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Human Powered Hybrid TRIKE Control System

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***Abstract*— This paper describes in details the control system of an effie-cycle. It describes the steering system, wheel assembly, power train and motor control system. The tri-cycle is operated by both the human power and electrical motor control system. It is an eco-friendly human powered vehicle with a compounded electrical drive also. We have focused on the simplicity of the controlling of the cycle, high performance and safety for the driver. Most of the components are used keeping in mind of their easy availability. This efficycle is designed for two users but for single driver. We have transferred the linear motion of the steering to the rotational motion of the wheel. As in this vehicle no engines are used so it is also totally pollution free as well as noise free. All these things together make this tricycle more efficient than another one.**

Key words: Hybrid, eco-friendly, pollution, mechanical.

I. INTRODUCTION[1]

With conventional fossil fuel consuming rides posing a threat to the existence of life on earth, it is high time to develop alternate and greener modes of transportation for a sustainable future. The effie-cycle was designed to be an electrically assisted, dual-human powered tricycle. Different topologies were analysed and based on the factors such as turning radius, stability, handling and ease of manoeuvring; tadpole design was adopted with 2 wheels at the front and one at the back. The design of the steering system and the power drive makes the vehicle very simple and easy to use.

II. DESIGN OF DRIVE

A. The power train:

As there are two drivers pedalling the cycle all the power together transmitted to a single shaft by means of sprockets and then from that single shaft the power is transmitted to the rear wheel which drives the whole vehicle forward. It is shown in the below figure:

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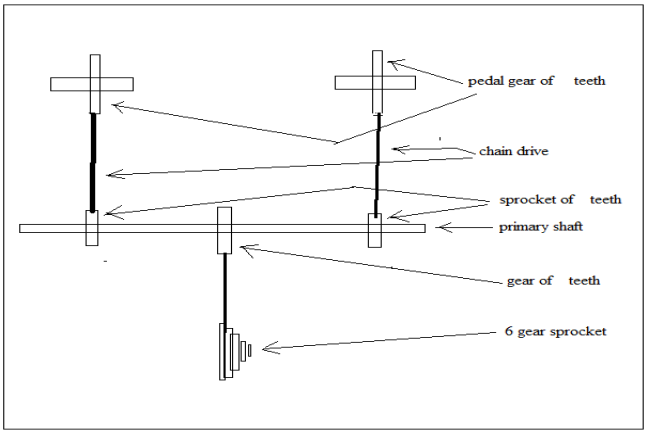


Fig: 01. Design of chain drive

We are using a six gear mechanism to run the vehicle with the pedal operation. An average person can pedal with maximum 90 rpm (N_1). So here the top speed on each gear when the cycle is in no load condition and there is no loss is shown below[5]:

Gear	No of Teeth (T_2)	T_1	V.R (T_1/T_2)	RPM ($N_2=V.R\times N_1$)	Top Speed (km/hr)
1st	28	With Single Driver Gear with teeth 44	1.57	141.30	17.588
2nd	24		1.83	164.70	20.502
3rd	21		2.09	188.10	23.415
4th	18		2.44	219.60	27.336
5th	16		2.75	247.50	30.809
6th	14		3.14	282.60	35.178

Table I: Speed-Gear relation

But this maximum speed will not maintain with full load. This may goes up to 20 km/hr.

B. Motor drive:

A PMDC is used to run the vehicle. The motor is connected to the primary shaft by means of chain drive which is already connected to the rear wheel.

MOTOR	
Type of motor	BLDC
Power	400 watt
Voltage	24 volt
Max Current	30 ampere
Initial Torque	11.46 N-m
Armature RPM	1200
Weight	3.5 kg

Table I: Motor specification

There are 4 numbers of batteries used whose details are given below:

BATTERY	
Type	Lead acid
Output Voltage	48 volts
Discharge Rate	30 amp-hr
Battery run time	2.5 hr
Weight per battery	8kg

Table II: Battery Specification.

III. SUSPENSION SYSTEM

For road holding and braking "Telescopic fork suspension" is used at front and "progressively wound coil suspension" is used at rear in the vehicle .Front suspension is selected because Forks help in better handlings and due to air inside the system[4] , front suspension is light in weight and its design is simple . Progressively wound coil suspension is selected as Rear suspension because it has the capability to bear weight and a road holding capacity.

