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Anti-Train Collision Implementation System with Vector Points

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Abstract: Train transport is a widely-used mode of transport in a global scale. Automated trains have become the trend of the current decade. Devising a mechanism that can effectively avoid collision between two locomotives is imperative in real-time. By using GPS and the coordinated usage of vector points corresponding to real geographic locations, we have devised an effective method that will ensure the collision avoidance of train locomotives. This technique also introduces the concept of automated trains controlled by a set of control centres. Trains that travel at the speed of sound have become a common sight but also this presents a very serious safety issue. The proposed model here adds the above-mentioned safety factor to the existing technologies that govern the automated train design industry.

Key words: GPS, vector points, automated trains, collision avoidance, mentioned safety, existing technologies

INTRODUCTION

The feat of train transport is a massively ingenious sign of human engineering. Every sovereign country in the world has implemented this feat of transport only because it guarantees safety and efficiency: A duo that is hard to generate or come-by. This study aims to further enhance the existing system of train transportation that efficiently guarantees collision avoidance and any kind of catastrophic events from occurrence (Gautam *et al*., 2010).

A train derailment or accident could be the deadly reason for hundreds of innocent deaths. Ironically, most of these accidents are contributed to the human factor (NMMC., 2016). The introduction of automated trains which rely on a central system for directions on locations, clearly curtails the chances of accidents of any kind. Thus, the trend of automated locomotive service must be heavily emphasised upon in every nation (Narendar and Ravi, 2013). Also, automated trains have proven to be faster and more reliable than human-controlled locomotive.

Automation by its very definition means the automatic processing of events provided the required information for the system is given (Frohlich and Plate, 2000). There have been a lot of developments in the field of automation in every walk of day-to-day life. Self-driven cars, motion-controlled doors and sensors are glorious examples of automation implemented in real time. Most of the time, the human factor is the cause of accidents in train derailments, we introduce the concept of automation supporting an anti-collision mechanism will ultimately result in a safer transportation environment.

Existing system: The existing system of train transportation involves a variety of factors. Some countries efficiently use automated trains while others rely on human coordinators. But none of these systems possess an efficient method of collision avoidance. Automated trains have become the new emergence of transport industry. The conception of the hyperloop by Billionaire-innovator Elon musk is a clear example which is being used to transcend into the new automated era of safe, reliable and efficient mode of transport.

There are several collision detection systems implemented in control centres for any given route (Jeevagan *et al*., 2014; Sambamurthy and Ahammad, 2013). But all of these algorithms depend on the GPS information of an adjoining locomotive. This data could easily be damaged or falsified. The ATC (Automatic Train Control) is the general class of safety mechanisms for trains that involve inputs from external factors. An ATC meter is deployed to indicate the predicted safety of the locomotive in the chosen track. Nations around the globe have implemented this set of safety mechanisms. In the proposed system intended technique is built on the same idea as that of the ATC with one change. We introduce a new mechanism to ensure two individual locomotives do

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not collide under any circumstance. In the anti-train collision system, a train will receive the destination details from a central system which acts as a spine for train transport in the entire region. This central hub will coordinate every technical aspect of the journey and of the locomotive itself.

Another significant mechanism is the Anti Collision Device (ACD) developed by Konkan Railway Corporation Limited (KRCL). The ACD is a fully integrated system with its primary goal being collision avoidance. A huge advantage with ACD is that it does not interfere with the regular commuting operations. Special devices called anti collision devices are created for this purpose. A collection of these devices constitutes an ACD route. All the ACD's have the capability to communicate with another ACD if it is in the range of 3 km. All ACD's in a given ACD route communicate with one another to ensure a safe pathway for the locomotive.

A network of Anti-Collision Devices (ACDs) are provided that comprises of a variety of devices such as onboard (Mobile) ACDs for Locomotives and Guard vans and track-side (Stationery) ACDs, level crossing ACDs, Loco Shed ACDs, sensor based ACOs and ACO repeaters. These are the common devices that are used for communication between two anti collision devices. If any two ACD's detect the slightest possibility of collision, the parent ACD system activates a breaking operation that successfully prevents collision of the locomotives involved. In the Indian railway system, more than 2000 ACD's have been installed over a 2700 km route out of which 1900 are of the North Frontier Railway and the remaining devices are on the Konkan Railway. But even the above-mentioned system has the greatest risk of the human factor which cannot be predicted with utmost certainty.

MATERIALS AND METHODS

Proposed technique: The existing technique for collision avoidance in trains is manual control over the switching points. Every switching point has a station that is manned by workers who perform the switching of tracks. This always leaves a chance of error occurrence in the switching which itself, presents a big threat to train transport. The anti-train collision system that we are proposing is to introduce automated trains to eliminate the fact of human control. A central controlling tower for a station will decide the destination for all of its trains. In the anti-train collision system, the vector collection of train points are obtained using the global positioning system. The optimal route is established between the source and destination points which is followed by the vector selection and authentication. The anti-train collision system is depicted in Fig. 1.

