. Both sets may be spring steel, but one has friction material bonded onto both faces, and since they operate in the transmission fluid they are called wet clutches. The friction material may be plain or grooved. Grooving allows for fluid to escape from between the plates when the clutch engages.

The steel plates may be dished, or waved, with alternate high and low segments. This design promotes smooth engagement. The size and number of plates in a clutch pack depends on the maximum torque it is required to transmit. Three to five plates of each type are commonly used. The plates are pressed together for engagement by a Hydraulically-operated piston. It moves in a short cylinder in a clutch drum, or in a cylinder machined in the casing.

Release can be affected by one large coil spring, or by a pack containing many small springs. When a diaphragm spring is used, it gives extra leverage to increase the apply force as well as providing the release force. The outer Circumference of the diaphragm spring rests against a step in the clutch drum. The piston pushes against the inner Circumference of the spring to apply the clutch. The force exerted on the clutch pack is multiplied by leverage from the Diaphragm, as it pivots against the pressure plate.

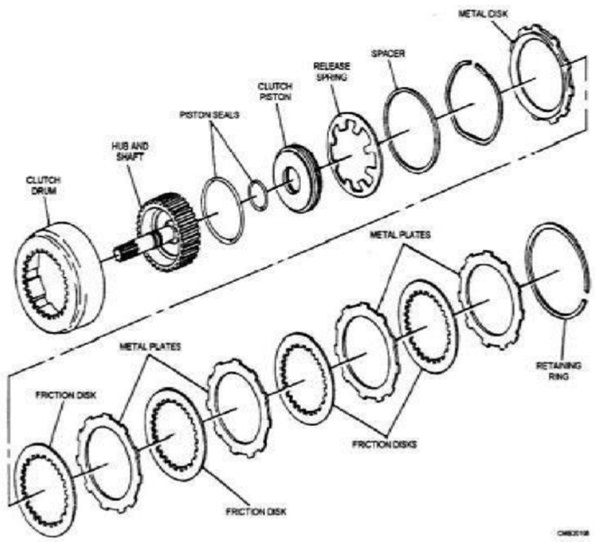

Fig.4 Clutch components dissected

E. Our specifications

1) System Used In our Design: The arrangement of the gear box is as follow the motor is connected to the gear box which has the driving and the driving gears and the axle is placed inside the gear box which is connected to the wheels. The reason for using this type of gear box is to increase the speed of the vehicle and to decrease the load on the motor and also the weight of the gear box will also be less it is often used to convey power to the rear wheel of the vehicle. Here as the clutches helps the gears to engage and disc - engage while transmitting motion.

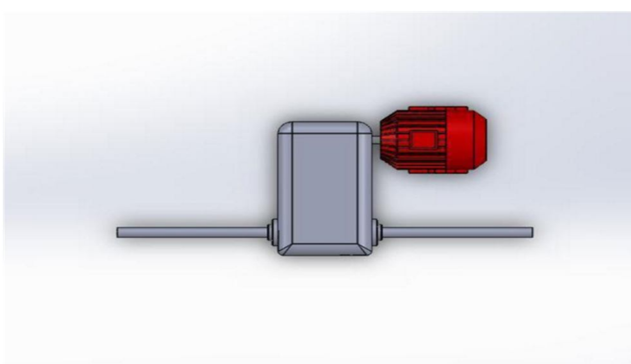

Fig.5 Gear Box Assembly in Solid Works for Transmission System

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2) Gear box design: Our team is using the power transmission through the gear box. The power is transmitted through the gear box from motor to driving shaft of gear box and to driven shaft and then to the rear axle which provides the required reduction ratio. Using of electric motors, electric transmission converts the mechanical power of the engine to electricity and convert it back to mechanical power with electric motors.

