Automobile Kriti Report Kapili hostel

February 2024

1 Problem statement

Build a fully remote-controlled buggy, powered by electric motors to go around a track in the shortest possible time. The track will consist of multiple jumps from ramps with heights ranging between 15-20 cm requiring a good shock-absorbing mechanism. The track may also include patches of rough terrain, sand pits, and tight turns. Visual appeal of the design will be considered in the final evaluation of entries

2 Design report

Our submission for this problem statement is a fully remote controlled buggy with some salient design features such as:

FRONT:The front part of the vehicle is on the lighter side comprising of just wheel and main chassis of the buggy. There are no suspension for the front wheels so to get less stress and shock in the front portion we shifted the centre of gravity of the buggy and for some of the shocks we added tubeless wheels which provide a good grip from the ground and adds a factor of sock absorbtion to this mechanism. We have placed a servo motor in the front to control the directing of the buggy precisely. For the front part we are using the *Ackerman steering mechanism.*

Ackerman steering mechanism:
This mechanism is a four bar linkage mechanism applied on the front axle. The wheels will have 2 types of velocities namely translational and rotational, if we assume no slip condition then both the velocities should be equal. While making a turn the wheels should travel different distances according to the direction of turning, for e.g. while making a left turn the left wheel should travel less distance than the right wheel to make a perfect turn.

So while turning the car the inner wheel has to travel less distance and need less translational velocity than the outer wheel, so both wheels must have

different translational velocities and different direction for rotational velocities.

This difficulty is overcome by the mechanism by employing different steering angles for different wheels. The angle is smaller for the wheel farther from the center of curvature of the turn, and slightly larger for the wheel closer to it.(here farther and closer are according to the center of curvature of the turn)

Steering geometry:
The geometrical solution for this is that we make all the axes of the 4 wheels arranged as radii of a circle with a common centre, as the rear wheels are fixed the point must be extended from the rear axes intersecting from front wheel's axes.

So when the front wheel is steered the inner wheel will have a greater angle than the outside wheel. Ackerman steering geometry makes the tyre toe-out which enables them to easily drive through steep maneuvers.

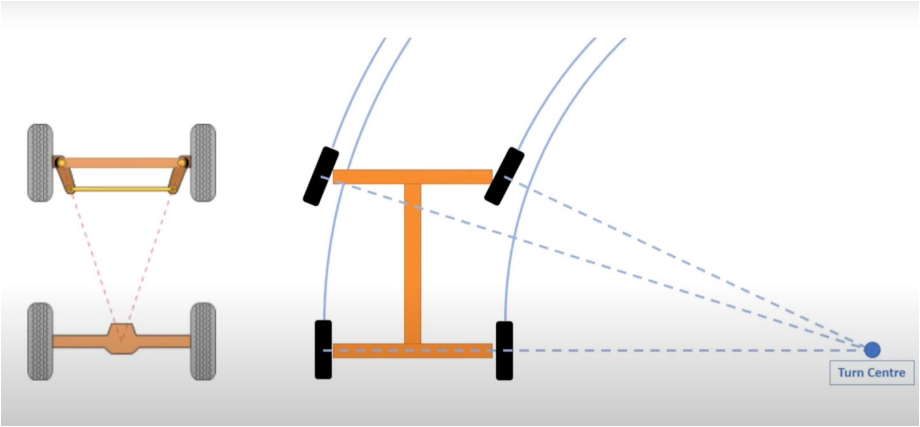

Figure 1: representation of ackerman principle

The toe-out mechanism has other advantages:

- Toe-out increases the slip angle of the tires, thereby improving the grip between the tire and the road.
- Engine-driven wheels benefit from increased grip, resulting in faster vehicle acceleration.
- For non-driven wheels, an increased toe-out angle adds resistance to vehicle motion, requiring greater effort from the driven wheels and, consequently, reducing acceleration.
- An increased toe-out angle can lead to a decrease in the vehicle's maximum speed.

- Toe-out enhances steering sensitivity, making it easier to turn the vehicle with minimal effort. This helps counteract understeer tendencies.

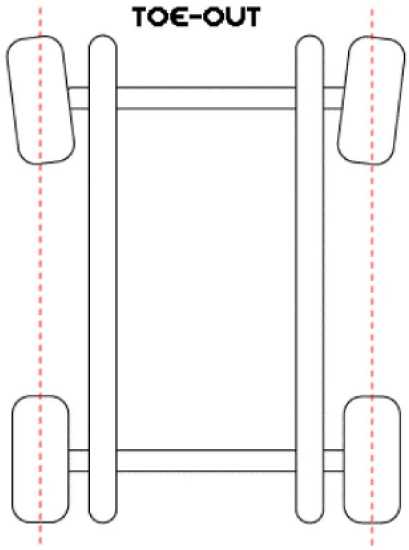

Figure 2: visual demonstration of toe out wheel alignment

MIDDLE: The middle section contains the suspensions, with two suspensions connecting the main body to the wheels. These suspensions are placed at a lower angle to prevent any direct impact on them, thereby avoiding potential damage, and to ensure they do not bear the weight of the car. The hinge point is kept distant from the tire to minimize compression on the suspension. The body is divided into two parts joined at the center.

