ITSP Final Documentation

**** This will be considered as your final documentation and will be made available for online usage.***

Overtake-Assist System

Saviors

ITS20027

Keywords (Include 7 or more keywords which will help others find your documentation easily)

Overtake, traffic, driving, assist, safety, car, collision, radar

---

Team Member Name	Roll Number	Email-Id
Harsh Meel	190040041	harsh.meel15@gmail.com
Ayush Jangir	190050025	jangirayush59@gmail.com
Paarth Jain	190050076	paarthj3@gmail.com
Sabhya Sanchi	190020098	ssas302123@gmail.com

Inspiration for Idea

Road accidents account for the largest no. of accidental and unripe deaths in India. Although overtaking isn't directly seen as a cause of accidents, insight into accidents happened due to fog, drunk driving, illegally licensed driver, etc. shows it usually leads to wrong decision to overtake because of the inability of the driver to take the right decision. Speaking of personal experience, team member Harsh Meel encountered this problem while he was travelling in a car while his friend was driving rashly ;) and also at many other moments.

So when the opportunity came, he had this idea of building a driver-assist system to prevent such accidents.

Problem Statement

The model we used to make the system was a three-car system on a 2-laned road. There is a car C1, a constant speed car to be overtaken by a car C2. There was a third car O1 in the adjacent lane coming from the opposite side at a distance.
We have the subject car as C2 which is driven by the subject to be assisted. The safety device must analyze the situation as the car C2 attempts to overtake by trying to come in the adjacent lane. It should

immediately judge if the overtake might result in a possible collision. If so, it must immediately alert the driver that overtake isn't safe and the driver should not proceed.

Existing solutions in the Market

Among numerous other safety techs in cars, **no safety system has a solution to our specific problem statement**. There are safety technologies in the greyish-vicinity of what we wish to use like "Front cross-traffic alerts" and "Blind-spot detection" but none of them achieves our aim.

Thus, we are sure this device is the first of its kind(As per our public knowledge).

Proposed Solution

We will make a device that will use Radar sensors mounted on a car to retrieve dynamic information of the two cars C1 and O1 as given in the problem statement(dynamic information is velocity and distance). The information would be fed to our program which judges on the basis of an algorithm we would develop, whether the overtake is going to result in a possible collision or not. If it is going to be a collision, a warning will be generated.

Brief Description

The solution starts with the detection of dynamic information of car C1 and O1 by the high range vehicle Radar Sensor mounted on C2, which would feed the information to an algorithm we have developed. A program is constructed on the algorithm.
If the program suggests a possible collision then a warning will be issued to the driver in C2 that the overtake can be dangerous.
A prevented collision would thus be "the successful working".

Progress

The idea of the project and the project itself was born when the new entries were taken in ITSP during the lockdown. The project was divided into 4 major portions:

1. **Overtake Model and Data:** We built up a physical problem out of the system and then solved it using physics and ingenious tricks to get an algorithm that would be used to make the computer program. We went

through a no. of research papers and used clues from them to do so (link in references). For data extraction, we went on a road with a car and collected data using a carefully designed experiment. We also cross-checked our values with a research paper related to a similar experiment. We then used the data to get the required values to make the program's algorithm.

2. **Program Development:** We made a simple web app using HTML, CSS and JS, that represents the above-depicted model/algorithm through a 2D animation. The program would take the velocities and the distances between the cars just when the manoeuvre commences, and predicts how a forced overtake would look like, and issues a warning in case a collision is predicted.
3. **Sensor:** Due to the lockdown and the unavailability of resources, we were not able to work on the hardware part of the project, the Radar sensors. However, we investigated every challenge we would have faced with the Radar sensor (using information out of the internet) and figured out ways to solve those issues. We would like to thank Pranav Sunil Deo from team SeDriCa, IIT Bombay who gave us some details about the working of Vehicle Sensors and Radar.
4. **Simulation:** We are working on a 3D simulation that deploys the algorithm we devised into an array of, say hundred, cars spawning at random places on the road. All the cars follow the algorithm while overtaking, and in case the overtake involves high risk, the car follows the succeeding car unless an overtake is feasible. This is implemented as a web app using THREE.js.