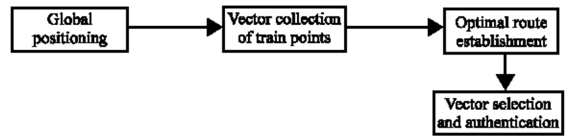

Fig. 1: Anti-train collision system

The route in which a train must commute is obtained in real-time. A destination is entered in a train as dest. A separate list of vectors is maintained that contains a list coordinates (in_coordinate) that when connected together will form the optimal route. This list is maintained in the central tower of the station. When a train is starting its journey, it does so by the optimal route that is formulated. The train will ask access for the first in_coordinate during the journey's inception. If the respective in_coordinate is free, then, it is activated. If the respective in_coordinate is already activated, then a replacement for the in_coordinate is found, all the while maintaining the optimality of the route thus obtained. The list of vectors will also include the train switching points and other points. If a given in_coordinate is already activated by a train then no other train can activate or access the point unless it is deactivated. Once the train has crossed the point corresponding to the in_coordinate, it is then deactivated. The in_coordinate will contain 3 fields: the latitude, longitude and the activation status.

The GPS status of a given location can be achieved by using a realistic hardware implementation. A location box that can pinpoint the GPS data of a given location and also stores the location ID of the particular location in question. The GPS of a given location can be accurately pinpointed using a standard-issue GPS microchip. This microchip comes in various forms and varieties. This GPS chip is also called as a GPS tracking unit.

The location box contains another important component. It contains the location ID of the specific location. A location ID is a unique identifier that is given to a specific location at the time of creation by the central system. The location ID is the only way in which locomotives identify a given location in order for inclusion in their route.

The location ID and the GPS tracking unit would, together, constitute a location box for the given location. A schematic representation of the GPS unit used in the location box is as shown in Fig. 2. The location ID would be a hexadecimal value that is unique for every individual unit. The location ID along with the a uniquely designed

Fig. 2: GPS tracking unit

GPS chip, together constitute a location box. Our proposed technique ensures the factor of safety. Locomotives that have been previously engaged in another route will not be able to participate as active vector locations in any other route formation. There is also the added advantage that for every route forming process, the central system only activated a given location vector only if it is available. If the location vector has been previously engaged by another route then the system will search for a location vector with similar properties Algorithm 1.

Algorithm 1; Algorithm pseudocode:

```
    String Dest, source
Input source, Dest
if(train_id == 0)
              faulty train
              remedial measures need to be taken
           Endif
R[] = Route_op(source, Dest)
              t = source
              L = begin(R[])
        while(L! = Dest)
              if(IN_CO(L) == 1)
                if(act.IN_CO(L)! = 1&&cood.IN_CO(L) == R[])
       journey(t, L)
        t = L
  endif
              endif
               L = next(t)
 endwhile
          end
   Route_op(source, Dest)
              N = count(Route(source, Dest))
              i = 0
              while i<n
                  Ro[i] = Route(source, Dest)
              endwhile
            For i = 0;i<n;i++
              For j = i+1;j<n;j++
      If Dist.Ro[i]< Dist.Ro[j]
                  Roop[] = Ro[i]
                 Else
                      Roop[] = Ro[j]
                 Endif
                Endfor
           Endfor
        End
```

If the train has encountered some malfunction, the fault will be identified by the central hub using a unique train_ID. Every locomotive will have its own individual and unique train_ID. This variable's value will indicate whether the train is suitable for commutation.

There is always the special case that the chosen locomotive is faulty in its nature. In that case, the central system will perform a full system diagnosis to determine the faults prevailing in the locomotive. These diagnostic measures will be performed in both the hardware and software side of the locomotive. As far as the hardware part is concerned, all of the engaging parts of the locomotive, from the engine to the brakes would undergo extensive scrutiny. All the features and liabilities of the control system would be identified and corrective measures would be undertaken.

There are a lot of custom-designed diagnostic software systems available in the market. These systems can always be altered to the specific needs of the diagnostic task in hand.

A diagnostic check on the software side would include verification of the GPS data, route formation element in the locomotive, precision factor of the calculated route, etc. These are some of the key elements that would undergo extensive scrutiny in the diagnostic process. The locomotive would be branded as functional (train_id! = 0) only if all of the elements of the diagnostic tests are approved in favour.

RESULTS AND DISCUSSION

An effective anti-collision mechanism for train commutation with the advanced improvement of automated trains has been explained in detail. The implementation of this proposal will undoubtedly save many lives by effectively avoiding collision of train Locomotive. By implementing this effective algorithm that ensures anti-collision of locomotives, we can guarantee the safety of commuters whose livelihood depends on train transport. Another noticeable point of this technique is that there is no space for human error. The deciding program implemented in the control centre is completely pre-programmed and is not influenced by any external factors, lest it be human.

The above proposed model can be subject to a lot of improvements in the forthcoming future. As this model is based on existing technologies, the factors of accuracy and precision are answered promptly. But every developing technology can be subject to new improvements at every instant. New improvements are being made in the GPS tracking unit every day that enable efficient real-time tracking of objects and entities.

CONCLUSION

The model proposed here depends on various inquisitive technologies like GPS, vector point formulation, etc. Using all of the above technologies, we have implemented a factor of safety in automated locomotives.

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