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Simulation Studies for Vehicle Tracking Using RADAR and LIDAR Sensors

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ABSTRACT

Vehicle tracking is a part of the obstruction detection system in cars. The present tracking system which big companies are using nowadays results in few noise and errors due to which it do not gives proper results to overcome this problem we will be using different sets of Kalman filtering algorithm. In this project we are making use RADAR and LIDAR sensors which would give us more accurate information about the location and speed of any objects which are there in front of the car. The information will then be fed into a suitable filtering algorithm to eliminate the effect of any unwanted noise in the system. The end result of this would be that we'll be getting constant information about the position and velocity of the vehicles around us with a pretty high accuracy.

Keyword – RADAR and LIDAR sensors, position and velocity.

1. INTRODUCTION

1.1 Motivation

The automobile industry has taken a massive boost in the past few decades. Driving has become a lot more comfortable and relaxing with the integration of automated electronic systems in vehicles. The primary objective of these systems is to reduce human effort in driving and control of the vehicle. Some ideas which were considered sci-fi a few years back are a reality now. This includes GPS navigation in cars, automatic transmission, parking assistance system, voice control and much more. But if the vehicle is to be made completely autonomous, only integrating these systems aren't sufficient. Many more sensors have to be deployed in order to achieve complete automation. Today, the entire automobile industry is running behind construction of autonomous vehicles which would be self-sufficient and would not require any human input while driving. These vehicles would require even a larger number of sensors integrated within them to make them completely self-sufficient.

1.2 Current technology

A modern car uses GPS for locating their position with the help of satellite and moreover without GPS it's practically impossible to travel in an unknown country. It is good as well as bad as it do not guarantee 100% accuracy most of the accidents occur because of this. The main limitation of GPS is that it can be easily jammed by the hackers and also can be used unethically, moreover GPS do not gives proper results under the tunnel hence, to eliminate this problem we come up with a different form of tracking with the help of RADAR and LIDAR sensors. RADAR has been used for tracking applications since a very long time. . A notable of RADAR tracking is the Air Traffic Control (ATC) system. Using RADAR and LIDAR sensors in the tracking of vehicles reduces interference and the filtering process reduces the effect of noise in the system.

2. OBJECTIVE

- Integration of various sensors for automation of vehicles.
- Working on the fusion of RADAR and LIDAR sensor data.
- Understanding how different kalman filter algorithms work

3. TRACK PROCEEDING

The unattended radar plot creates a new radar track. The radar plot creates new track when the tracker is switched on but when the tracker is in running state only the tracker spawns new track normally a new track is provisional until plots from the next radar have been successfully linked to new track provisional tracks are not shown as the final track to the operator as to prevent any accident , more disciplined way of approaches with some provisional values, if we use statistical approach related to complex mathematics then the track will return more proper results

3.1 Track Maintenance

In this method it totally depends on the operator whether to end the life of a track or not there can be condition where a radar fails to locate the target so in that case, we need proper discipline when to end the track and when to start

3.2 Track Smoothing

In this final and the most important step the track proceeding and the associative tracks are combined to give a new one and that new one will be considered as the final track However there is a wide variety of algorithm to display the results of estimated tracks i shall explain them in the next few pages.

3.3 Kalman Filtering

The Kalman filter was described and first partially developed in technical papers by swerling (1958). It is used to estimate variable indirectly whenever there is too much noise in the surrounding. Take a very simple example of a hunter. Imagine you are a hunter and you have to hunt and so you went to the jungle, so there is a rabbit and let's estimate that the rabbit is around 10 meters away from you. And we can map the distance using Gaussian curve and then can say that the rabbit is around the mean of 10 meters that's where the highest probability of rabbit will be now let's estimate the initial position of the rabbit will be around 15 meters at time T = 1 second now we can also use equations of motion to find the exact position of the rabbit by calculating suppose you get the distance as 17 meters then here comes the problem. Do you throw a ball at 15 meters or throw a ball at 17 meters it is quite difficult to decide because the rabbit is in constant motion now it will make a huge different if you throw a ball 1 meter ahead or behind you know that you will lose the rabbit? so we have to find optimal distance of the rabbit from the hunter so we will take the mean and variance of the two distance with the use of Kalman filter algorithm , by using predict and estimate and then we will take out the difference between the two at the end to get the exact position .
This algorithm only works when we have to deal with only linear function.

