International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:2682
Vol.4, No.3, March 2015 DOI:10.15693/ijaist/2015.v4i3.69-74

ANALYSIS OF COLLISION AVOIDANCE SYSTEM

Gayathri Devi.N*[1] and Dr.K.Batri[2]

PG Scholar, Department of Electronics and Communication Engineering, PSNA college of Engineering and Technology, Dindigul -624622, India[*1]
Professor, Department of Electronics and Communication Engineering,PSNA college of Engineering and Technology, Dindigul -624622, India[2]

Abstract:

The advent of technology has increased the traffic hazards and the road accidents takes place. Collision detection system in automobile aims at reducing or mitigating the severity of an accident. This project aims at avoiding Vehicle head on collision by means of collision detection algorithm. This collision detection algorithm predicts the collision and the avoidance or minimization have to be done within few seconds on confirmation. Under critical situation collision minimization is made possible by turning the vehicle to the desired turn radius so that collision impact can be reduced. In order to avoid the collision completely, the turning of the vehicle should be achieved at reduced speed in order to maintain the stability.

Keywords: Collision avoidance system, Time to collision, Time to turn, Turn Radius.

I. INTRODUCTION TO EMBEDDED SYSTEM:

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

Modern embedded systems are often based on microcontrollers (i.e. CPUs with Integrated memory or peripheral interfaces) but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also still common, especially in more complex systems. In either case, the processor(s) used may be types ranging from rather general purpose to very specialized in certain class of computations, or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP). Embedded systems are commonly found in consumer, cooking, industrial, Automotive, medical, commercial and military applications. Telecommunications systems employ numerous embedded systems from

II. AUTOMOTIVE EMBEDDED SYSTEM:

For the design of embedded automotive systems, the entire vehicle system is usually split up into four different functional areas, which could be separated during the design phase

- Chassis
- Drive-train
- Body

III. VARIOUS TYPES OF COLLISION:

A Traffic collision occurs when a vehicle collides with the other vehicle. Vehicle collision may results in injury or death along with the vehicle damage. Generally road collision may occur at lane departure or at junction and may involve pedestrians or animals. Vehicle collision are of two types

- Head on collision
- Intersection collision
- Rear end collision

Head on collision often have serious outcomes because of speed involved when collision takes place. When one vehicle inadvertently interrupt into the path of other vehicle, it is referred to as Head on collision. Risk of Head on collision will be more on road with narrow lane, sharp cure and there is no separation of opposing traffic and also due to heavy traffic. In head on collision, the speed is directly proportional to the measured risk of death or injury (ie. as speed increases consequence of the collision also increases).Median separation or median treatment is one of the countermeasure for head on collision which can reduce collision in order of 70%.

Prevention can be done by providing various barriers such as

- Rigid barrier
- Semi rigid barrier
- Flexible barrier

These barriers help in impact minimization as well as to provide cost effective reconstruction after the collision.

Crashes at intersection may involve direct head on impact, when one vehiclecrosses the opposite lane or the side impact, when vehicle turn at intersection. In urban area, the intersection collision may be high compared with the rural. At lane crossing the possibility of side impact may be more. Clear road marking and signing are low cost method of improving safety at intersection.

Rear end crashes are caused due to the sudden deceleration of the moving vehicle.

An automobile safety system was designed to reduce the severity of the accidents, which is known as collision avoidance system or collision mitigating system. In case of critical situation, these system either provide a warning signal or takes action autonomously. It uses small radar or sensors or cameras to detect the collision. There is also another possibility for minimizing the impact of the vehicle collision which is known as collision minimization system.

IV. RELATED WORK:

A.COLLISION AVOIDANCE SYSTEM:

Collision avoidance system is the emerging feature after the collision detection. Collision detection system in automobile aims at reducing or mitigating the severity of an accident. This system provide a warning to the driver about the imminent collision in order to take immediate action to mitigate it .Crash avoidance system is the emerging feature after the collision detection. Advanced technology assists the driver with warning or automatic braking to help, avoid or mitigate a crash. Six common new technologies are forward collision warning, auto brake, lane departure prevention, and adaptive headlights and blind spot detection.