Work Distribution in team:

Due to the Covid-19 pandemic, the team members were not able to coordinate on-spot due to lockdown and couldn't do work together effectively. Thus, we decided to split the work into the parts explained above and different team members were given to work on the part allotted to them individually(or sometimes with the assistance of others). The detailed work distribution is thus given in the "Contribution of Team Members" section.

Work Flow between Review Meets:

Before Review meet 1 - The Overtake model was developed before the first review meet. We had gone through numerous research papers and had

developed a crystal clear view of the job to be done later on. The work on Radar sensors was completed too.
Before Review meet 2 - We refined our algorithm considering few other research papers and statistics. Also, we explored the available software to accomplish our simulation, including some Python and JS libraries.
In the last month - Mistakes were found in the initially used data from a research paper after manual scrutiny by a team member. To replace that, an on-field test was done by the team member and new data was collected. Edits were also done to the previous overtake model after gaining more understanding of the problem.
Then we finally implemented our refined model into a 2D prediction model and a 3D simulation.

Noteworthy Challenges and how we overcame them:

1. The very first challenge was to have efficient co-ordination between the team at such large distances amid the lockdown. Our Team Leader Harsh Meel did this job by organizing group calls and discussing work distribution and repeatedly making sure things are done in synchronization.
2. To construct an algorithm for the device, we needed data about the overtaking manoeuvre of a car. We even found one such paper but it was old(Pub. 1986) and inconsistent with modern cars. To get data, a team member did a manual experiment by going out on a 2 laned road with a driver and an assistant. He constructed the entire experiment and took live readings which ultimately yielded as a new set of data.
3. We faced a major challenge with the Radar sensor as no market available Vehicle Radar sensor had ranges as long as we have wanted them for our system. To overcome this challenge, we have decided that by decreasing the beamwidth of Radar to a very small degree and by directly extracting data we can increase the Radar's capacity considerably.
4. In reality it is very difficult to estimate the length of the car C1 from behind. But it is an essential parameter in the equation. We devised a method to overcome this problem.
5. There were multiple challenges faced while making the 2D and 3D simulation.

Calculations: *We would not like to make the calculations public in first hand. The calculations in the project have been one of the most rigorous, tricky and time-mind consuming practice and we would thus like to keep it enclosed but are willing to discuss if approached.*

