

DESIGN OF THREE WHEEL STEERING SYSTEM FOR THREE WHEELED VEHICLES

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Abstract:

Three-wheeled vehicles with delta configuration are a popular and common means of short distance transport in Ethiopia. Indeed these vehicles have been delivering a great service for the most peoples of the regional cities of our country, but there is also a great fatality rates on accidents caused by such vehicles. Among the accidents most of them are rollover accidents on these vehicles without crashing with other vehicles. So there was a great deal of problems needed to be solved on stability and maneuverability of such vehicles. This thesis study is mainly focused on designing a three wheel steering system so that the stability and maneuverability of three wheeled vehicles will be enhanced. The design was achieved by designing new three wheel steering system which can be implemented on three wheeled vehicles by some new component designs and other remaining component modifications. This was done by using SolidWorks and ANSYS software. There has been a reduction of turning radius of these vehicles from 2880 mm to 1471.79 mm and also increasing the maneuverability of the vehicle from 2 to 5, so that the vehicle can turn with narrow roads around crowded areas of the cities. The main thing I have done was connecting all the three wheels by a mechanism so that they can turn accordingly and the rear wheel turns opposite to the front so that it can cover shortest distance to turn around in crowded areas. The system I have designed is a better steering system than the existing one in a ways such as easy and economical to manufacture, it has better maneuverability suitable to operate and does not affect the appearance of the existing vehicle body.

1. Introduction

Growing population in cities and rising number of vehicles have brought vehicle designers into a new challenge for production of small, fuel efficient, and safe vehicles. In this vein, a new generation of small three wheel vehicles have come into existence and populate most middle and low income cities of the world. Nowadays, because of their low fuel consumption and ease of driving and parking in populated areas, they are gaining more attention. Despite their popularity, three wheelers, due to their typical light and narrow design, have one major drawback: they are not very stable in harsh and small radius maneuvers.

Everybody travels from one place to another place either to work or to do business or to study or to enjoy using various transport options. Vehicle is one of the most widely used transport alternative and the major source of road traffic accidents in the world. Due to road traffic accidents, a greater part of road users could not return to home: farewell this world for once and all, spent long days, weeks, months, and even years in health centers and/or hospitals, and never be able to work or play as they used to do before. Particularly, nowadays, road traffic accident has been both public health and development issue and attracted the attention of governments, civil society organizations, and business and community leaders alike throughout the world. In Ethiopia, the number of deaths due to traffic accidents is reported to be amongst the highest in the world. According to the WHO, in 2013 the road crash fatality rate in Ethiopia was 4984.3 deaths per 100,000 vehicles per year, compared to 574 across sub-Saharan African countries. Besides, the number of people injured or killed in one crash in Ethiopia is about 30 times higher than that in the US. In general, the scale and the severity of the problem are increasing from time to time and adversely affecting the economy of the country in general and the livelihood of individuals in particular.

2. Materials and Methods

An auto rickshaw is a motorized development of the traditional pulled rickshaw or cycle rickshaw. Bajaj Auto is the fourth largest manufacturer of two- and three-wheelers in the world and the largest three wheel producer in India which makes them a rival to TVS. The Bajaj auto

rickshaws are very common on the Indian and Ethiopian market. One common version is the Bajaj RE which is shown in Figure 1. The first rickshaw built by Bajaj was licensed under Piaggio/Vespa and appeared on the market 1950. They used same mechanics as the Piaggio Ape but changed its appearance and even introduced a taxi version which Piaggio Ape did not have. This means that they still used the trailing arms together with shock absorbers and springs as rear suspension and leading link as front suspension and handle bar. [5] discussed a project, Proton Exchange Membrane (PEM) energy unit are progressively being referred to by governments as a conceivable pathway to the decrease of ozone depleting substance outflow. It is one of the forthcoming force hotspots for car applications, prepare machines, stationary cogeneration frameworks, and portable electronic gadgets. Be that as it may, the dryness of the film of a PEM power device diminishes the ionic conductivity, bringing about execution decrease. In this work, a two-dimensional model is utilized to examine the fundamental and collaboration impacts of five outline factors, at three levels in a proton trade layer (PEM) energy unit. Investigation is directed for working possibilities of 0.7 and 0.6V and a scope of current densities. An engine that picks up its energy from a hydrogen tank and a power device Stored in a tank. The substance vitality from the hydrogen will be changed over into electrical vitality by the power device to push the prepare at up to most extreme speed of 80km/hr. Prepare apparatuses like Fans, lighting may likewise keep running on PEM energy unit. This new hydrogen prepare is along these lines ideal for shorter, calmer extends of the system that jolt hasn't yet come to.



Fig.1 Bajaj RE

These three wheeler benchmarks are available in Ethiopian markets, among them Bajaj Auto rickshaw-Rear Engine 4 Stroke, Petrol model manufactured by Bajaj Auto Limited, shown in Figure 3, is the most widely used types of public transport in Ethiopia and it's the basis for this thesis.