The design of collision warning/avoidance system is based on three possible algorithms.

- Forward collision algorithm
- Intersection collision algorithm
- Rear end collision algorithm

Collision warning /avoidance is assisted via communication system which incorporates the wireless transmission system for transferring the warning message.

Forward collision algorithm:

i. Sensors are mounted on the bumper.
ii. Depending on the range and coverage of the sensor, the TTC is estimated.
iii. TTC is calculated from the distance and velocity of the colliding vehicle.
iv. With the value of TTC, forward collision is confirmed.

The system may use microcontroller based processing unit running RTOS and it .The discussion on forward collision avoidance system aims at avoiding the host vehicle frontal collision which is done either by warning or braking or steering away. It focuses on method for calculating the risk is estimated [Antonio nieto* and kadridagdelen].when the probability of collision is predicted brake is activated to mitigate collision. It uses various sensor in which time and space are handled in kalman filtering framework. The overall system reduces the impact speed in frontal collision.

Intersection collision algorithm:

i. Base station has to be implemented at every four junction area.
ii. By using the wireless sensor network the vehicle information is collected.
iii. With respect to the distance of the intersecting vehicle at the collisionzone,alert message is transmitted to the vehicle.

Intersection collision warning system can be implemented as a part of vehiclesafetysystem. It incorporates vehicle data acquisition, transferring of data to the base station and the analysis of the collected data. Importance in accuracy and time prediction is achieved in intersection collision warning at the point of road intersection. This system provides warning when the high probability of collision is predicted.

Rear end collision algorithm:

i. The sensors are placed at the rear end of the car.
ii. In case of sudden deceleration, signals are transmitted to the following vehicle.

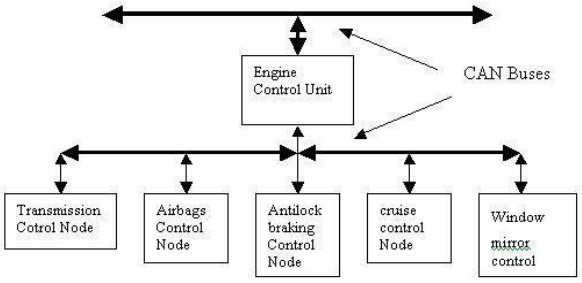


Fig 2.1.3

B.COLLISION CONFIRMATION SYSTEM:

Collision confirmation system provides collision confirmation warning message signal on or before few seconds at collision.

Confirmation algorithm is estimated by calculating the time to stop and stopping distance of the collision vehicle [AvishekParajuli *1, Bryan Riley.H]. The last second decision for braking and steering input is the essential factors to be considered. The parameters to be considered are road surface, speed of the vehicle mass and brake callipers pressure. TTC is computed from size and

position of the vehicle. Relative distance and velocity may also use for TTC calculation. It deals with the use of TTC measures as per the speed and braking instructions [Richard van der Horst &JeroenHogema].crash confirmation uses various sensing technologies such as microwave radar, laser radar are improved to develop the colliding objects. Vehicle information were considered to improve the reliability of the prediction. CHAMELEON system is supposed to identify impending collision. By using various sensor configuration, different angled collision are tested under various test scenarios. Sensor placement places an important role.

Various trends in automotive active safety assist in pre detection, configuration and minimization of accident which include ABS, Traction control, Stability control, Adaptive cruise control, Forward collision mitigation, Primary warning, Secondary warning, Collision damage reduction, Lane detection and Blind spot warning. The above features are considered to detect the pre-crash and collision confirmation. [Andreas Eidehall]

In camera based forward collision confirmation systems the images are generated by the camera on detecting the collision to alert for confirmation. TTC estimation is used for assessing whether an imminent closing conflict FCA warning is merited. It provides the development and testing of sole forward collision alert sensing mechanism [Eric Raphael and Raymond Kiefer, PiniReisman and Gaby Hayon].

Collision avoidance system may also involves Collision minimization system which aims at reducing the impact of the collision so that serious death constraints can be reduced. By considering Time to collision (TTC) as a risk indicator, the collision minimization can be achieved. Depending upon the value of TTC, the driver is warned about the collision [Yupengwang;wenjuan,E.;DaxinTian;Guangquan; Lu;GUIZHENYu;Yifan Wang].

