Collision Avoidance Using Vehicle to Vehicle Communication.

I. Introduction

International traffic safety Data and Analysis group has given statistics about vehicle collisions for the year 2008 which says that lane changing is one of the dangerous maneuvers that accounts for about 250,000 crashes every year in US. This is about one crash in every fifteen minutes. This is because while cruising along a three-lane highway we come across a vehicle moving before us. In order to overtake drivers flash lights on the left and moves into the left lane and begins to pass over the vehicle that was ahead of us. At this point if a car approaches in the passing lane then a situation arises where the overtaking vehicle has to pass or slow down to leave the passing vehicle. In either of the cases there is high possibility of accident occurrence. Cruising on the left affects the traffic as well as the people passing on the right.

According to the analysis of lane change crashes report issued by the United States Department of transportation on march 2003. The problem can be caused because of several pre-crash scenarios like: (i) two vehicles travelling in parallel lanes and either one changes lane intentionally when not allowed to pass over, in that lane. (ii) one vehicle merging into another limited access highway lane. (iii) one vehicle moving into another lane to pass over two vehicles. (iv) two vehicles travelling in parallel paths and one turning at a junction while other passing. About 46 % of the lane change crash are because of the above listed scenarios.

Based on the statistics, lane change crashes can be classified into categories like changing lanes, merging, exiting, passing, weaving. The most common scenario amongst all that contributes to about 38 % of the crashes is one vehicle changing lanes intentionally and sideswiping or being sideswiped by a vehicle in the adjacent lane. Collision can occur in a two lane or in a multilane road. When a driver

knowingly or unknowingly does a passing maneuver in a two lane road, head on collision occurs. This happens unintentionally when the driver falls asleep or intentionally while travelling fast. Other factors include alcohol and speeding. Any of the above reason will result in a fatal head on collision.

II. Problem Solution

Having in mind the combination of causing factors and pre-crash scenarios, crash countermeasure concepts and essential functional requirements are developed. The system that is designed should have the following functionalities:
(i)prevents the vehicle from encroaching into the opposite lane.
(ii)Reduce the severity of the collision.
(iii)prevents the vehicle from passing over when there is little or no space in the lane.
(iv)preventing the vehicle from turning right from the left lane when another vehicle is passing in the rightmost lane.
Considering the above possible logical solutions, a system is developed by us that covers most of the issues that is listed.

III. PROJECT OBJECTIVE

The project objective is to develop a collision avoidance system using vehicle to vehicle communication. The proposed system will assist the driver while overtaking other vehicles and avoids any collision that might happen because of either speeding or vehicles passing in the blind side. This system is designed for both single and multi-lane roads. The system also monitors whether the vehicle is travelling within the lane so that it prevents the vehicle in moving into the other lane.

IV. BLOCK DIAGRAM

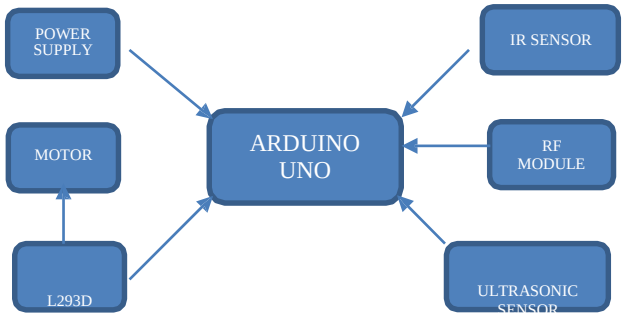


Figure 1.1 Block diagram of collision avoidance system.

