Design of an Auto-Tilting Car

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Abstract--- *In this I have tried to develop a tilting mechanism for a normal fuel run track car to give it the flexibility of a motor cycle. This feature enables the car to tilt in to the curve while negotiating it. Our analysis shows that to increase the maximum curve at speed by more than 50%. The method I have used is a simple mechanical tilting system controlled by a simple DC stepper motor which is controlled electronically. This tilting mechanism if successful should dramatically increase the maximum speed in curves. This should also provide the advantages of increased passenger comfort and handling. The idea is to develop a tilting car of normal fuel run track that seats two people in tandem. This can be operated on reduced lanes thereby increasing the effective capacity of highways.*

Keywords--- *Auto-Tilting, Capacity of Highways, 3R-C.*

I. INTRODUCTION

Normal fuel run cars are without doubt the future of urban mobility. These cars have a very short wheel track in comparison to normal cars. Most of the international car companies have production models and prototype of normal track cars. Some examples are Nissan Land Glider, Nissan Pivo, Honda 3R-C, etc.

Such cars are mostly single seated or double seater with back to back seating configuration. These cars have several advantages:

1. Half the width means half the weight, more rigidity, more access to normal roads, easier parking and much quicker transit times.
2. In an electric vehicle, the lighter weight of this much smaller vehicle will help to enhance torque power characteristics of an electric motor to achieve “linear acceleration”.
3. At highway cruising speeds, such cars will be using half the frontal area and half the drag co efficient, plus reduced running losses make for a very energy efficient vehicle.

All these advantages make the normal track vehicle so appealing as an alternative to the car.

Such cars combine the comfort of a car with the functionality of a motor bike. But these cars have a very important and dangerous drawback. With a very comparatively normal track and heights almost equal to normal fuel run cars, these cars are very susceptible to rolling. As of now all such normal track cars are electrically driven and

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Received: 05 Apr 2019 | Revised: 03 May 2019 | Accepted: 04 June 2019

have a limited top speed and hence this drawback is comparatively negligible. But sooner or later these cars will have to get highway cruising speeds. Then this drawback will be of grave importance.

Our project took shape as an attempt to face this drawback. We thought so if the cars has the functionality of a motor cycle why not give it the flexibility of a motor cycle. This gave use to the idea of an auto-tilting car. There have been many tilting body designs in rail but what we have done is not just a body tilting, in it the car tilts as a whole. Recently there had been some development in making three- wheeled tilting cars like the carver, but only prototypes or concepts exist in the field of four-wheeled tilters.

II. OBJECTIVE & METHODOLOGY

The objective of this project work is to successfully develop a design of a tilting mechanism for a normal fuel run tilting car. The mechanism is to be reliable, simple, cost-effective and practically feasible. The aim of this tilting mechanism is to provide banking to the car on unbanked curves, so as to enable added threshold speed on curves in comparison to a normal fuel run cars non-tilting car. This system is also supposed to enhance passenger comfort as the side force felt by passengers in a car taking a turn is comparatively less in a tilting car. Also in our purpose is the fabrication of a mini-prototype–a remote controlled toy car-to demonstrate the tilting in real world.

The methodology adopted to use standard and presently used components in design rather than to design all components from ground up. The advantage of this method is that, you do not have to spend ridiculous amount and time in testing the integrity of each part as they have already proved their worth in real world applications.

III. FRAME DESIGN

The frame has been designed with parameters taken from an already existing and successful normal fuel run rack car. The entire suspension system has been redesigned and an additional tilting tyre holder was welded on the frame both at front and rear. The adoption of an already existing frame for our design ruled out the requirement of stress analysis. The frame is sure to hold on, even in case of most hostile conditions, as it is a tried and tested design. The frame design is shown in Fig A

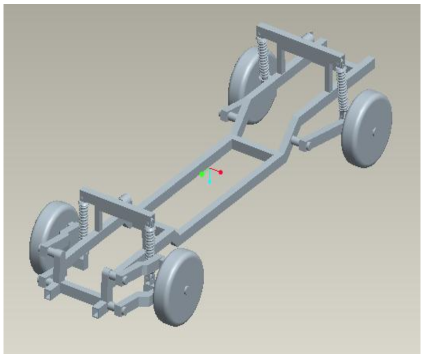


Fig A

IV. DESIGN OF TILTING MECHANISM

The tilting mechanism design was a complex question. Initially it was decided to use power screw driven screw driven screw holders for each individual wheel controlled by a stepper motor. The design almost completed. It had several advantages:

1. Each wheel could be moved independent of the other.
2. More precise control was possible with power screw lifters.
3. It could be modified to incorporate other systems like body level control, ground clearance adjustment system etc.

But analysis showed some critical disadvantages of screw lifters. They were

1. Their response was slow at very high speed and repeated steering and control steering.
2. The wear and tear in screw parts was more than desirable. This would only aggravate in a real life situation where dust and sand particles can accelerate the wear of the screw and lifters.