The another minimization system is based on measuring the distance and velocity with respect to sensor limit which outperforms the common parameter of collision warning system in detecting the collision [Chung-Ming Huang ; Shih-Yang Lin].

C.COMPLETE COLLISION AVOIDANCE:

The complete collision avoidance can be made by turning with the constant turn. radius which is fixed at 90' and then $t_{turn}$and TTC, the distance and the lateral distance will be evaluated to avoid the collision completely [Dana Desrosiers, Charles Birdsong, Peter Schuster]

ALGORITHM:

1) Time to turn is estimated from the values of fixed radius of turn and the vehicle velocity. $T_{turn}= (pi/2) * (R_{turn}/V_v)$
2) Lateral displacement is the movement of the vehicle through certain distance
3) during the estimated time to turn. $X_1=R_{turn}+(TTC-T_{turn}) * V_V$.
4) Distance between the colliding vehicles is calculated from the product of the Time to collision and the vehicle velocity. Distance (D) =TTC * V.
5) From the calculated distance and the fixed radius of turn, the angle through
6) which vehicle turns can be found. Turn angle (θ) = D/R_{turn}.
7) With this, the lateral distance travelled by the vehicle is $X_2=R_{turn}* (1-\cos \theta)$.

Where

R_{turn}-Turning radius
T_{turn}-Time to turn
V_V –Vehicle Velocity
X_1 –Displacement in TTC seconds
TTC –Time to Collision
X_2 –Lateral displacement

V. DIAGRAM:

MINIMIZATION THROUGH TURN ANGLE:

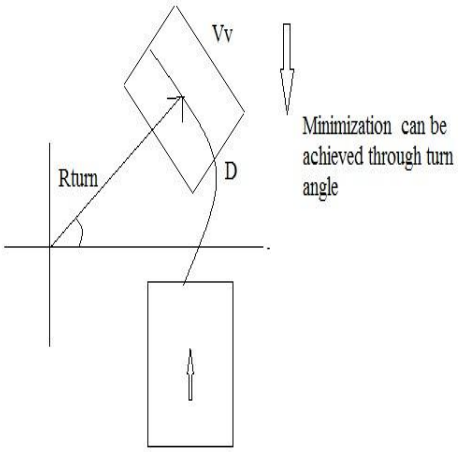


Fig 4.2.1

HEAD ON COLLISION:

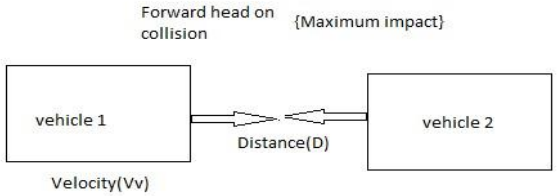


Fig 4.2.2

VI. CHALLENGES:

The disadvantage over the system is that the 90' turn angle is impractical to achieve at high speed of the vehicle. As per the tire road friction the turning of the vehicle at the high speed causes vehicle to lose its stability and it may cause skidding or rollover which leads to the serious issue.

IMPACT OF TURN ANGLE:

Turn angle is the angle at which the vehicle turns to avoid the collision completely. Achieving the required turning angle at high speed of vehicle is practically tough because there arises a question of vehicle stability. The impact of turn angle directly focuses on stability of the vehicle. As per the proposed algorithm the turn angle of 90' can escape the vehicle from the target vehicle but the speed also need to be considered to maintain the stability of the vehicle.

STABILITY CONSIDERATION:

On analysing the stability criteria of the vehicle, the force of tire-road friction is taken into account. The nominal tire road friction value is considered to be 0.8. Any possible degree of turn of the vehicle should not disrupt the vehicle stability condition so that the skidding of the vehicle can be prevented. Sudden turn at high speed disrupts the friction between the road and tire and may cause roll over.

VII. PROPOSED SYSTEM:

The proposed system overcomes the drawback on the stability condition. This condition is achieved by reducing the speed of the vehicle before taking the required turn radius, so that safest turn without skidding is possible.