3.4 Extended Kalman Filtering (EKF)

Let me tell you about extended Kalman filtering a more complex form of Kalman filtering, again i will be stating a very simple example to explain how extended Kalman filtering works. We want everything straight in our life without any disturbances and every human individual aspires to to live his lifetime without any hindrances, it means in matter of success, Income or joyful, But in reality life can never be straight or linear, it is a combination of happiness and sadness both comes hand in hand it is like a large bicycle nothing stays permanently. Take an example of the same hunter and the rabbit situation now think of it as a rabbit is running in zig-zag motion and not on the straight or linear path as described above, So in this case to overcome the problem of the nonlinear state we will be using extended Kalman filter. Nevertheless, it has got few limitations
1-the cost of calculating them numerically is very high (computational cost)
2- So in the last case the linear function becomes invalid as linear function cannot be describe by system dynamics

3.5 Unscented Kalman Filter

Instead of approximating the non-linear function as an EKF does, unscented Kalman filter approximate the linear function. This algorithm selects a minimal point in such a way that their mean and covariance is same. Its basic idea is to generate several sigma points outside the current state and estimate based on its covariance. Outside the mean the sigma points are located. It is mainly used when the functions are highly non-linear. The error is calculated using state transition in linear function. However, in UKF we get it by means of observation. The most important point is the unscented Kalman filter do not use Jacobean to obtain a linear model, unlike EKF and KF. It only focuses on unscented transformation

4. TOOLS REQUIRED

4.1 RADAR (AWR1642)

The device is a single chip radar sensor which works in the region of 76-81 GHz. The AWR1642 is perfect for low power dissipation and more accurate sensors and radar system in three-dimensional space. This device is a complete package as per as the terms are considered related to software size, hardware requirements, API guide, and user configuration

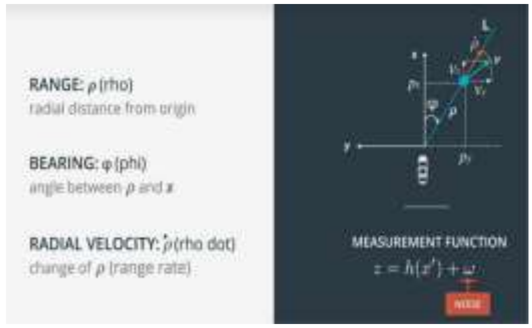

Fig 6: Measurement function of the RADAR sensor

4.2 LIDAR

It works just like SONAR sound navigation and ranging is a technique to detect any object underwater by sending sound waves and measuring their return after being reflected. Just like that the emitter in LIDAR sends a laser beam and records the time of the signal coming back and hence noting the object with very less noise, the data is intercepted by the receiver and then the vehicle would be able to know any exact location of its surrounding

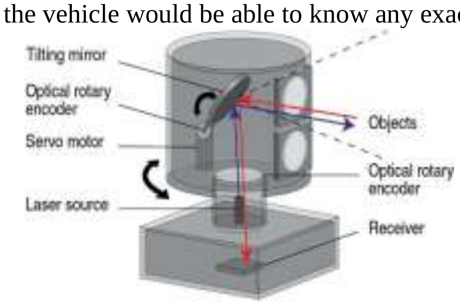

Fig 7: A typical LIDAR system

Table 2: Comparison between LIDAR, RADAR and Camera

Sensor type	LIDAR	RADAR	Camera
Resolution	median	low	high
Direct velocity measure	no	yes	no
All-weather	bad	good	bad
Sensor size	large	small	small
Sense non-line of sight object	no	yes	no

Fig 8: Another aspect of comparison between the three sensors

5. COMPARATIVE STUDY

As we have seen that for linear function the KF is good but it got some disadvantages because it cannot process nonlinear functions, the problem persists with the EKF as well but it got pretty smooth when we are aware of the UKF algorithm where it can easily calculate nonlinear function.

The UKF has proved itself to be a most powerful among all three-algorithm mentioned above to solve the problem of non-linearization and moreover is a best alternative to other algorithm.

6. CONCLUSION

As we are all aware that Karl Benz in 1885 was the first one who invented car and as technology advances we strive to make our life easier. Because of the driverless car even a blind man will now be able to travel without the help of anyone in nonlinear roads or anywhere in the world. With the help of new sensors there will be more accuracy and even the smallest particle on the road can be identified by lidar sensors and if bigger object is considered then there is radar sensor for that

- Both sensors have cover up each other, to give the accurate results.
- Moreover because of the UKF it will be easier for all the cars to run in nonlinear function.

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