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A RETROSPECTIVE STUDY OF ANTI-COLLISION DEVICE FOR LOCOMOTIVES

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ABSTRACT:

Railway is the most popular mode of transport in most of the major cities of the world so it needs to be safer to serve in right direction to the mankind. The major problem with the railways round the globe is the problem of collision, so to overcome this fatal situation the locomotives are now be fitted with the anti-collision devices which are based on GPS. This device works within a radial distance of 3kms. If the ACD detects another ACD bound train on the same track it warns the loco pilot regarding the situation but even if no action is taken by the locopilot it automatically applies the brakes of the locomotive & brings it to a halt to avoid the collision.

KEYWORDS: *GPS, ACD, transmitter, receiver.*

I. INTRODUCTION

The Indian railways has the world's fourth largest rail network after that of Unites States, Russia & China. For an over-populated country like India its railway network act as its lifeline. There are large number of trains running daily on the track which undoubtedly makes it risky & dangerous as per the safety of the passengers are concerned. In a survey it was found that in India around 1235 trains collide every year which it quite large & if we associate the parameter of loss of life to it, it gets even huge. There is a significant need to implement a life saving device in the locomotives to avoid these collisions. The type of collisions it is able to prevent are head-on, side-on, rear-on collisions. So to minimize these collisions ACD's are installed in the locomotives.

This paper is arranged as Section I gives the introduction & the need of invention, Section 2 tell about the anti-collision device & its components. In the 3rd section its working has been discussed, in the 4th section its advantages & limitations are being discussed. The 5th section gives the brief of its applications, in 6th section its advancement & future scope are being discussed & in the last section the study is concluded.

II. ABOUT ACD

The anti-collision device is a train collision prevention system invented by Rajaram Bojji (former M.D) & patented by Konkan Railway Corporation limited in year 2005. ACD's have embedded intelligence. The basic ACD invented was the IR (infrared) based ACD. Then a new ACD to overcome its limitation (i.e. Line of Sight) was invented which was the GPS (Global Positioning System) based ACD.

CLASSIFICATION OF ACD-

There are basically 2 types ACD's
1-IR based ACD 2-GPS based ACD

IR based ACD- the IR based ACD is the older of the two & its working is basically based on the infrared rays. The IR based ACD has a set of receiver & transmitter fitted at the front & rear of the locomotive. It uses infrared rays to communicate. The receiver of the train 1 receives the transmitted signal of train 2 &vice-versa, so in this way both the trains detect each other & follow specific instructions which are pre-fed in the ACD.

The IR based ACD was rejected & not implemented because of its limitation which is, that it requires LOS(line of sight) to communicate with other train.

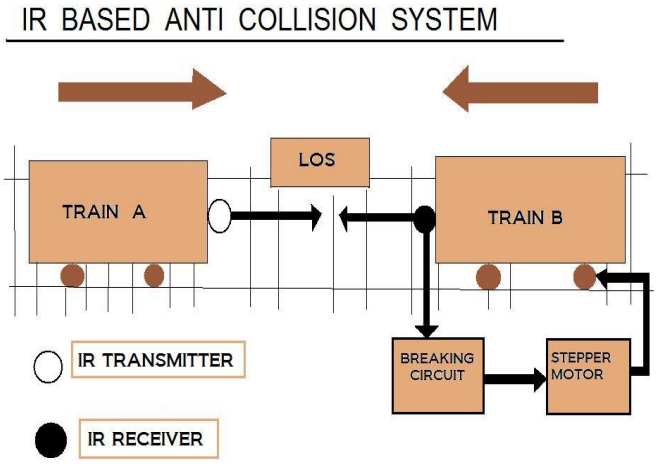


Figure 1: IR based ACD

GPS based ACD-This is the type of ACD & the type we are focusing on. This GPS based ACD takes input from the constellations of satellite (31) that GPS uses. The ACD continuously keeps looking for the other ACD bound train, if it founds one it transmits the data regarding its time, speed, latitude, longitude, angle to the ACD of other train. The CCU on making necessary calculations stops the train if both the trains are heading for collision.
The best part of this ACD is that it prevents every type of collision let it be head-on, rear-on or side-on which removes the limitations of the IR based ACD & makes it superior.
This type of ACD is being implemented in the Indian railways with just a name "TCAS (train collision avoidance system)" to avoid giving credits to the Konkan railways.