ANALYSIS:

The mass of the vehicle is considered with respect to the gravity and the normal force of the vehicle is estimated. By considering the nominal tire road friction as 0.8, the force of friction is calculated, which is the product of normal force of the vehicle and the value of nominal tire road friction. We know that the force of friction is equal to the centripetal force, by equating the force of friction and centripetal force, the velocity of the vehicles estimated. From the calculated velocity the reduced speed to achieve the required turn angle is estimated. At this reduced speed of the vehicle the safest turn can be made without skidding. To find the required velocity of the vehicle the basic concept is to balance the frictional force with the centripetal force.

PROPOSED ALGORITHM:

Normal force of the vehicle has to be calculated from the mass of the vehicle and the gravity.

$$F(normal) = mg$$

Force of friction is to be determined for stability condition which is the product of nominal force of friction and the normal force.

$$F(friction) = u * F(normal)$$

By equating the value of force of friction to the centripetal force, the velocity of the vehicle for a stable turn is determined.

Force of friction = Centripetal force

$$F(Centripetal) = m*(v^2/R)$$

$$V^2 = [F(Friction)*R]/m$$

Where,

F (normal) –Normal force in newton
F (friction) –Force of friction in newton
F (Centripetal) –Centripetal force
m –Mass of the vehicle
R –Radius of the vehicle
V –Velocity of the vehicle in m/s

ANALYSIS RESULT

Turn Radius	Vehicle speed	Vehicle velocity(m/s)	Time to collision(s)	Time to turn(s)	X1	Distance(D)
10.82	100	27.77	0.500	0.6115	7.721	13.889
11.2	110	30.55	0.500	0.5754	8.893	15.278
11.5	120	33.33	0.500	0.541	10.11	16.667
11.7	130	30.11	0.500	0.508	11.38	18.056
12	140	38.88	0.500	0.4844	12.60	19.44

Table .7.1

Table .7.1(cont.,)

VIII.DISCUSSION ON RESULT:

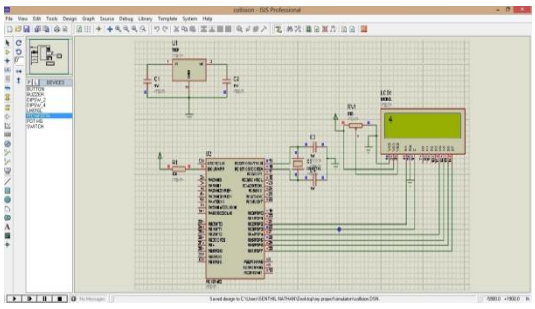
The radius of the turn is fixed around 10 to 12m to achieve the maximum turn of 90'for escape manuver of the vehicle. The vehicle speed is considered to be in the range of 100 to 140km/hr. From the considered turn radius and vehicle speed, vehicle velocity at the turn is estimated. Time to collision is calculated from the distance between the colliding vehicle and the vehicle velocity. As per the algorithm, the angle of turn, lateral displacement and total displacement are found. The obtained parameters are analysed for the stability condition of the vehicle at high speed. Hence to determine the required velocity of the vehicle the force of friction and the centripetal force are equated. The obtained velocity is converted to the

Theta	Total Displacement	Mass (kg)	F(Normal) (N)	F(Friction) (N)	Velocity Required	Speed Required
0.7136	2.640	1010	9898	7918.4	7.7805	28.009
0.794	3.348	1010	9898	7918.4	8.3502	30.061
0.897	4.166	1010	9898	7918.4	8.903	32.053
0.973	5.117	1010	9898	7918.4	9.448	34.01
1.0503	6.033	1010	9898	7918.4	8.350	30.061

speed in km/hr, which the required reduced speed to achieve the safest escape turn angle. The stability of the vehicle is ensured for which the required speed is around 30 to 35km/hr.

IX.SIMULATION RESULTS:

The above analysed data is simulated using proteus simulating software.The simulating software is used to interface pic microcontroller with an LCD display. As per the previously mentioned condition during collision the analysed parameters have to be displayed in the LCD, which acts as a source to reduce the risk of collision.