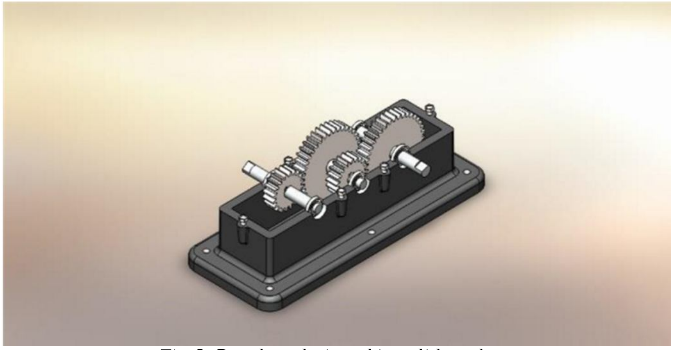

Fig.6 Gear box designed in solid works

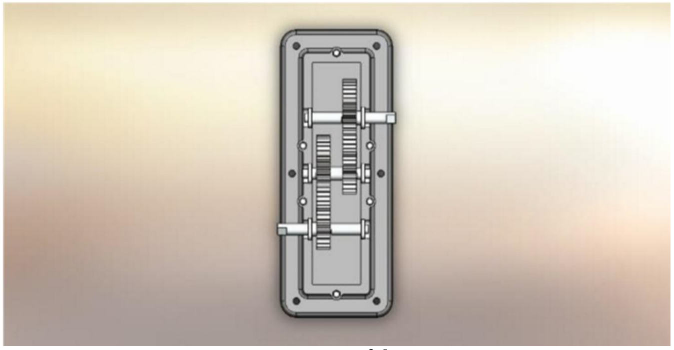

Fig.7 Top view of design

F. Gear ratios

Our team is using the gear ratios of hero Honda splendor plus which has the above gear ratios for the transmission of power through the motor.

TABLE.I
GEAR RATIOS

1st	35/17=2.059
2nd	29/17=1.706
3rd	26/21=1.238
4th	23/24=0.9583

V. CALCULATIONS

Calculations obtaining a higher torque at the wheels are our priority, which means reducing the top speed. Therefore after the

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calculations we got the top speed to 76kmph.

A. Input Torque

P =2πNT/60

T =60xP/2πN

=60x2000/2xπx 3500 = 5.45 Nm

B. Output Torque

T= 60x2000/2xπx2000

=9.54 Nm

C. Maximum speed of the vehicle = 76 kmph = 21.11m/s.

D. Rear Wheels radius(r)

=0.2794/2

= 0.1397m for RPM,

E. Using formula

=30 =30x21.11/πx

=1442.98rpm.IG

F. Initial Torque required at wheels = μWR

=0.08×130×9.81×0.137

= 13.97Nm

G. Taking 1.5 times the initial torque required at wheels =20.955Nm

H. Motor starting torque required (Using formula initial torque/motor torque) = 20.955/3.2= 6.54Nm

Torque at maximum speed: T=Px60/2

=14.372Nm

1) Motor specification

Max. Power = 2K W

Max. Torque = 12.8 Nm at 2400 rpm

Max. Rpm = 3000

2) Chain drive calculation

First chain # 35

Roller chain having pitch of 9.5mm and second one is #45 roller

Chain having a pitch of 13mm

Teeth on smaller sprocket = 12

Teeth on bigger sprocket = 66

Gear ratio: Max. =16.5:1

Min=5.5:1

Length of chain #35 = 108.15mm

Length of chain #45 =1095.24mm

I. Calculation of vehicle dynamics Assumptions

Gross vehicle weight=130kg

Coefficient of rolling friction = 0.015

Coefficient of static friction = 0.6

Gravity g=9.81m/s2

Tractive force (at static condition):

FT= µmg = 0.6*170*9.81 = 1000.62 N

Starting torque =178 N-m

T = FT*R, T = 1000.62*0.1778

= 177.91

Where R= radius of wheel Ft = Total tractive force (at static condition)

Since our source torque is less due to which we are using two chains so our gear ratio will increase. Therefore we can increase our output torque. It is sufficient to start the vehicle.

1) Max possible acceleration of vehicle

Amax = (Tractive effort – Tractive force) /mass of vehicle

A max =1.10 m/s2

2) Air drag

FD=1/2*ṗ*A*Cw*V 2 Where, ṗ = Air density,

A=frontal area

Cw = Coefficient of air drag

V = Max velocity of vehicle

FD = 0.5*1.19*0.39*0.35*43.2*43.2*5*5)/18*18

FD = 11.6 N

3) *Max possible speed of vehicle*

Smax = (ωmax * Coeff)/Gts

Smax = Max speed of vehicle

Coeff = Distance travelled per axel revolution

ωmax = revolution per hour

Gts = minimum gear ratio

ωmax =144000

Coeff =1.116

Gt s=5.5

J. Drive shaft analysis

1) Intermediate shaft

Ultimate tensile strength = 450 MPa

Yield tensile strength = 310 MPa

Modulus of elasticity = 200 GPa

Max. Shear stress = 210 MPa

2) According to torsion equation

T/J=τ/R [2]

Where,

T= twisting force on shaft

J= second moment of inertia

τ= max shear stress on shaft

r= radius of shaft d=diameter of shaft
T=70.4 N-m
R=22mm
J=16T/πd3
τmax = 33.68 MPa
τ = 210 MPa (Used shaft material)
So factor of safety = τ/τmax = 6.2

3) For Final Drive Shaft
T=211 N-m (used shaft material)
d=25.4mm
τmax = 65.61 MPa
τ = 210 MPa (Drive shaft material)
\So Factor of safety= 210/65.61= 3.2

VI. COVERINGS

All the drive train parts has properly shielded with a proper shielding material and no rotating part has been left uncovered.

