© 2016 IJSRSET | Volume 2 | Issue 6 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

InterTrain Communication Based System : Indian Perspective

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ABSTRACT

Today's advanced railroads find themselves forcing to consider a CBTC upgrade because of its promises of increased security, dependability, availability and associated reduction of maintenance costs; increased system capability using the same civil infrastructure and its capacity to diminish downtime during an upgrade. The urban rail transit system has quickly developed around the world, and due to increasing traffic pressure, there is a high demand to increase the effectiveness of rail transit system. Communication-based train control (CBTC) network is an automated control network for railways that assures the safe and efficient operation of rail vehicles by data communications.

Keywords: CBTC, Minimum Turn-Back Interval Time, ATO, Turn-Back Capacity.

I. INTRODUCTION

Recently, urban rail transit systems have been fastly developing around the world. Due to large urban traffic pressure, increasing the efficiency of urban rail transit systems is in big demand. As a key subsystem of urban rail transit systems, communication-based train control (CBTC) is an automated train control system that uses train–ground communications to assure the secure and efficient operation of rail vehicles. CBTC can do better the utilization of railway network infrastructure and raise the level of service offered to customers [1][2]. Building a train control system over wireless networks is a challenging work. Due to unreliable wireless communications and train mobility, the train control performance can be significantly affected by wireless networks. Since CBTC systems are safe, critical trains normally run according to the front train's condition, including velocity and position. When a wireless network brings big communication latency caused by unreliable wireless communications or hand-offs, the current train may unable to obtain the perfect state information of the front train, which would affect train operation efficiency, or even cause train emergency stopping[3][4].

II. METHODS AND MATERIAL

A. Literature Survey

In last year's, research on train-to-train communication has been carried out by different organizations, including the German Aerospace Center(DLR). Though the RCAS has undergone some improvement in physical-layer design, it only supports train operation speed of lower than 200 Km/h, which is inapplicable to a high-speed railway. Generally, the speed of a high-speed railway train is up to 360 Km/h. In this case, safety distance among trains is 10Km, which will result in intence path loss and bad receiving signal quality if two trains on the identical track perform direct communication. The BER of the receiving signal is about 0.5[5].

Communication-Based Train Control (CBTC) System- Whereas a conventional signaling system determines train location using Interlocking Controllers ("Interlocking") that monitor track circuits, a CBTC system hire Carbon Controllers (CCs)[5] to find train location primarily from wayside devices such as transponder tags. The CC typically augments this data by reading finer positioning devices such as tachometers, speed sensors, radar, and accelerometers, and transmits suitable resolution position, speed and direction status information to wayside Movement Authority Controllers (MACs)[6], each of which communicates with CCs and interlocking, to get the status of all trains and routes in the control area.

A CBTC system is considered to provide the classical Automatic Train Control (ATC) functions of Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Supervision (ATS), generally in granting with the requirements as follows:

- ATP functions provides for fail-safe protection against collision, extra speed, and other dangerous conditions through a combination of train detection, train separation, and route locking;[8]
- ATO functions typically contains automatic speed regulation, automatically programmed station stopping, and automatic door control; and[8]
- ATS functions typically gives all monitoring, control and automation necessary to fully support[9] and coordinate system-wide train movements: This contain tracking of trains during normal operations and capacity to support degraded service due to external conditions such as equipment failure or environmental factors; the adjustments can be to performance of individual trains to uphold schedule or corrective action to be taken by Control Centre staff.

Depending on the principles of CBTC train control, whether the MA is timely transmitted decides the performance of the CBTC system. MA is the basis for ATO and ATP decisions, which come from ZC according to the state information of the front train. An MA is defined as a physical point on the track. In CBTC systems, the current train needs the information of the front train to control acceleration/deceleration at each communication cycle. If ZC can send the accurate information to the current train, which means the current train can get require information, the current train can make accurate decisions. In CBTC systems, ZC transmits an MA to the current train according to the information sent from the front train.[7][8] Hence, we can see that the information gap in CBTC systems is the difference between the derived state of the front train from the received MA sent by ZC and the actual state of the front train.