Figure 2: GPS based ACD

The GPS based ACD have several components listed below:-

1-GPS (Global Positioning System):- It is a space based navigation system that provides location & time information in all weather conditions anywhere on the earth where there is an unobstructed line of sight to 3 or more GPS satellites. It has a precision of about 5 meters.
2-CCU (Command Control Unit):- It is the heart of ACD. It receives input from the GPS. It controls the whole breaking circuitry attached for the prevention of collision.
3-Radio receiver & transmitter: - It is the unit of the ACD which is responsible for the transmission & reception of information. It is placed at the roof of the locomotive.
4-Display: - The display is the LCD display which is used to notify the condition traced by GPS & processed by CCU. It is placed in the loco pilot's cabin.
5-ABU (Automatic Braking Unit):- It is one of the most essential unit present in the ACD. Whenever there is a collision like situation the CCU commands the ABU to apply the brakes before the estimated contact point of 2 trains.
The ACD also comprises of a microcontroller. A microcontroller is a basically defined as a small computer on a single integrated circuit. The microcontroller being used by the ACD is "AT89C51" which is developed by Atmel Corporation which is based on Intel 8051 core.

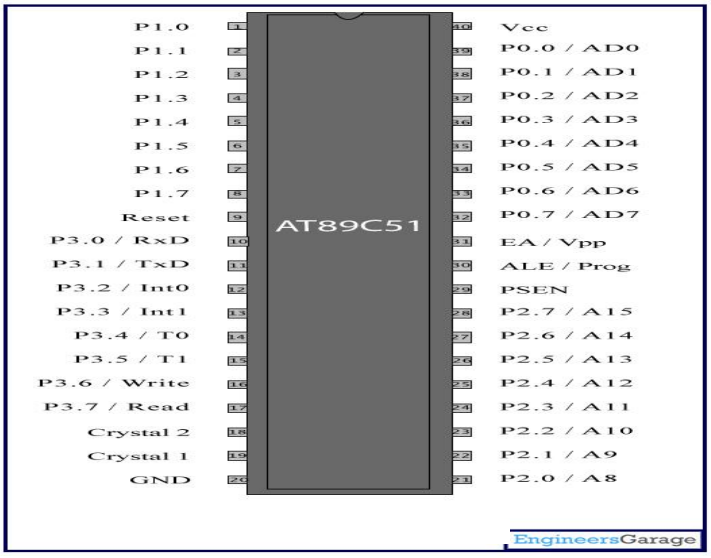
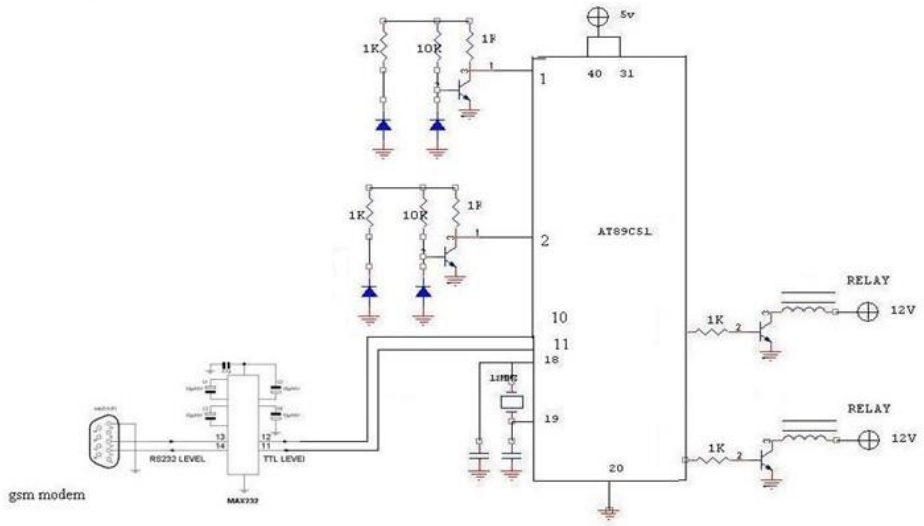


Figure 3: Pin Diagram of AT89C51

It is a low power, high performance C-MOS 8-bit microcomputer. It has 4Kb of ROM memory. A 128 bit RAM, 2 16-bit timers/counters, 32 input/output lines with 6 interrupt sources having a fully static operation of 0-24MHz. It works on a constant 5V power supply.