VII. RESULTS

Max Speed of the vehicle: 76kmph.

Starting Torque required at wheels: 20.955 Nm.

Starting Torque required by motor: 6.54 Nm.

TABLE.II
RESULTS

Input (rpm)	3500
Output (rpm)	2000
Axle diameter (inch)	1
Length of axle (inch)	34

VIII. CONCLUSION

The conclusion of this paper is that to select an appropriate transmission for electric go kart and also help to enhance the stability of vehicle. The idea behind this transmission system is that to get a maximum speed with minimum load on the motor
As the design component of the paper, various, mathematical formula was derived from the fundamental to calculate the various parameters needed under assumption of some basic values of the vehicle.

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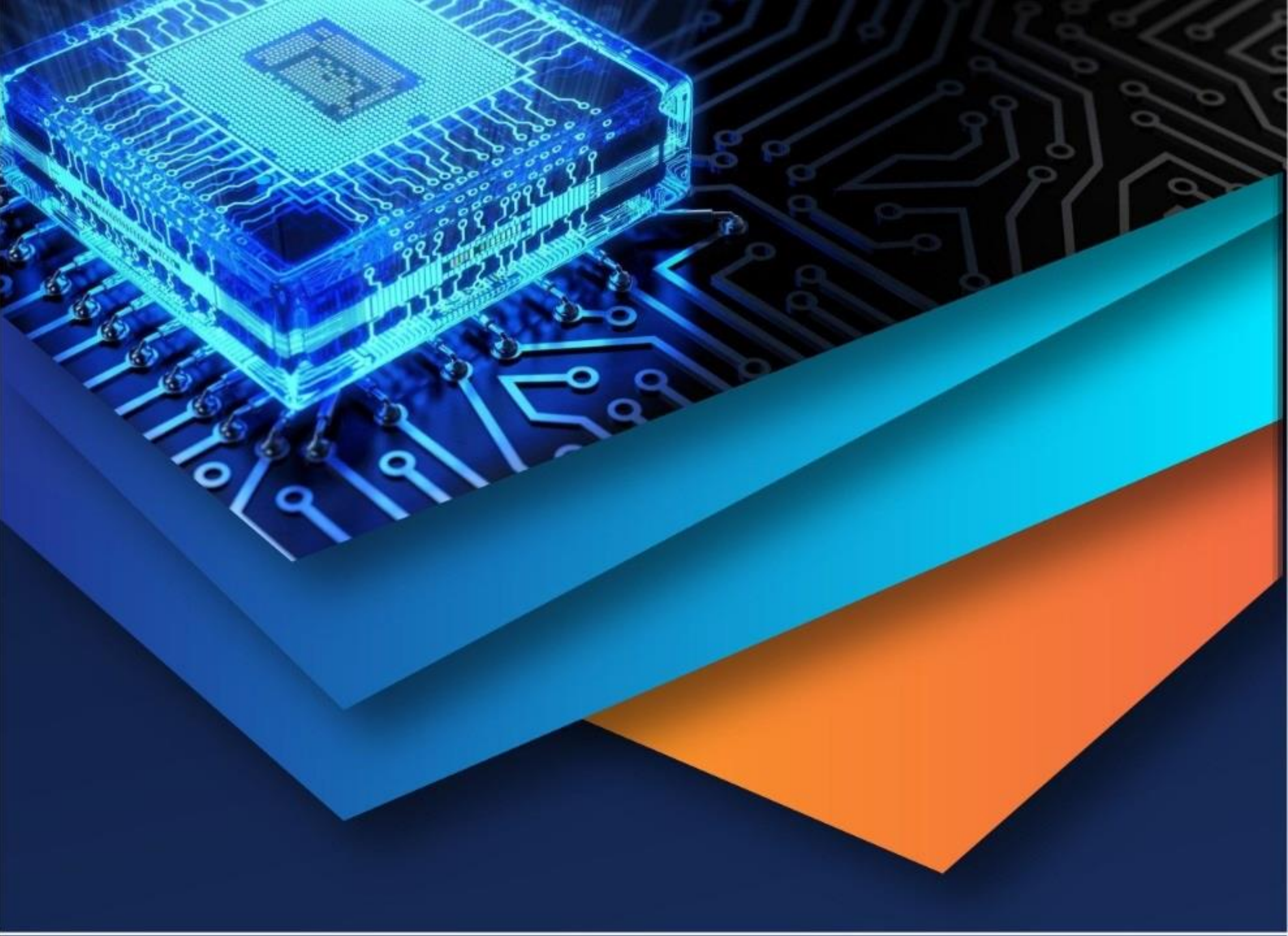

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