Interlocking System using AI(Artificial Intelligence)

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Abstract - Railway interlocking is a safety critical domain, where still traditional technology is in use. There are many reasons for using traditional technology. One of the main reason behind this is the proven safety performance of the older systems (Relay Based). As the rail traffic is increasing and with higher speed of trains there is an acute need for modernization of Railway Interlocking Technology. Even with the advent of Microprocessor based technology, the problems have not been solved. It shows the use of Artificial Intelligence in Railway interlocking domain which uses the GPS and train details from the official IRCTC'S API and take sessions accordingly, which is suitable for high Speed Railway Traffic. It uses Reinforcement Learning an area of Machine Learning and also, it uses the Q-learning Algorithm and shortest path Algorithm. It can also control the signals and guide the On-Board crew accordingly.

Keyword's: Interlocking, Artificial intelligence, API, GPS, Reinforcement learning, Q- learning.

1.Introduction

The railway Interlocking domain is a safety critical domain, where safety is given utmost importance. The railway Interlocking domain is mostly operated using traditional technology, which is considered safe and time proven. The New advances in technology have not been able to solve age old problems of safety and reliability.

1.1 About Indian Railways

Railways traverse through the length and breadth of the country covering 63,140 route kms. As the principal constituent of the nation's transport system, Indian Railways own a fleet of 2, 16,717 wagons (units), 39,236 coaches and 7,739 number of locomotives and manage to run 14,444 trains daily, including about 8,702 passenger trains. They carry more than a million tonne of freight traffic and about 14 million passengers covering 6,856 number of stations daily.

Over the years, Railways have built up an elaborate and well established manual information system to help them monitoring their moving assets. Supported by a dedicated voice communications network, it collects and transmits information from the remotest corners of the country to control centres, at the highest level. The size and complexity of their operations, growing traffic and changing technologies, placed inevitably a heavy burden

1.2 Problem Statement

India Railways are one of the safest mode and Budget Friendly way of transformation. For that they use Interlocking systems like RRI(Route Relay Interlocking) and SSI(Solid State Interlocking), which has a chance of Human(Man Made)errors.

Image -1: Indian Railway Station Yard.

on this manual information system. Need for its modernization was therefore felt for sometime.

1.3 Objective

In large and busy stations they should handle high volume of train momentums, which is not much efficient. To make it more efficient and easy by using Artificial Intelligence we can reduce the Man Made errors and this increases the safety of the passengers and reduces extra burden for the Railway Cabin Department.

1.4 What is Interlocking System?

An Interlocking is an Arrangement of Signals apparatus that prevents conflicting moments Through an Arrangement of Tracks Such as junctions and crossings.The signalling Appliances and Tracks are sometimes collectively referred to as an Interlocking Plant. An Interlocking is designed so that it is impossible to Display a signal to proceed unless the route to be used is proven safe.

1.5 Introduction to Artificial Intelligence

It is a science of creating machines that are tasked to solve problems and accomplish some work that is too complicated for the human brain to process by itself.

(AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving.

The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal.

2. Existing System
 At Present Indian Railways are using two types if systems

1. Route Relay Interlocking(RRI)
2. Solid State Interlocking(SSI)

2.1 Route Relay Interlocking(RRI)
 The Control Rules are implemented using Relays. These relay based circuits implement all types of Logic and take inputs from Signals, Points and Track Circuits Etc. in the form of relays. The Command to set and clear the route for the train is taken in the form of button form the Station master's console (Control cum Indication panel). When a command is given the RRI checks if the command given is safe and takes necessary action, but if the command given by the station master is invalid and unsafe it does not execute it.

The output of the Interlocking Logic is also a relay, which in turn drive the signals and Point Machines associated with points. RRI till date is the safest system implemented, because it implements the proven interlocking rules and also since the Relays used in RRI are inherently failsafe, they (Contacts) drop to safe state due to gravity even when power supply is not available or in any kind of malfunction.

Image 2: Route Relay Interlocking.

2.2. Solid State Interlocking(SSI)
An Interlocking System When built using Electronics replacing traditional Mechanical Levers and Electro mechanical relays is called as Solid state Interlocking System. System. The Same Interlocking rules or control equations equations used in RRI form the basis here also. The relays relays used to form the logic circuits in RRI are replaced by by software variables. The field inputs are collected using

using digital input cards and outputs are given using digital output cards. The processing is done by a processor where the the virtual relays (Software Variables) are evaluated using the the Interlocking equations, which are now in digitized form either as Algorithms, Boolean equations or state charts in the the processor memory. These algorithms now being executed by executed by the processing unit take appropriate action.