III. WORKING OF ACD

The components of ACD have already been discussed in the earlier section. The GPS is mounted on the roof top of the locomotive, it receives input regarding latitude, longitude, date, time, speed, angle of the locomotive from the constellations of satellites for communication. The GPS passes the same information to the CCU & it holds it. By this time the ACD continuously keeps looking for another ACD bound train within its radial range of 3km.

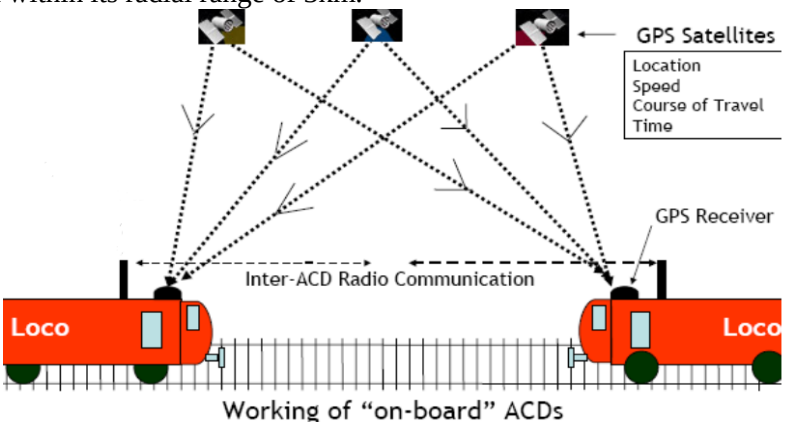


Figure 4: Working of GPS based ACD

If it detects another ACD both the ACD's share their information obtained by the GPS. The CCU makes the necessary calculations from the information about each other & decides whether they are heading for collision or not.

If the calculations made by the CCU come to a conclusion that both the trains are in a collision type situation it immediately informs the loco pilot about the situation through the sound & display system. If the loco pilot ignores this warning, the CCU automatically sends the signal to ABU to apply the brakes.

The ABU on receiving the signal applies the brakes which reduces the speed to 15km/hr. & then finally stopping it.

