CAR TOPPLING PREVENTION SYSTEM

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KEYWORDS:

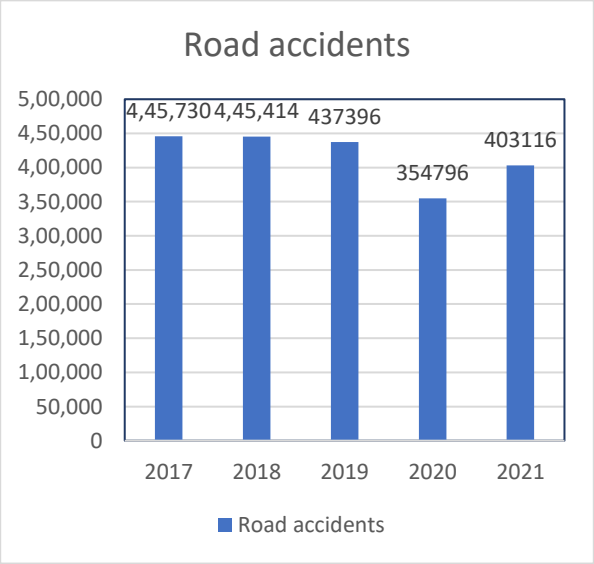
turning radius,
steering angle,
topple velocity

ABSTRACT:

Every day, there are numerous vehicle accidents happening all around the world. Accidents can result in driver and passenger fatalities as well as injuries to persons. The most serious sort of traffic accidents includes car accidents with several rollovers. There is frequently noticeable significant deformation of the car, especially of the roof, even at the initial relatively low speed of the rollover collision. Even when passengers are buckled in, this frequently results in catastrophic injuries. Car accidents are one of the main causes of the increasing mortality rate. Speeding is one of the major factors in car accidents, which can result in car crashes, car toppling, and loss of control, among other things. The major topic of this research paper is how to stop cars from tipping over. Here, we present a new safety system called the Car Toppling Prevention System that guards against car toppling and assures the security of the driver and passengers. This system performs correctly in situations where the car's center of gravity is at the center of the body and the car is moving on a leveled road without any slope or curve.

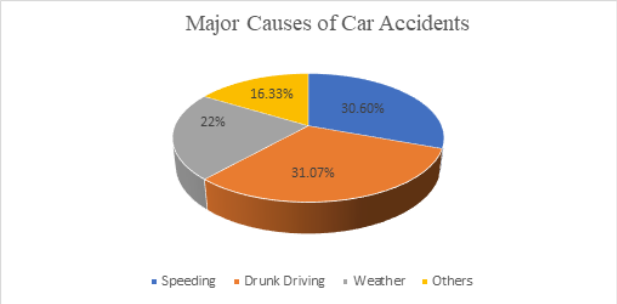
INTRODUCTION:

Currently, road accidents are a major cause of mortality. The national criminal records bureau (NCRB) reports that a total of 3,54,796 road accident cases were registered in 2020, and that number rose to 4,03,116 in 2021 with fatalities in particular seeing a 16.8 % rise. According to the overall number of fatalities in 2021, traffic crashes claimed the most lives in Uttar Pradesh (14%), Tamil Nadu (9.88%), and Maharashtra (8.94%).



Car-related concerns are one of the growing problems in traffic accidents. 4039 out of 23531 recorded fatalities were car accidents. There are many reasons for car accidents such as Over-speed, Drunk Driving. The

below Pie Chart shows the main causes of car accidents in 2022.



The major Causes of Car Accidents are Over Speed (30.6%), Drunk Driving (31.07%), Bad Weather (22%), and Others (16.33%) like Car condition, Driver Fatigue, and Cell Phones. Most Car accidents are happening due to excess speed. The Causes of Speeding may be age, alcohol and some people may encourage drivers to drive fast for enjoyment or it may be traffic density, traffic composition, etc.

According to the report titled 'Road accidents in India – 2020', A total of 2,65,343 road accidents occurred in during the year 2020 due to over-speeding. Speeding not only refers to exceeding the posted speed limit but also includes driving too fast by not keeping the road condition in mind and also driver recklessness. Speeding leads to dangers such as car toppling, car crashes, increased stopping distance, increase loss of control over the vehicle, and hitting pedestrians, cyclists, and motorcyclists.

Car toppling happens when a car takes a turn at high speed. And also, the main issue in racing cars is toppling when turning. The images of cars toppling are shown below. In the first image, the car gets topples due to Overspeed at turnings. In the second image, the car gets toppled due to Overspeed while overtaking on the bridge.