Image 3: Solid State Interlocking.

2.3 Disadvantages

1. The Relays used to build the logic circuits are bulky and take a lot of space.
2. The relay wiring is very huge and it may take years to complete an installation.
3. The testing of RRI is still an informal process that take months to verify and validate the installation.
4. Any change to the station yard such as adding an additional

   line requires most or entire RRI wiring to be changed or replaced, which take years to complete.

3. Proposed System

An AI(Artificial intelligence) interlocking system can track the location of the and distance from the yard(place where the tracks are seperated).This AI itself adjusts the tracks into their respective positions safely without any human interference or man power .

The Neighbouring Interlocking cabins follows Three-way Handshake protocol to allow trains to travel from one place to another. AI give the continuous and accurate updates of trains in which platform it is there, through API's.
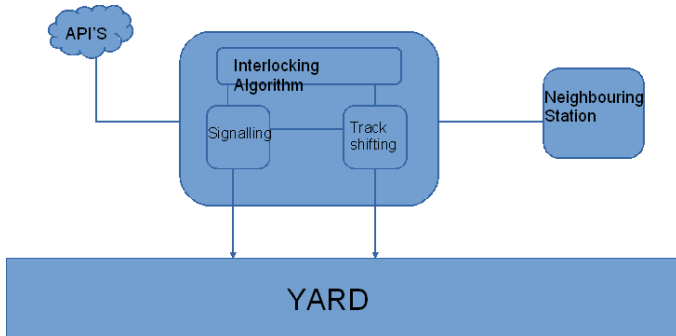
3.1 Architecture
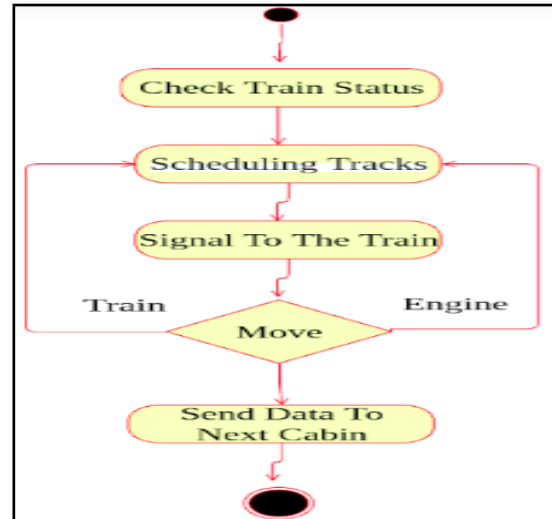

Image 4: Architecture of Proposed System.

3.2 Methodology

When a train is allowed to travel from one yard to another Yard, then the neighboring yard cabin starts tracking the train using GPS system. If the train is near the station around 2kms then the AI will start working. It then detects the number of trains present on the yard and also detects number of tracks which are vacant and then AI starts the algorithm to find the best track to station the train by using regular train arriving data and sets the route for the trains using AI. Then the AI gives the signal to the train to come into the yard. After the trains arrive AI sends the request to other cabin about the train. If the neighboring cabin accepts the request then AI again sets the root to the main track from the distributed tracks in the yard and gives signal to the train to pass from the yard.
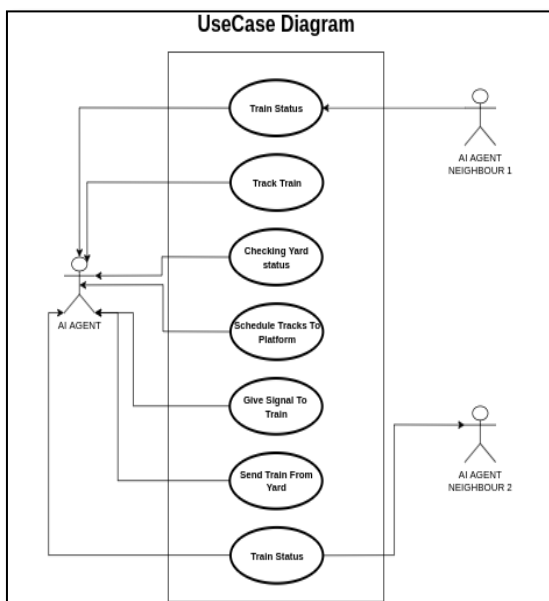
3.2.1 UML Diagrams

Image5: Use Case diagram

Image 6: Activity Diagram

3.3 Implementation

1. Creating a Simulator:

   We create 3D Simulator of a Railway yard in 3D modules software and give them physical properties to act like in how in real world works.