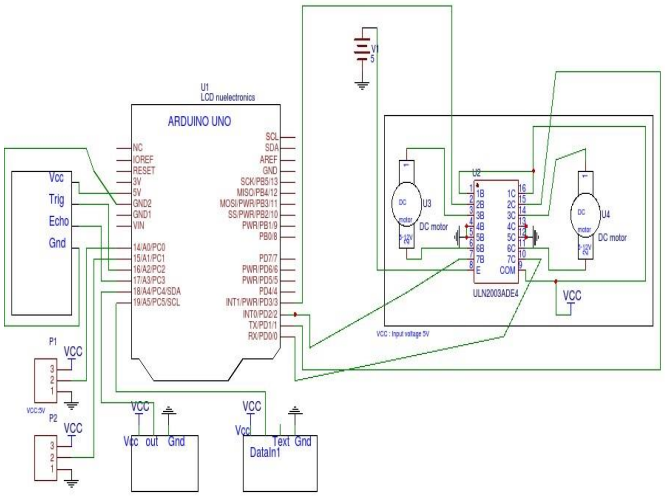


Figure1.2 Schematic Diagram of the collision Avoidance system

V. COMPONENTS DESCRIPTION

A. *ARDUINO UNO*

The prototype of the system can be made using any programmable logic boards. Out of all the options available we chose Arduino UNO and ATMEGA 328 because of its ease of programming and controlling and it has open source Software. Arduino has 14 i/o digital pins and 6 analog inputs. In the project the rover's speed and overtaking decisions are controlled by the Arduino board. Despite the presence of more powerful boards in the market we have chosen to go with Arduino Uno because of its easy interfacing capabilities and cost. Also to implement the logic the Arduino board was sufficient enough.

B. *ULTRASONIC SENSOR*

Ultrasonic sensors emit short high frequency sound pulses at regular intervals. These pulses propagate at the velocity of sound and gets reflected back when it strikes an object. Based on the time between the emitting the pulse and receiving the echo the distance of the target can be calculated. The sensor used in this project can be used to measure distance up to 2 meters. To measure the distance between the rovers, ultrasonic sensor is used. The distance information is calculated using to the Arduino Uno board.

C. *IR SENSOR*

The IR sensor works based on the light sensor.IR sensor works by detecting a specific light wavelength in the IR spectrum. The LED produces light at the same wavelength as that of IR radiation. When any object is close to the sensor, the LED light falls on a object and gets reflected back and is picked up by the photo detector. So based on the intensity of the reflected light the resistance of the photodetector varies which gets translated as a varying voltage level. This can be made use for the tracking application. In this project in order to guide the rover to move in a straight line or make appropriate turns two IR sensors are used in each rover. The values sent from the IR sensor are read by the Arduino digital pins. From these values the direction of rover movement is decided.

D. *RF MODULE*

In the project RF transmitter and receiver modules are used to transfer and receive the distance information between the rovers. RF signals can travel longer distance compared to infrared. RF receives and sends the information at unique bandwidths so that other RF signals cannot interfere. The frequency range of the RF transmitter and receiver module is around 433 MHz The distance between the rovers in the passing lane are sent to the rovers behind, through this RF module. Depending upon the distance received the rovers does the overtake action. RF module is set in all the rovers and the distance information is sent to all the vehicles in the vicinity of about 3 meters in the prototype. For real time systems the distance can be scaled to about 100 meters.

E. *L293D MOTOR DRIVER (MOTOR DRIVER SHIELD)*

The L293D is used for providing bidirectional drive currents of up-to 12V. This device is used to drive inductive loads such as relays, DC stepping motors. L293D is a quadruple high current half-H driver that can be used to produce high voltage outputs that can drive inductive loads. In the project L293D is used to drive the DC motors. The rover moves at various speed according to the conditions declared by the software. L293D is used as a motor shield to drive these motors. L293D is coupled with PWM which makes it possible to adjust the speed of the DC motor.