Scenario-1:

A car is moving at high speed and in the turning, the car lost its control and toppled and also hit the pavement near a petrol bunk in Gujarat.

Scenario-2:

An SUV car moving at high speed crosses a car and tries to overtake another car that comes in opposite direction, lost its balance, and got toppled on the bridge. This accident happened in Marthandam district in Kanyakumari.

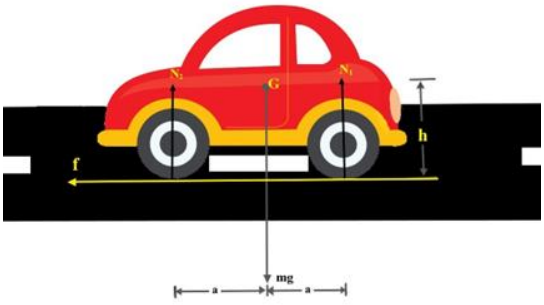
Based on the preceding two scenarios, we can conclude that car toppling may result in the death or injury of the car driver and passengers. A safety feature is required to ensure the safety of the car, driver, and passengers. There are many Standardized safety features including Anti-lock Braking System, Automatic Emergency Braking, Adaptive Headlights, Forward Collision

Warning, Left Turn Crash Avoidance, Obstacle Detection, High-Speed Alert, etc.

In this research paper, we will discuss preventing car toppling with a new safety feature called the car toppling prevention system. In this car toppling prevention system, a device is used called a safety device is used to prevent toppling. It is placed near the car turning tires. It is essentially connected to angle sensors which measure the car turning angles from the angle made by the tires and to the braking system of the car. It is loaded with a program that checks the safety velocity limit of car for a car without making into toppling. It always receives the turning angles through the data sent by the angle sensor, performs a certain algorithm and if the speed of the car is not within the safe limits, then it forces brakes automatically so that the speed of the car is within the safe limits thereby preventing possible car toppling accident.

LITERATURE SURVEY:

[1]Condition of toppling of a car on circular tracks:



Let Normal reaction on the outer wheels of a car = N_1

Normal reaction on the inner wheels of a car = N_2

While the car is moving in a circular track normal reaction on the outer wheels of a car is greater than normal reaction on the inner wheels

$$N_1 > N_2$$

This can be proved as below.

Let Distance between two wheels = 2a

Height of centre of gravity of car from road = h

For translational equilibrium of car

N_1+N_2=mg ….(i)

and f = $\frac{mv^2}{r}$ ….(ii)

and for rotational equilibrium of car, net torque about centre of gravity should be zero.

or N_1(a)=N_2(a)+f(h) ….(iii)

From Eq.(iii), We can see that

$N_2 = N_1 - (\frac{h}{a})$f = N_1- $(\frac{mv^2}{r})$ $(\frac{h}{a})$ ….(iv)

or N_2 <N_1

From Eq. (iv), we see that N_2 decreases as v is increased.

In critical case,
N_2 = 0

and N_1 = mg [From Eq.(i)]

N_1(a)= f(h) [From Eq.(iii)]

(mg)(a)=($\frac{mv^2}{r}$) (h) or v=$\frac{gra}{h}$

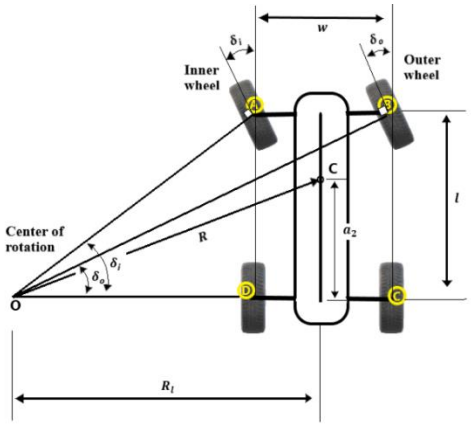
Now, if v > $\sqrt{\frac{gra}{h}}$, N_2 < 0, and the car topples outwards.

Therefore, for a safe turn without toppling v ≤ $\sqrt{\frac{gra}{h}}$.

maximum speed for toppling = $\sqrt{\frac{gra}{h}}$.

DIAGRAM:

[2]



MATHEMATICAL FORMULAS AND PHYSICS FORMULAS :

Turning radius of car is given by

$$R = \sqrt{a_2^2 + l^2 cot^2\delta}$$

where

$$cot\delta = (cot\delta_o + cot\delta_i)/2$$

PRANAY'S CTPS ALGORITHM:

1. Obtain the steering angle from car front tyres.

2.let the angle obtained from these two front car tyres be ifronttireangle (from inner tire angle) and ofronttireangle (from outer tire angle).