X.CONCLUSION AND FUTURE ENHANCEMENT:

The data analyses were made on the existing system to find the required reduced speed of the vehicle to achieve the escape turn angle. Stability has to be consider on high speed of the vehicle when speed increases, the stability during the turn does not maintained hence by equating the frictional value, the speed need to be reduced for the required turn angle is estimated. As a result, stability of the vehicle is maintained and the crash can be prevented.

The algorithm for the accident prevention is analysed and the future work focuses on efficient placement of various sensors in the vehicle. On placing the sensors, analysed data can produce the exact result for the complete avoidance of the crash without skidding or rollover.

REFERENCES

[1] Deepak1.A,Sriramprasath2.M, Lokesh.R, Sarath Kumar.M **"Automotive Collision Avoidance System"** International Journal of Modern Engineering Research(IJMER)

[2] Fadi Basma, Hazem H. Refai **"Collision Avoidance System at Intersections"** FINAL REPORT - FHWA-OK-09-06 ODOT SPR ITEM NUMBER 2216

[3] Peter Seiler, Bongsob Song, Karl Hedrick.J **"Development of a Collision Avoidance System"** University of California-Berkeley

[4] Jonas Jansson, Jonas Johansson, Prof. Fredrik Gustafsson **"Decision Making for Collision Avoidance Systems"**

[5] Yizhen Zhang, Erik K. Antonsson and Karl Grote **"A New Threat Assessment Measure for Collision Avoidance Systems"**

[6] Ramesh.S, Ravi Ranjan, Ranjeet Mukherjee, Swarnali Chaudhuri **"Vehicle Collision Avoidance System Using Wireless Sensor Networks"** International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-5, November 2012

[7] Antonio nieto* and kadri dagdelen **"Development and Testing of a Vehicle Collision Avoidance System Based on GPS and Wireless Networks for Open-Pit Mines"**

[8] Avishek Parajuli *1, Bryan Riley.H 2 **"Estimation of Critical Stopping Distances and Time to Stop for Passenger Vehicles Under Various Operating Conditions"**

[9] Erez Dagan Ofer Mano Gideon P. Stein Amnon Shashua **"Forward Collision Warning with a Single Camera"**

[10] Richard van der Horst & Jeroen Hogema **"Time-To-Collision and collision avoidance systems" TNO Institute for Human Factors.**

[11] Kay Ch. Fuerstenberg1; Pierre Baraud2; Gabriella Caporaletti3; Silvia Citelli4; Zafrir Eitan5; Ulrich Lages6; Christophe Lavergne7 **"Development of a Pre-Crash sensorial system – the CHAMELEONProject"**

[12] Andreas Eidehall **"Tracking and threat assessment for automotive collision avoidance"** Linköping Studies in Science and Technology. Dissertations. No. 1066

[13] Martin Distner Mattias Bengtsson Thomas Broberg Lotta Jakobsson **"city safety – a system addressing rear-end collisions at low speeds"**

[14] Charles Birdsong, Ph.D., Peter Schuster, Ph.D., John Carlin, Daniel Kawano, William Thompson **"Test Methods and Results for Sensors in a Pre-Crash Detection System"** California Polytechnic State University, San Luis Obispo, California ,Paper Number 06AE-19.

[15] Eric Raphael and Raymond Kiefer, Pini Reisman and Gaby Hayon **"Development of a Camera-Based Forward Collision Alert System"** 2011-01-0579

[16] Yupeng wang;wenjuan,E.;Daxin Tian;Guangquan;Lu;GUIZHEN Yu;Yifan Wang, **"Vehicle collision warning system and collision detection algorithm"** Advanced Forum on Transportation of china(AFTC 2011).

[17] Chung-Ming Huang ; Shih-Yang Lin ,computers and communications(ISCC),**2010 "A cooperative collision early warning system for vehicle in the curve environment"**

[18] Jiangfeng Wang ; Feng Gao ; Shaoyou Shi ; Jian Wang **"A New method for distance and relative velocity measurement in vehicle collision warning system"**Intelligent system design design and application,2006.ISDA '06.Sixth international conference.