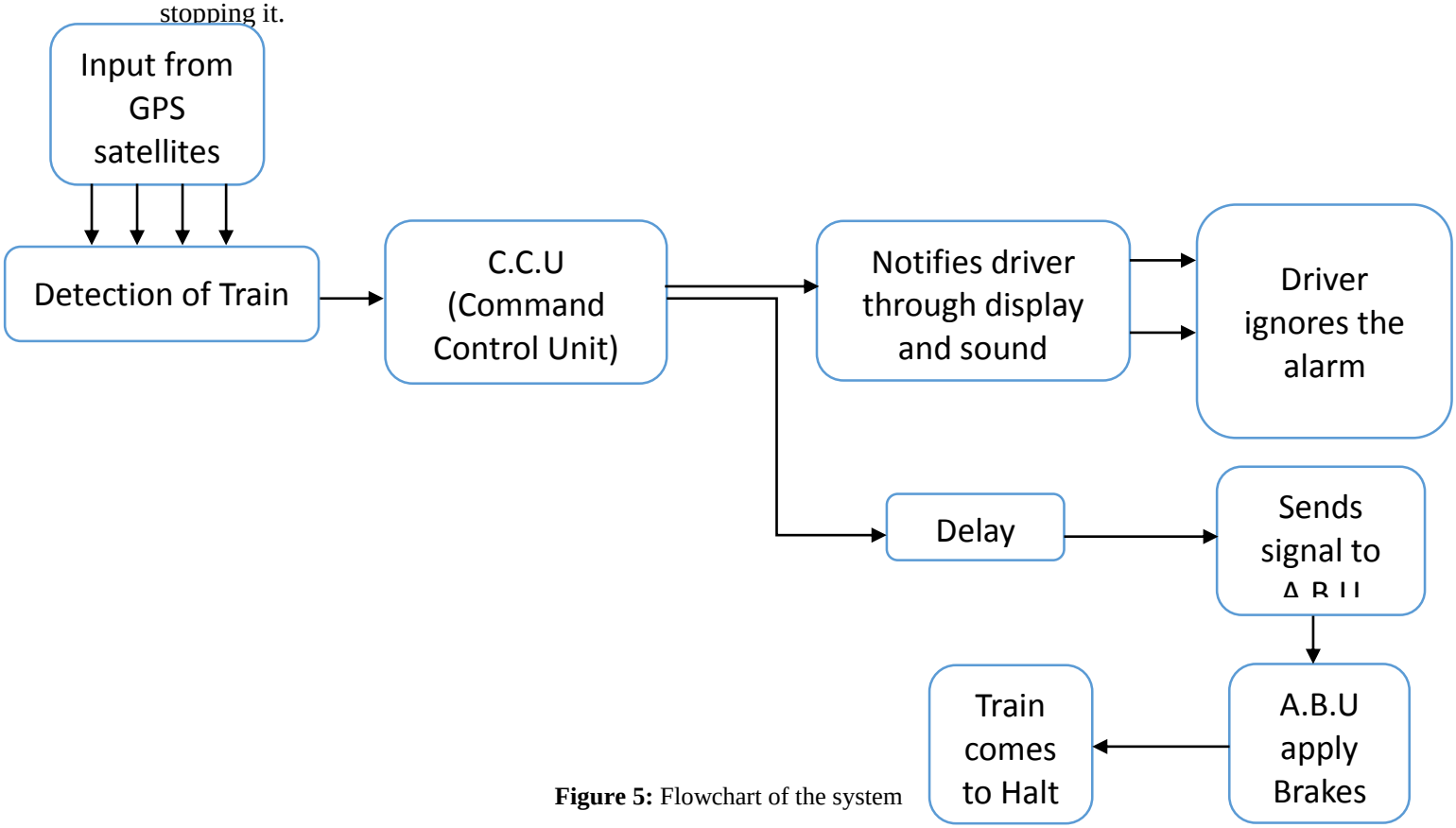


Figure 5: Flowchart of the system

IV. ADVANTAGES

The advantages it provides are:-
1-Economical as no cabling of tracks are required.
2-Elimination of human error.
3-Provides a robust system.
4-Can work in a temperature range of -10C to +70C.
5-Makes the train tractable between stations.
6-Extended capability to detect any collision like situations.

V. LIMITATIONS

ACD is no doubt the best system ever developed which prevents almost all type of collisions but still has some drawbacks which makes it an imperfect system. Some of its limitations are:-
1-Other train is a Non-ACD train:
If the other train is a non-ACD then the train with ACD will not be able to detect it so in that case collision can't be prevented.
2-Failure of break power of the locomotives:-
If there is a brake failure then the brakes to the locomotive can't be applied.
3-Power failure:-
ACD requires external power supply for its functioning, if the power supply is not available the ACD can't work.
4-Adequate braking system is not available:-
To stop the train adequate brake force needs to be applied but if the braking system is not upto the mark the train will not stop in the desired manner.
5-GPS failure:-
This is one of the most important limitation of GPS based ACD because if there is a GPS failure ACD cannot work. Example- Failure of GPS in long tunnels where it cannot connect to its satellites.

VI. APPLICATIONS

1-In automobiles, heavy vehicles etc.:-
ACD proves to be very helpful in avoiding collision in automobiles & heavy moving vehicles which carry heavy load.

Figure 6: ACD in automobiles

2-ACD can be used as a tracking device:-
It can be used to track the exact location of the train even between the stations.
3-ACD can be used to decrease the distance between two consecutive trains:-

As each passing day the traffic load on the railway network is increasing, to cope with it is a challenge but with the implementation of the ACD it can be made possible.
4-ACD's can be used at level crossing gates to avoid collisions at gates:-
The ACD proves really useful in preventing collisions at level gates, it informs the loco pilot about the situation of the gate before 2000metres of approaching it.

Figure 7: Loco Pilot Display before 2000mt of approaching gate

VII. ADVANCEMENT & FUTURE SCOPE OF ACD'S

1-The range of the GPS based ACD should be increased
2-ACD can be used for speed limit impositions
3-ACD using zig-bee & Wi-Fi can be installed
4-Electromagnetic sensors can be used in ACD

VIII. CONCLUSION

With the implementation of this system in the locomotive, accidents are reduced by an effective means, which has been a positive response for the working of ACD.
The introduction of GPS based ACD has removed the limitations of the older version of ACD. Still there is a scope of improvement in this technology regarding its radial range & failure of GPS system in tunnels. The present cost of implementing a single unit of ACD is 5.3lakh so its cost can be brought down to ensure its implementation in the railway network.

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