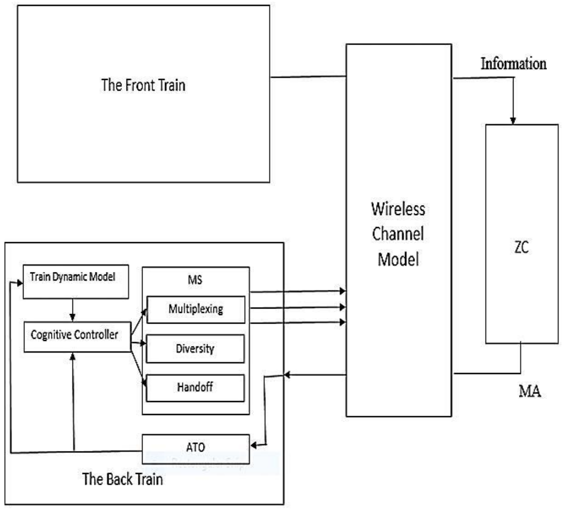

Figure 1: Block diagram for CBTC

B. Indian Survey

CHENNAI: As Indian Railways is planning to bring semi-high speed trains, Southern Railway is gearing up to equip its signaling and communication system in such a way that there will not be human errors when trains are runs at 160kmph.

A railway company belonging China conducted a study recently to find out if semi-high speed trains can be conducted on Chennai-Bengaluru/Mysore route. The company is yet to give its report. Railways are planning to bring Communication Based Train Control System, (CBTS), widely used in metro rail networks, to assure that more trains could be operated on the same railway line without compromising on security by improving the signaling and anti-collision safety features. This technology is necessary for running high-speed trains.

Speaking at a seminar on "Capability and Safety Enhancement with Modern Signaling System" consolidated by Institute of Railway Signal and Telecommunication Engineers (IRATE) railway board extra member S Manohar said importance would be given to CBTC on the mainline and on suburban routes where the number of trains operated was high.

A study in Delhi metro rail showed that CBTC could originate a headway of 120 seconds. Hyderabad metro is also planning to bring the system. The system will also display signal status on the dashboard of the train.

TVM Signaling and the Transportation Systems Ltd managing Director Gopalakrishnan P said, "When the speed of the trains is increased, we have to depend more on technology to assure safety. Technology should control on the loco pilot who drives the train[9]. This will reduce human error. CBTC is one such technology. In semi-speed and high-speed trains, the role of the loco pilot will be supervisory. The control will be with an automated system with a chosen number of people monitoring the movement of trains."

The Research Design and Standards Organization (RDSO) director general P K Srivastava said that "Anti-collision system like the Train Collision Avoidance System (TCAS), which has the feature of local technology called Train Protection and Warning System (TPWS), is being developed because safety is critical as the speed of trains go up. This will be the future."

TPWS has been under trial in between Moore Market Complex suburban station and Gummidipoondi since 2008. Manohar said the victory rate of the system was 99%[10]. In a paper, Ravi Prakash Karcherla from Thales India said, "Radio-based train control technologies is a state-of-the-art and proven signaling system for growing density of trains on a route by minimizing headway and increase in asset utilization ability. Execution of such system in metro rail network should give the chance for railways to explore the technology for mainline networks."

III. CONCLUSION

In this paper, we have specific a cognitive control approach to CBTC systems to increase the train control performance, considering both trainsground communication and train control. In the proposed cognitive control approach, we introduced the information gap, which is defined as the difference between derived state of the front train and the actual state of the front train in CBTC systems. The Linear quadratic cost for train control performance in CBTC systems was considered in the performance measure. In addition, the information gap was formulated in the cost function of cognitive control to quantitatively describe the effects of train–ground communication on train control performance. Based on the cognitive control formulation, RL was used to obtain the optimal policy. Moreover, the wireless channel was modeled as finite-state Markov chains with multiple state transition probability matrices, which can bring more accuracy than the model with only single state transition probability matrix. Simulation results were presented to show that cognitive control approach can significantly increase the performance of train control comparing with other policies.

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