3.obtain the value for velocity of car and store it in velofcar variable.

4.Input the value of length of car as lengthOfCar.

5.Input the value of height of car as heightOfCar.

6.By using the above mathematical formulas obtain the value of steering angle, turning radius, max toppling velocity and store it in a variable as angle, radius and maxToppleVel respectively.

7. If the velocity of car is greater than the maximum safe turning velocity then automatically reducing the car velocity to safe toppling velocity.

8. Else the velocity of car is within the safe velocity limits of toppling condition

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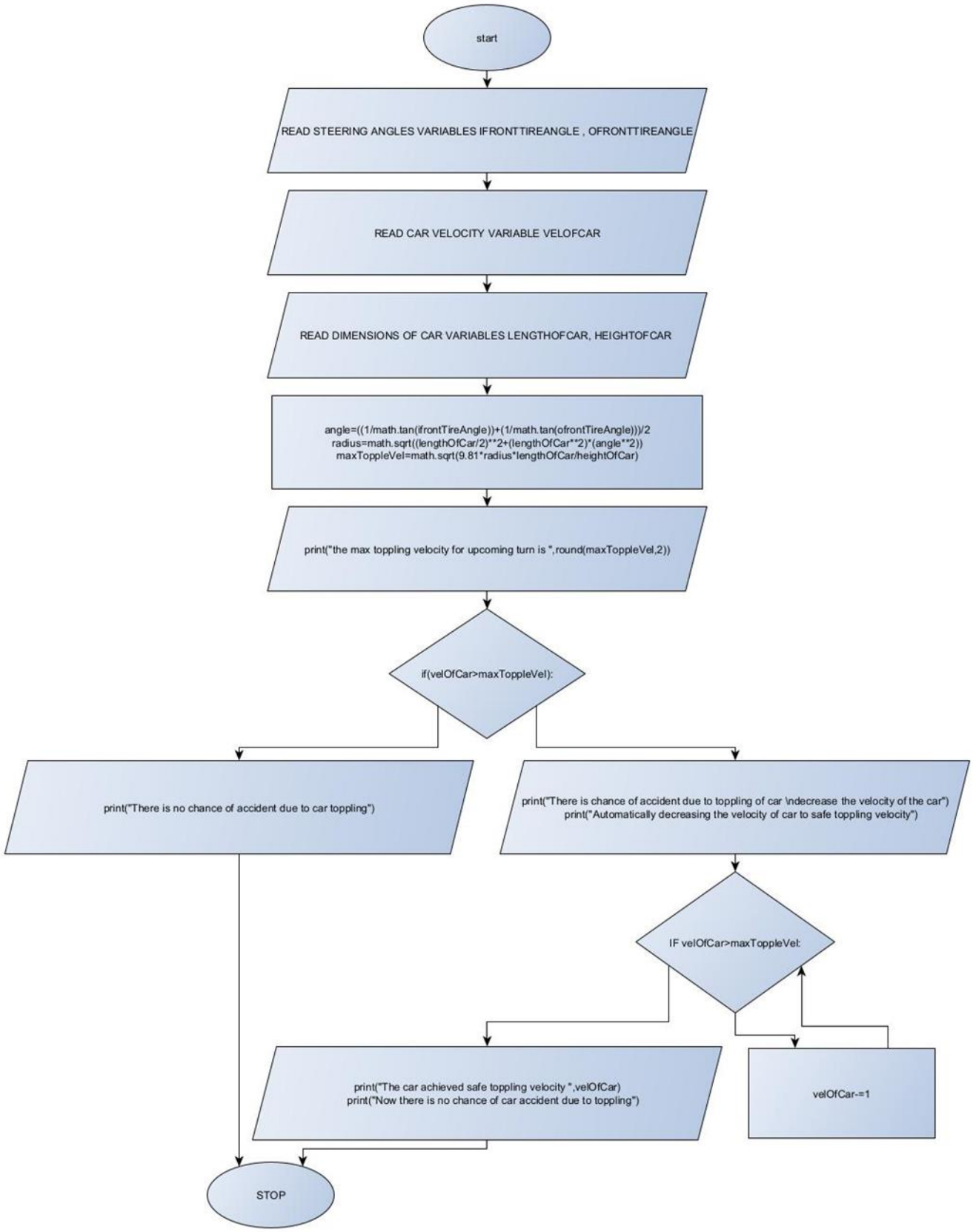
FLOWCHART:


start
READ STEERING ANGLES VARIABLES IFRONTTIREANGLE , OFRONTTIREANGLE
READ CAR VELOCITY VARIABLE VELOFCAR
READ DIMENSIONS OF CAR VARIABLES LENGTHOFCAR, HEIGHTOFCAR
angle=((1/math.tan(ifrontTireAngle))+(1/math.tan(ofrontTireAngle)))/2
radius=math.sqrt((lengthOfCar/2)**2+(lengthOfCar**2)*(angle**2))
maxToppleVel=math.sqrt(9.81*radius*lengthOfCar/heightOfCar)
print("the max toppling velocity for upcoming turn is ",round(maxToppleVel,2))
if(velOfCar>maxToppleVel):
print("There is no chance of accident due to car toppling")
print("There is chance of accident due to toppling of car \ndecrease the velocity of the car")
print("Automatically decreasing the velocity of car to safe toppling velocity")
IF velOfCar>maxToppleVel:
print("The car achieved safe toppling velocity ",velOfCar)
print("Now there is no chance of car accident due to toppling")
velOfCar-=1
STOP

EXECUTABLE CODE IN PYTHON LANGUAGE:

```
import math

ifrontTireAngle=float(input("enter the angle made by inner front tire : "))
ofrontTireAngle=float(input("enter the angle made by outer front tire : "))
velOfCar=float(input("enter the velocity of car : "))
lengthOfCar=float(input("enter the length of the car : "))
heightOfCar=float(input("enter the car height : "))

angle=((1/math.tan(ifrontTireAngle))+(1/math.tan(ofrontTireAngle)))/2
radius=math.sqrt((lengthOfCar/2)**2+(lengthOfCar**2)*(angle**2))
maxToppleVel=math.sqrt(9.81*radius*lengthOfCar/heightOfCar)

print("the max toppling velocity for upcoming turn is ",round(maxToppleVel,2))
if(velOfCar>maxToppleVel):
    print("There is chance of accident due to toppling of car \ndecrease the
velocity of the car")
    print("Automatically decreasing the velocity of car to safe toppling
velocity")
    while velOfCar>maxToppleVel:
        velOfCar-=1
    print("The car achieved safe toppling velocity ",velOfCar)
    print("Now there is no chance of car accident due to toppling")
else:
    print("There is no chance of accident due to car toppling")
```

OUTPUT:

python -u "d:\Pranay\vit\22 fall sem\java\tempCodeRunnerFile.py"

enter the angle made by inner front tire : 15

enter the angle made by outer front tire : 10

enter the velocity of car : 50

enter the length of the car : 4

enter the car height : 1.5

the max toppling velocity for upcoming turn is 7.47

There is chance of accident due to toppling of car

decrease the velocity of the car

Automatically decreasing the velocity of car to safe toppling velocity

The car achieved safe toppling velocity 7.0

Now there is no chance of car accident due to toppling

REFERENCES CHART :

INNER FRONT TIRE ANGLE	OUTER FRONT TIRE ANGLE	VELOCITY OF CAR	LENGTH OF CAR(IN METRES)	HEIGHT OF CAR(IN METRES)	MAXIMUM SAFE VELOCITY	PROBABILITY OF CAR BEING TOPPLED
15	10	50	4	1.5	7.47	YES
15	10	40	4.5	1.5	8.41	YES
30	28	20	4.5	1.5	15.95	YES
30	28	14	4.5	1.5	15.95	NO
20	17	20	4.5	1.5	9.06	YES

RESULT AND DISCUSSION:

For a specific turning radius, there is a safe turning speed for a specific turning angle. If the velocity of the car for making a turn exceeds th e safe turning velocity, then the car toppling prevention system reduces the velocity to the safe velocity limits to prevent toppling. In this way, the car toppling prevention system prevents possible car accidents. This system performs correctly in situations where the car's center of gravity is at the center of the body and the car is moving on a leveled road without any slope or curve.

FUTURE SCOPE:

This system can be made to perform well even when car's center of gravity is not at the center of its body and when car is not moving on the level road(I.e when car is moving on slopy road).

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[2] V.Aravind, Optimizing the turning radius of a vehicle using symmetric four wheel steering system, IJSER, 2013.

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https://www.businesstoday.in/latest/trends/story/over-speeding-caused-maximum-accident-related-deaths-in-2020-govt-report-346533-2022-09-06

IMPLEMENTATION LINK:

https://docs.google.com/document/d/1X6L9ScMHKam6O8Vb3zh8SUdKIGWlscvt3VDNfQosWJE/edit

VIDEO LINK:

https://we.tl/t-1zZivsOiBc?utm_campaign=TRN_TDL_05&utm_source=sendgrid&utm_medium=email&trk=TRN_TD