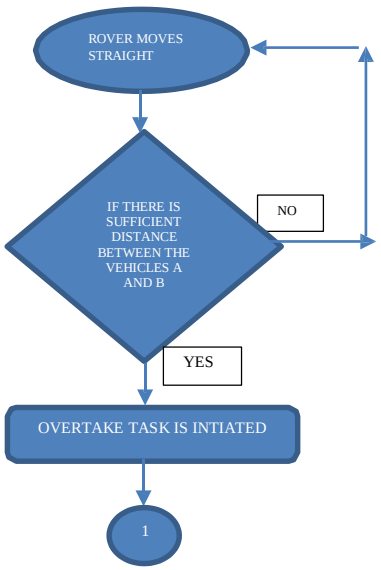
F. *DC MOTOR*

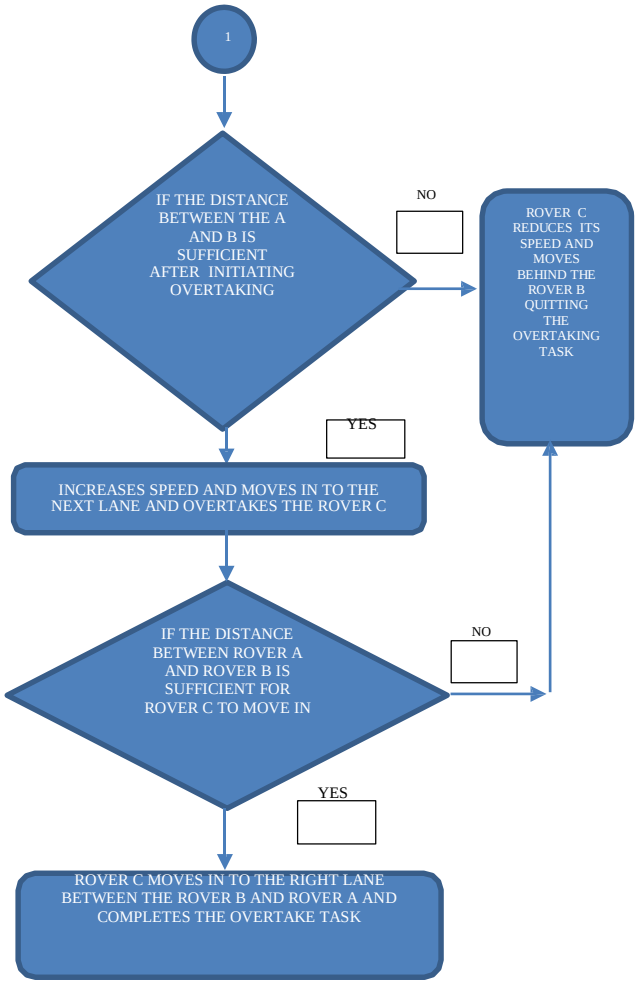
The DC motor produces rotatory motion that make the linear motor produce force and move in a straight line. This motor is driven by a motor driver. The rover moves either right or left and by default moves in a straight line. In the project, Arduino controls the motor through the driver. Depending on the distance information received, Arduino controls the speed and the direction of the motor.

VI. FLOWCHART

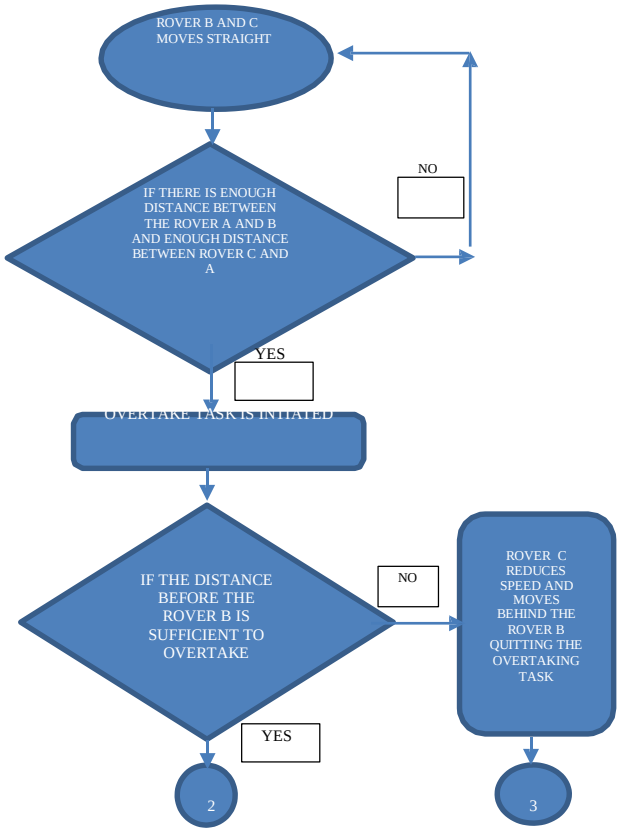
For multilane and two lane roads, the system behaves differently. The behavior is captured in the below flow chart diagrams:

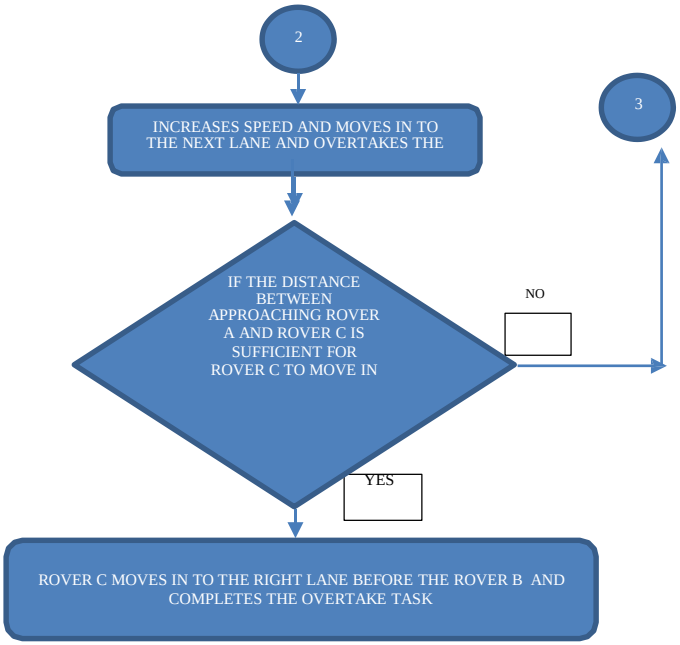
A. *FOR MULTI LANES:*





B. FOR TWO LANES:





VII. IMPLEMENTATION

The assumption of the project is that this system is involved in all cars and the information are sent and received by all the cars in the vicinity of about 10 meters. For demonstration of the idea this project is designed with three rovers named A, B and C.

For two lane roads,

B is the rover that is moving in front of C on the right most lane. C is the rover that is trying to overtake B. A is the rover that is approaching from the opposite lane.

For multi-lane roads,

B is the rover that is moving in front of C on the right most lane. C is the rover trying to overtake B. A is the rover that is moving forward in front of B.

With these naming conventions the implementation is as follows:

The A rover moves forward in the lane and receives the distance information from the rovers before it.

The rover B travels behind the rover A. Rover B receives the distance between the rover A and rover B and passes this distance information to the rover C. To measure the distance an ultrasonic sensor is used.

To guide the rover IR sensors are used that aids the rover to move along the path. This is done because rover cannot move in a straight line without proper wheel encoding.

A. For two lane implementation:

The rover A approaches in the opposite lane
The rover B moves forward in the right lane.
The rover C moves behind the B rover.

When there is enough distance before the rover A, the rover C initiates the task of overtaking and moves into the other lane on the left side. Here there are two possible conditions to occur:

(i) When it moves to the other lane it detects the distance between itself and the rover A in the opposite lane. If this distance is more than 30cm then

the rover C moves forward and then moves into the right lane before the rover B. That is, it completes the task of overtaking.

(ii) When it moves into the left lane and the distance between itself and the rover A is less than 80cms then the rover C reduces its speed and allows the rover B to proceed forward and then moves into the right lane and merger into the traffic behind the rover B.

When the distance before the rover B is not sufficient for the rover C to overtake and proceed then it reduces the speed and follows the rover B.

B. For multilane implementation:

The rover A proceeds in the rightmost lane.

The rover B proceeds behind the rover A.

The rover C moves behind the rover C

The rover C travelling behind the rover B receives the distance between the rover B and C from the ultrasonic sensor installed in it.

The rover A calculates the distance of the vehicles in the vicinity that is the distance between the rover A and B is also calculated and sent to rover C.

Based on this information the rover C takes a decision of overtaking or not.

If there is sufficient space for rover C to overtake A and pass in to the leftmost lane without colliding with the rover B then the overtaking task is initiated and the rover C moves into the next lane. Therefore Lane changing is done safely.

While passing if the rover B unexpectedly decelerates or rover A accelerates the rover C that is continuously monitoring the distance between the rover A and B will reduce its speed and remains in the same lane.

Therefore, the decision of overtaking the vehicles is taken by the system. This prevents the driver from violating any traffic rules while overtaking. The most dangerous maneuver while driving is overtaking and this can be at ease with this kind of system installed.

VIII. PROBLEMS FACED

At the beginning, we built the rovers and coded it to move in a straight line. The rovers were not able to make sharp turns and move in a straight line which was very important to make it as a prototype of our project. So we had to draw separate guide lines to guide the rovers. After this step the task was accomplished.

IX. CONCLUSION

We successfully implemented our idea of collision avoidance and made a prototype of the same using three rovers. This project will aid the drivers while overtaking and prevents them from any collision that might occur because of (i) poor judgement of the distance between the vehicles (ii) passing into other lanes without looking for the approaching vehicles (iii) not having control over the vehicles or not intending to reduce speed when there is no enough space to overtake. All these situations are handled by the system and avoids the vehicle from getting collided.

Through this project we learnt Arduino software which was new to us. We followed many tutorials and got an idea of how to accomplish the task.

X. FUTURE WORK

This system has to be implemented in an actual car and has to be tested. While implementing in real time, many other challenges might come up like synchronizing of the information transmitted and received between the vehicles by the Arduino. The transmission and reception has to be encoded so that those information is not tampered or interfered.

V. REFERENCES

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[3] http://safety.transportation.org/htmlguides/HOcrashes/exec_sum.htm.