2. Implementing in Game Engine:

   Place this modules in a game engine which we like to use and start testing them. After that implement Reinforcement learning algorithm a method in machine learning. And start training the AI in simulator using the game engine.

3. Implementing the AI:

   After Ai is perfectly trained, use the created data set to implement on the real Railway cabin to control the yard.

3.4 Advantages

- There will be no man –made errors by using AI.
- It is low cost and gives the accurate data.
- It Reduces the time complexity.
- We can use the same for the different types of cabins.

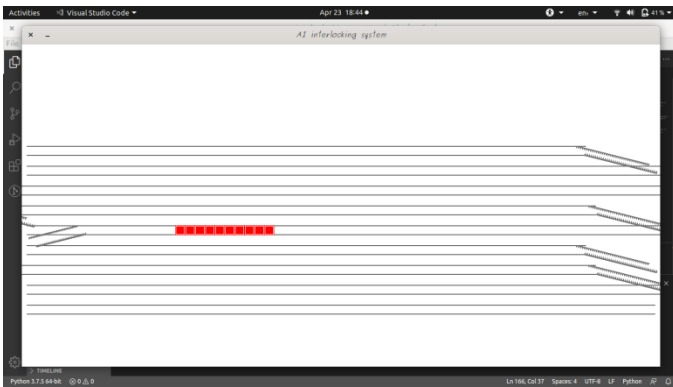## 4. Final Results

Image 7: 2D Simulater in pygame.

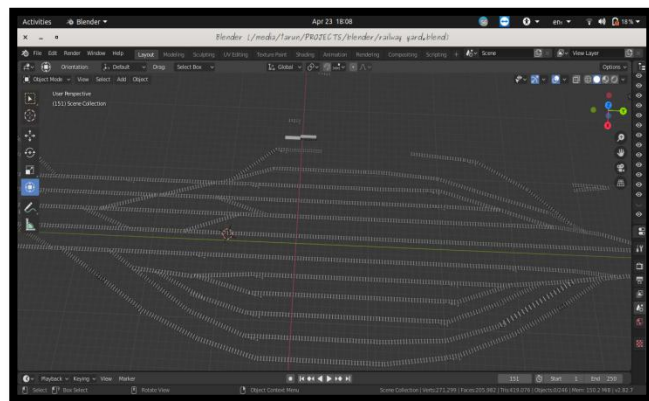Image 8: 2D Simulator while train is moving.
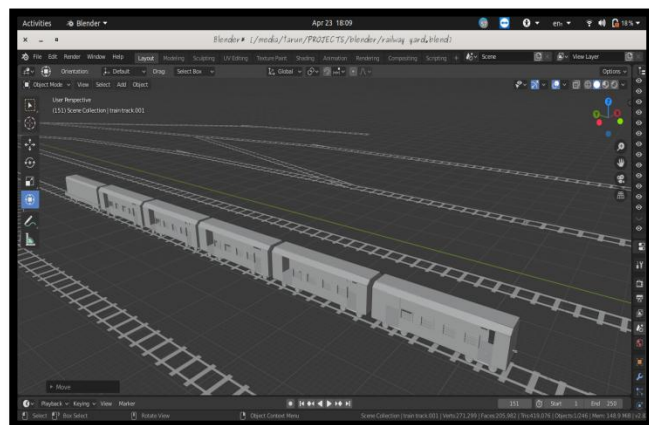

Image 9: 3D Vizag Railway Station Yard in Simulator.

Image 10: 3D Simulator in Blender when trains in motion.

5. CONCLUSION

The main aim of the model is to advance the development of the indian railway systems with more fast and and accurate system. By using AI in the interlocking system we system we can help the railway cabin people work easy and and user friendly. We can run high speed train and help the the people to reach there destinations faster and safer. By using By using this system speed increases and waiting time of the the train decreases for trains to arrive into the platform and they and they can also give the accurate output to which platform platform the train is arriving in the station. Making the world world run more into the future. This is how AI interlocking system helps humans to make a world a better place.

6. Future Scope

The trained AI can be used to the other railway cabins in other places which dosen't have the interlocking system. Which can help the AI to interact with other cabins more effectively.

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