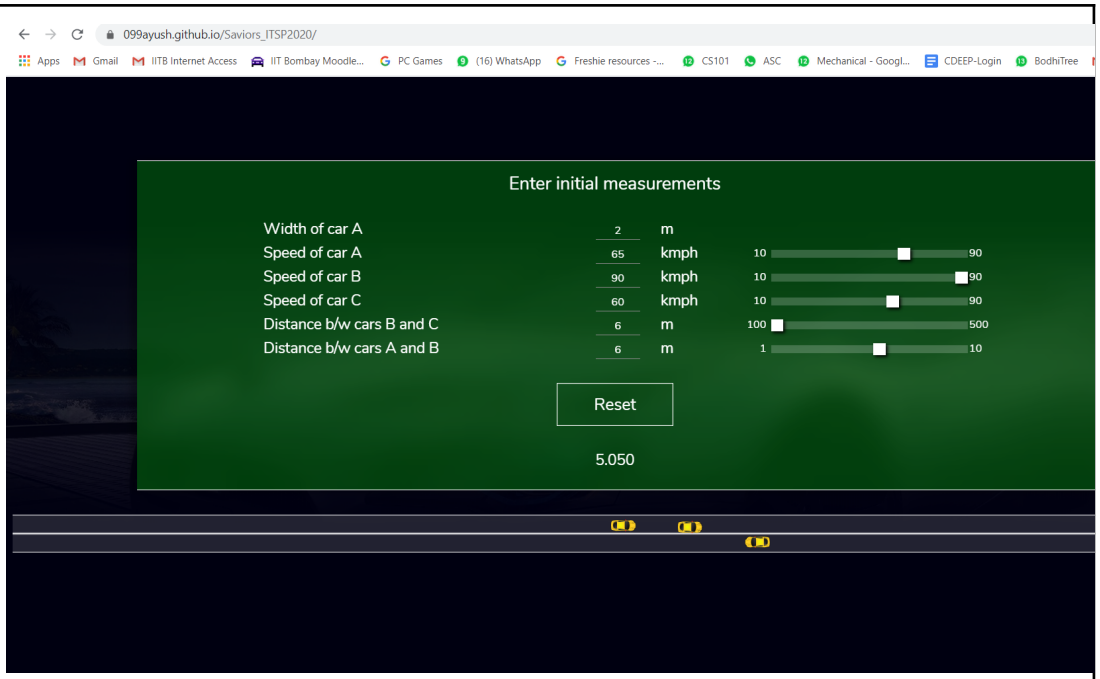
Results

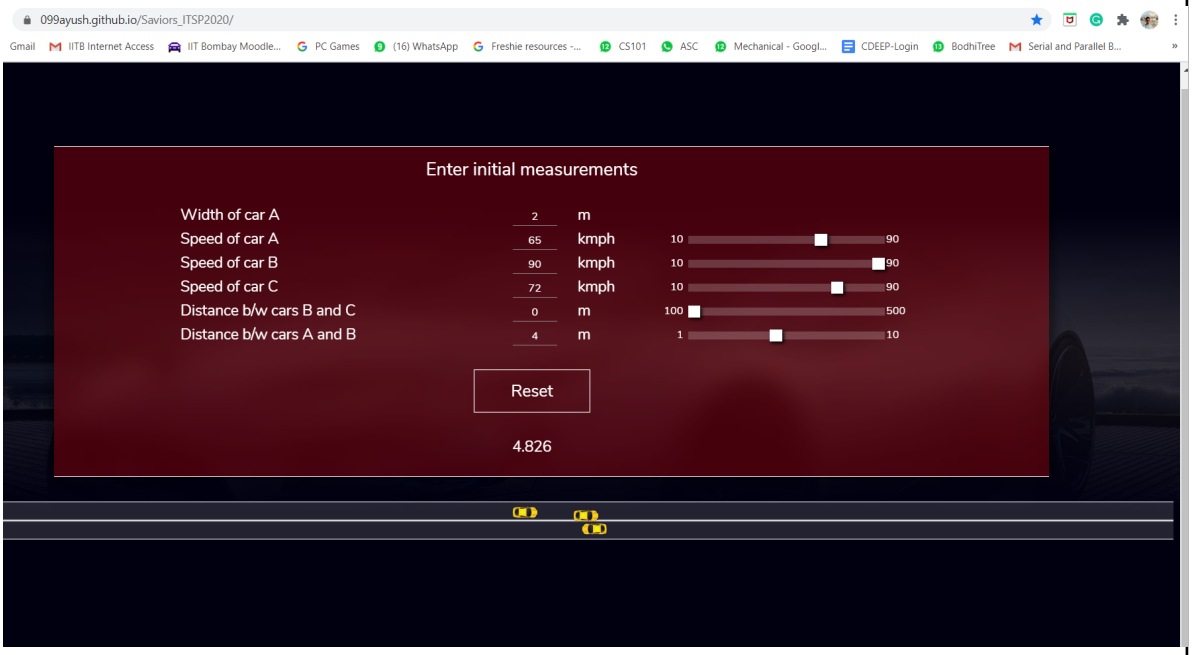
A detailed description of the results you have achieved

Results:

1. We have developed a well-defined model of vehicular overtake manoeuvre and divided it into relevant stages, which we have then used to simplify overtake kinematics. By this, we have found some equations to judge the distance and time taken to overtake and predict a collision. (*We have decided not to make the final equations public)*
2. We have also developed our own data chart of vehicle capacity at different speeds which were used in the algorithm.
3. We developed a prediction web app to predict the overtake manoeuvre from the algorithm we developed. The web app also animates the top-view of the overtake in real time for presentation of the working, however it can do the prediction in just milliseconds.

Stills of working collision predictor program:





Green - Overtake is safe, no alert **Red-** possible collision, Alert issued

Simulations/ Project Video :

Program cum 2D simulator webapp: https://099ayush.github.io/Saviors_ITSP2020/

3D testing Simulator: https://saviors.netlify.app/

Project Short Video:

https://drive.google.com/file/d/1GpNGKER00ywUpKlZfveC4DW4q241c--w/view?usp=drivesdk

Final Presentation Link :

https://docs.google.com/presentation/d/1r5SAIKgML4Rq_fENCV2k3DmYUESlXitYTJhnWbeloBk/edit?usp=sharing

Github Repositories :

We wish to keep the code which encloses the algorithm and calculations, private.