Table 1 Bajaj Auto Rickshaw RE Compact 4S PETROL Specifications

Engine	Petrol
Displacement	198.88 cc
No. of Cylinders	1
Max Power	9.00Kw@6000rpm
Max Power RPM	16.7 N.m@4500rpm
Transmission Type	4 forward and 1 reverse
Clutch Type	Wet multidisc type

3. Result and Discussion

The following are the details of the results obtained from the existing steering system and also by implementing the new steering system I have designed, which is three wheel steering system for three wheel vehicles with delta configuration. By considering the input parameters (Wheel Base: 2000 mm, Wheel Track: 1150 mm, Turning radius: 2.88 m) and implementing on the existing three wheel vehicle steering geometry I have found the maximum angle of the front wheel at the given turning radius value of the vehicle. Which is $\delta_f = 42.8^\circ$. After implementing the new concept of three wheel steering system I have found the two remaining wheels turning angle, which are $\delta_i = 63.21^\circ$ and $\delta_o = 31.14^\circ$. So, the new designed steering geometry of three wheel symmetric steering system reduced the turning radius of the vehicle from 2880 mm to 1471.79 mm. which means it reduces the turning radius by 946.43 mm. Which means this optimum configuration gives 48.8 % reduction of the turning radius for this vehicle. There is also a great enhancement in degree of maneuverability of the vehicle from 2 to 5. Which indicates that this three wheel steering system increase the maneuverability of the vehicle.

Table 3.Comparison of the existing and new designed steering system

Parameters	New Size / Dimension	Existing Size / Dimension
Wheel base	2000 mm	2000 mm
Wheel track	1150 mm	1150 mm
Turning radius	1471.79 mm	2880 mm
Steer angle (δ_f)	42.8°	42.8°

Inner rear wheel angle (δ_i)	63.21°	0°
Outer rear wheel angle (δ_o)	31.14°	0°
Degree of mobility (δ_m)	2	1
Degree of steer ability (δ_s)	3	1
Degree of maneuverability (δ_M)	5	2

3.1. Cost Estimation of prototype

Cost analysis is carried in order to estimate the cost of the new three wheel steering system prototype Implemented on the three wheeled vehicles. The analysis is based on the current cost of the materials in the market. Figure 5.1 shows the numbers given to each components of the designed steering system to identify each other.

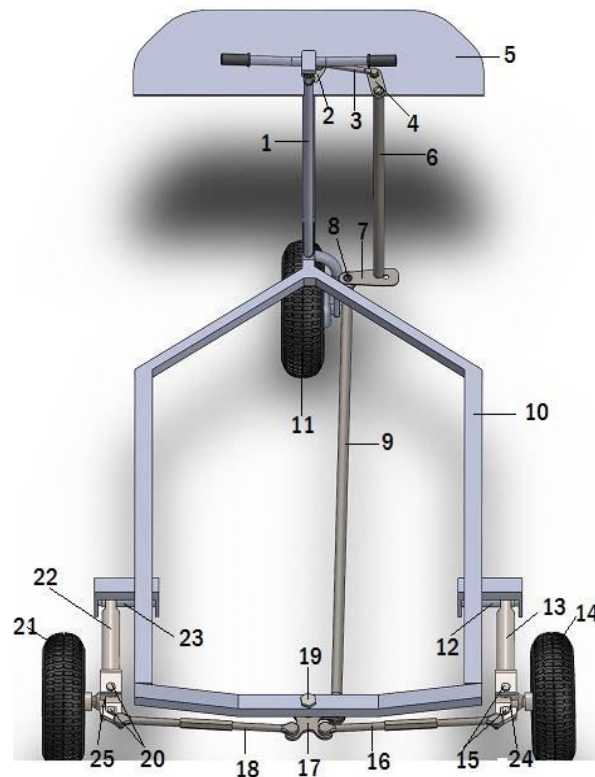


Table 3.2 Identification numbers, materials and cost for each components

No	Material	Dimensions (length, width and thickness)	Cost/birr
2,4,5,7, and 17	Flat iron	50x3	335
3,6,9,12,13,16, and 18	Round pipe	0.5 " 6000 mm	2*430

24 and 25	Compound		400
8,15,19, and 20	Bolt and Nut	Different	7*22
11,14, and 21	wheel		3*200
22, and 23	Modified trailing arm		2*420
		Total	3189

4. Conclusion

Rollover events are classified as tripped and untripped, in this thesis study I only focuses on designing in order to solve the untripped rollover accidents caused by improper driver input, that is, steering and speed while cornering by Designing new steering system for three wheeler vehicles. The three wheel steering system was designed so as the vehicle is capable of turning all three wheels without any difficulties and to experience a better maneuverability, stability and shorter radius cornering. The trailing arm is modified so that it can hold the steering knuckle and to enhance the suspension coil spring efficiency. The designed steering system has as low weight as compared to the whole vehicle weight, and it also doesn't have an appearance effect on the looks of the existing vehicle body. In order to accomplish the steering system design for the three wheel vehicle, there has been some components which are newly designed and some of them are modified so that they can support the new designed steering system. So, by designing three wheel steering system for three wheeler vehicles I have reduced the turning radius of the vehicle from 2880 mm to 1471.79 mm. which means it reduces the turning radius by 946.43 mm or by 48.8 % reduction. And also increased maneuverability. This shows that since these vehicles operate in areas which are crowded and give service for lots of peoples in a short period of time on narrow roads, they can turn with shortest radius of our country's crowded area, like market places and crowded traffics and still the vehicles can be more stable and efficient.

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