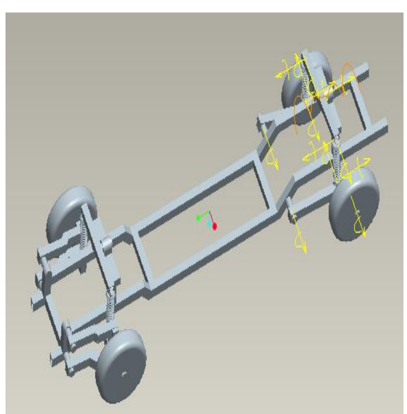
Hence the design was discarded and we were on the look out for a new and simple tilting mechanism. It was at this point, it was decided to use the present design of a tilting mechanical tyre, controlled by a stepper motor. The ends of the tyre were linked to each rear wheel through struts as used in bikes rear shocks but with universal joints on both sides. The tyre is moved about a central pivot mount on the frame, this motion in result lifts the wheel on one side, while lowering the other, this in result tilts the vehicle to one side.

The reverse motion of the tyre tilts the vehicle in opposite direction.

After much thought and consultation, it was decided to power only the rear rotating tyre, the front was free and was supposed to follow the rear.

This was adopted not to reduce the cost but it had the following advantages:

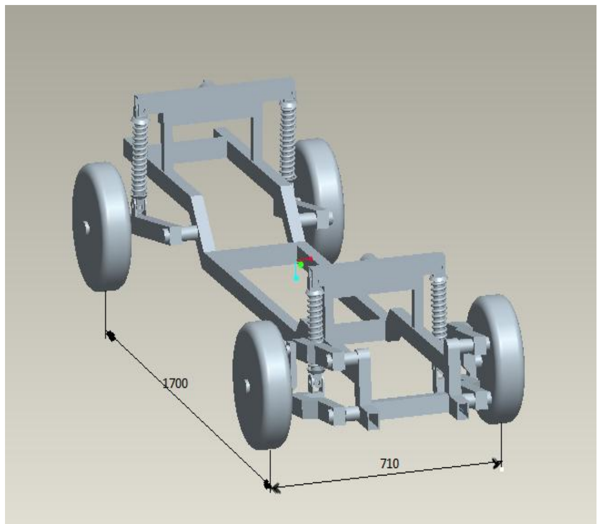
1. It provided more freedom of movement to the front wheels, which ensured better comfort.
2. The freedom of movement of front wheels also give the vehicle added steer ability and maneuverability.
3. It also reduced the overall weight of the vehicle.



V. Testing Of Design

The designed tilting mechanism has been recreated and tested in pro-e simulation program. Initially, the tyre resisted movement and after many rounds of fine-tuning the dimensions, the assembly began to show positive results. Only the rear rotating tyre had to be tested as the front was not under powered motion. The front rotating tyre assembly was also dimensionally modified to suite the rear one. Certain range of motion was imparted to the rear rotating tyre and the process was captured as a video for presentation.

The complete frame design with final dimensions



VI. Comparison Of Threshold Velocity On Curves For Tilting And Non-Tilting Cars

From equations of vehicle dynamics, for a vehicle in a curve

Maximum sliding velocity, $V_s^2 = gC(\sin\theta + \mu\cos\theta)/(\cos\theta + \mu\sin\theta)$

Maximum overturning velocity, $V_o^2 = gC(a\cos\theta + 2h\sin\theta)/(2h\cos\theta - a\sin\theta)$

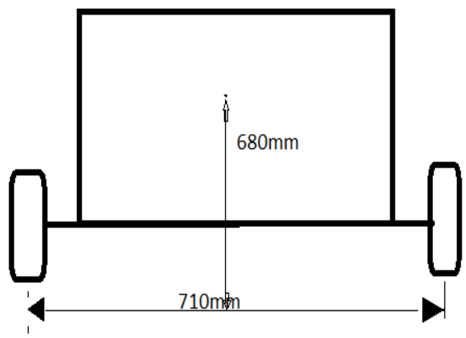
For a non-tilting car under the following parameters

$\mu=0.6$
$\theta=20^0$
$C=50m$
$g=9.8m/s^2$
$a=0.71m$
$h=0.68m$
Sliding velocity for non-tilting car =17.14m/s =61.7kmph
Overturning velocity for the same =15.99m/s =57.56kmph
Whereas for a tilting car that can tilt 20 degrees into the curve,
Sliding velocity = 24.58m/s =88.48kmph

Overturning velocity = 82.86kmph

Increase in sliding velocity = 43.4%

Increase in overturning velocity =43.9%.



VII. CONCLUSION

In this journal carried out for the "DESIGN OF AN AUTO – TILTING CAR" a brief study of design of frames and the selection & design of battery and the mechanism which was carried out by CREO was seen.

It can be seen from the above result that, our objective to increase the threshold velocity of a normal fuel run cars in a curve has been successful. The design of the car and tilting mechanism worked flawlessly in simulation as well. The mini-prototype to demonstrate tilting is also working successfully, all these facts point to the completion of our objective in high esteem.

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Received: 05 Apr 2019 | Revised: 03 May 2019 | Accepted: 04 June 2019