Learning Value

1. We learned how to resource better information and clues from the internet by scrolling through research papers available on it. We never knew such extensive details are available related to this project!
2. We learned how rigorous and time taking the process of conducting an experiment can be. Even the formulation of an experiment has to be given a lot of stress and thought and all possible causes of error must be rectified beforehand. We also learned the importance of error and statistical calculation in experiments.
3. We learned the crucial soft skills of teamwork and how one can complete a lot of stuff quickly and with less error if the team is well coordinated.
4. We tried to enhance our programming and web designing skills, while adding few other JS libraries such as THREE.js to our scope of knowledge.

Software/ Hardware used

- GitHub
- WebStorm IDE
- Visual Studio Code
- THREE.js 3D library: github.com/mrdoob/three.js

Suggestions for others

If someone starts with this project or something similar to it, we would suggest the following things crucially:

1. Before going on the road and analysing the overtake by yourself, go through the research material available on the internet(quite decent papers are present) and plan your on-road test precisely. Otherwise, nothing efficient would come out.
2. Do give a nice thought to all different ways of solving the problem. There are many ways to get the result and each has its pros and cons. Don't stick to the first method you've found.
3. The present technology has rendered almost everything virtually possible. So, before integrating complete hardware and software, you can test your algorithms using virtual simulations. Through this you can refine your algorithms.

Contribution by each Team Member

Contribution by different team members are:

1.Harsh Meel: He is the Team Leader.
He came up with the idea of the project and the entire initial draft of the working project was made by him.
He co-ordinated the team and supervised most part of the project.
His core contributions to the progress of the project were:

a. Developed the overtake model, formulated and solved the kinematic equations of overtake.Gave the idea to go through research papers to have an in-depth idea of the problem.
b. Designed an on-road experiment and went out to get the required data by performing it.(Visuals in Video)
c. Processed the crude experiment data into the value chart required to run the program cars in the program.
d. Entire work on Radar sensors was done by him.

2.Paarth Jain:

a. Mined and went through various research papers, relevant to our project. The papers mentioned in the “references” were found by him.
b. Solved the kinematic equations to derive the condition for a safe overtake.
c. Suggested possible acceleration ranges and other data based on [3], which were later modified by Harsh Meel. Devised a method to approximate the length of the vehicle in front(C1).
d. Assisted Ayush Jangir in making the 3D simulation.

3. Ayush Jangir:

a. Created both the 2D model and the 3D simulation from scratch.
b. Contributed in the derivation of the algorithm by going through the research papers and posing constructive arguments.

4. Sabhya Sanchi:

a. Explored existing safety devices available in various vehicles and gone through various research papers
b. Contributed by giving suggestions during ideating equations and taking different values and created the project video with the help of other teammates.

References and Citations

Research papers we went through:

1.Asaithambi, G., Shravani, G., Overtaking behaviour of vehicles on undivided roads in non-lane based mixed traffic conditions, Journal of Traffic and Transportation Engineering (English Edition) (2017), https://www.sciencedirect.com/science/article/pii/S2095756417301940?via%3Dihub

2. Vehicle Standards Information, https://nacto.org/docs/usdg/vehicle_standards_information_nsw.pdf

3. Passing Experiment on Two-Lane Rural Highways, Abishai Polus and Andrej B. Tomecki, http://onlinepubs.trb.org/Onlinepubs/trr/1987/1112/1112-015.pdf

People we consulted to during the project:

1. Pranav Sunil Deo, Team SeDriCa, IIT Bombay.
2. Aaron Sabu, Team ITSP Mentor.

GitHub repositories, rather JS libraries, used:

1. THREE,js: https://github.com/mrdoob/three.js

3D car model downloaded from

iSteven's Sketchfab: https://sketchfab.com/Steven007/models/

Disclaimer

Licenses

1. **WebStorm: JetBrains Student License**
2. **THREE.js: Open-source JS library**
3. **Visual Studio Code: Open-source**