Fig II: Rear Spring Suspension

Fig III: Mounting of Rear Suspension

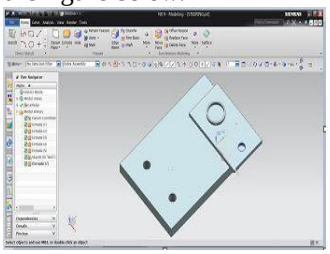
Calculation of suspension system[5]:

For rear suspension system:

1. Length of spring(L_f) = solid length(L_s) + maximum Compression + clearance
   = (n+3) × d + δmax + 0.15 δmax
   = (6+3) ×10 + 100 + 0.15×100 mm
   = 205 mm
2. Spring Index(C) = Mean dia of coil/Dia of wire
   = 50/10
   = 5
3. Pitch of coil = $\frac{free\ length - solid\ length}{total\ no\ of\ coil} = \frac{205-90}{9}$
   = 19.444 mm
4. Shear stress factor = $1+\frac{1}{2C} = 1+\frac{1}{2\times10} = 1.05$
5. Max shear stress = $K_s \times \frac{8\times W\times D}{\pi\times d3} = 1.05\times\frac{8\times1000\times50}{\pi\times103}$
   = 1.337×10^2 N/mm^2 = 133.7 MPa

IV. DESIGN OF STEERING SYSTEM[3],[4]

This is a linkage steering system. The links of the tie rods are mounted on a common plate by means of which the steering mechanism is controlled. The plate is mounted on a bearing which helps to rotate the wheels. For rotating the plate we have used another plate mounting on the same bearing but in 90° to the first plate. This linkage is shown in the figure below.



a. Cad design of steering system

b. Actual Steering System

Fig IV: Steering Linkage

When we push the 2nd plate to its maximum it rotates by 45° and hence the 1st plate also rotate by 45° towards right to its original position and pushes the right hand side tie rod in right and pulls another tie rod also in right side and hence the front wheels take turn to left by 30°.

The specification of the steering system is shown below:

Steering System	
Steering mechanism	Link Mechanism
Control	T-bar
Turning radius	2.51 m
Fork length	160 mm
Steer angle	30°
Steer ratio	1.5:1

Table III: Steering Sysem

V. BRAKES

We are using three mechanical disc brake in the rear and in the front wheels.

Disc brake is used because of its High heat dissipation capability, high torque transmitting capacity; good efficiently in wet weather conditions (because centrifugal

force tends to fling water off the brake disc and keeps it dry)[2].

Fig V: Disc brake

Max velocity of the cycle	35kmph	Internal diameter of disc	140 mm
Coefficient of friction	0.4	External diameter of disc	160 mm
Braking efficiency	50%	Thickness	2 mm
Stopping distance	4.6 m	Brake torque	135N-m
Stopping time	3.31 sec	Braking force	409.99N

Table IV: Specification of Disc Braking System

These brakes do not have Self-locking capability. As alternative, Hydraulic drum brake could be used as the vehicle is not a high power, high weight vehicle also it is not good in muddy road.

VI. WHEELS AND TIRES

Tires provide contact between the road and the vehicle. Road shocks are first absorbed by tires and then transmitted to suspension. The tyres are chosen in such a way that it must provide traction in all kind if surfaces without slipping. Wheels which are responsible for the steering responsiveness and effortless steering, targeted top speed can be achieved without any compromise in the COG of the trike. So the sizes of both the wheels are 26" which also fulfil the need of necessary ground clearance. 26-inch wheels offer excellent rolling resistance and made the ride significantly smoother.

VII. SEATING ARRANGEMENT

This TRIKE has two good and comfortable cushioned seating arrangements for both two drivers. These are inclined by 15° and adjusting arrangement so that the drivers can adjust the seats as their comfort.

VIII. SAFETY

It provides the safety of vehicle and its occupants. Three important points harness, helmets, and elbow and knee guards, safety glasses for eye protection are essential for rider's safety.

a) The placement of key controls like emergency brakes, kill switch in reach of both the drivers easily.

b) Vehicle is free from any kind of sharp edges that can harm rider or crew members.

c) Steering system has auto centre springs which helps the cycle to keep in forward direction movement even we do not touch the steering.

d) We have used indicators which ensure safety of both riders and bystanders and pedestrians.

IX. ERGONOMIC FEATURES

a) More stable at medium and high speeds because of the low centre of gravity.

b) Two wheels in front offer excellent overall braking.

c) Three point harness, helmets, and elbow and knee guards, safety glasses for eye protection for rider's safety.

d) Do not pull the rider over the handle bars in severe stops.

X. CONCLUSION

The simple steering system makes it very much easy to steer and attractive. This eco-friendly vehicle is compounded with the electric motor drive and the gear shifting mechanism converted the cycle easy to drive and the systematic arrangement of the motor, electrical controls gives the more safety. All the parts are fitted with respond to easy maintenance and so it has got a wide scope in automotive industry as it reduces the efforts of driver & provides more automatic control of the vehicle. Hence it makes the vehicle more efficient. This Human powered hybrid trike control system can be used in every ways.

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