REAR: It is the most important part of our buggy as this section contains two brushless motors connected with gear pulley mechanism to the tyres, we kept the ratio of the pulley at the motor to the wheel 3:1 which implies that when the motor rotates 3 rev the wheel rotates 1 rev resulting in better torque. The brushless motor are used to provide better acceleration as compared to the brushed motor. The wheels at the rear are larger than the wheels at the front and both the motors are placed there as well thus making center of gravity towards the rear of the vehicle which brings more stability and less toppling effect for the vehicle. The rear wheels are made from pure rubber which are heavy and the front portion in lighter. The vehicle will be operating on neutral steer. Neutral or normal steer condition occurs when the K-gradient is equal to zero.

$\mathrm{K} = W_f/C_{\alpha f} - W_r/C_{\alpha r}$

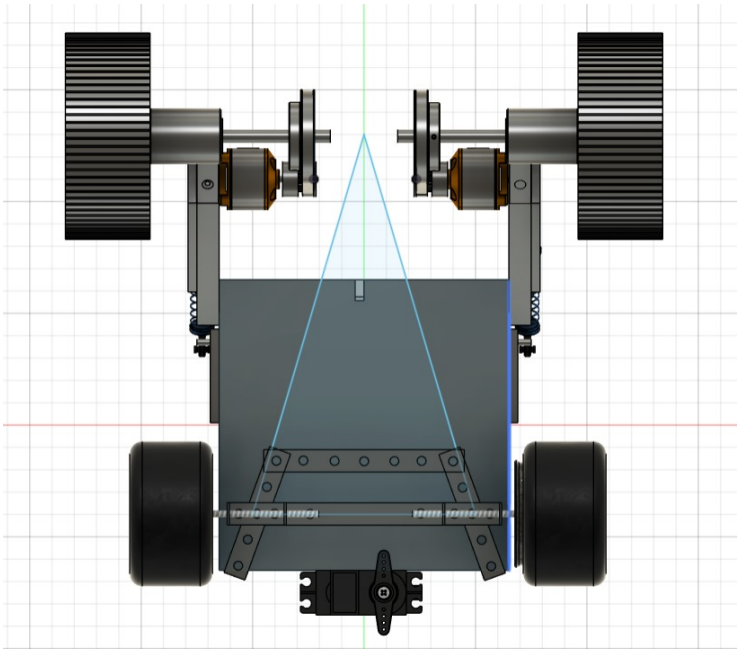

Figure 3: visual demonstration of ackerman principle in our model

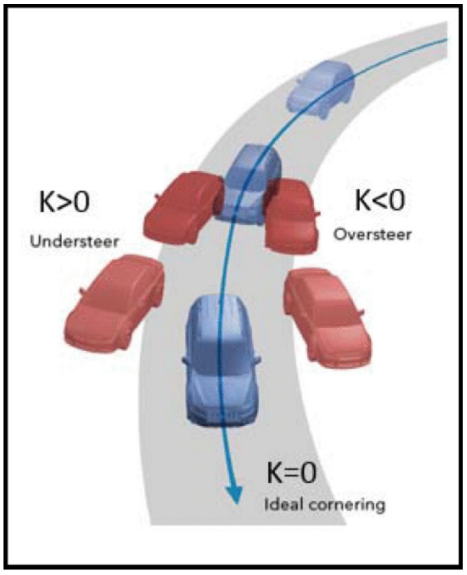

Figure 4: Representation of over, neutral, and under driving

K=0;

- Vehicle load on front trans axle W_f
- Vehicle load on rear trans axle W_r
- Front tire cornering stiffness $C_{\alpha f}$
- Rear tire cornering stiffness $C_{\alpha r}$

To make this whole equals to zero we have high stiffness tyres and larger load in the rear and low stiffness tyres and lower load in the front thus equalizing the ratio and making K=0. Both the wheels have independent drive and thus making it more suitable for the harsh terrains if there is some disturbance in one of the wheel it will not effect much to the main body and makes the body more stable and since the wheels are large we can overcome obstacles easily without affecting the motion much.

This sums up our report for this particular problem statement.
Tinkercad link