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Biologically Inspired Approach for Increasing Safety in Railway Transport

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Abstract— **This paper proposes a biological solution to avoid train accidents caused due to signaling hardware malfunction and human error. Using this proposed solution train collisions can be avoided with considerably higher cost efficiency than the existing safety systems. This solution does not require any track mounted infrastructure, instead it relies on continuous coordination between trains by varying their speeds automatically using Radio Frequency communication. In this paper, a simple algorithm is proposed an d implemented for managing points of conflict or switches where priority of trains has to be handled carefully. This algorithm uses Radio Frequency communication to share the network status messages among the trains and to achieve coordination between trains in possible conflict zones around switches or in shunting yards. This proposed biological solution can decrease the signaling cost of railway transport greatly. In addition, this proposed solution can lead to time and energy savings in railway transport. This biologically inspired approach is implemented using PIC Microcontroller and simulated using PROTEUS IS IS Professional software.**

Keywords—**Biological approach, RF communication, PIC Microcontroller, Automatic train traffic control, Master - S lave concept of train traffic control.**

I. INTRODUCTION

Railways form the major part of the public transport system serving millions of passengers and carrying tones of goods everywhere all over the wo rld. Carry ing capacity of trains are ext remely large and it is also elastic which can be easily increased by adding more wagons. Develop ment of trade, industry and commerce of a country largely depends on development of railways of that country. This makes railway transport as a major form of passenger and freight transport in many countries compared to other modes of transportation.

Major d isadvantage of railway transport is its cost of construction and maintenance is very high. With the increase in number of trains over the years, there is also an increase in number of t rain accidents. Damage due to these accidents are more severe and takes many lives of passengers. Train accidents are main ly caused due to human and hardware errors.

II. EXISTING SYSTEM AND ITS DRAWBACK

An existing safety system in railway transport is signalling. In this signalling, tracks are divided into blocks. Trains are given permission to move into the blocks by means of signals.

The main purpose of this signaling is to avoid two trains to occupy the same block at the same time . This signaling system requires track equip ment for every b lock. So the cost of safety will be higher if the railway includes more kilo meters, because it requires more track equip ment.

Moreover, despite the cost of safety for railway is high, If there is any hardware malfunction of the track equipment and the motorman does not know about that means then the probability for getting accident is high.

Fig.1 T rain accident caused due to human error

Above Fig.1 shows that the train accident caused due to human error. Chennai Beach – Vellore Cantonment Electrical mu ltip le unit train crashed into the Arakkonam – Katpadi passenger train as it was waiting for signal clearance.

Fig.2 T rain accident caused due to signal error

Above Fig.2 shows that the train accident caused due to signalling error. Brahmaputra Express from Dibrugarh

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collided with Avadh Assam Exp ress from New Delhi at the remote station of Gaisel, 300 miles fro m the city of Gauhati in Assam. The crash was at such high speeds that the trains actually exploded with killing at-least 290 people.

From this it is clear that there is a need for completely new safety system.

III. BEHAVIOR OF STARLING BIRDS

Starling birds live as highly social family. Most starling species associate in flocks of varying sizes. Starling birds never collide when they are flying close together in tight flocks. They are achieving this by maintain ing a safe distance between each and every birds in the flock. In each flock one master b ird will be there and all the remain ing birds in the flock will act as slaves. Speed and direction of this master bird will be followed by all the remaining slave birds in the flock. Master bird in the flock will be keep on changing on the fly. This same master – slave concept is used in this project to improve the safety of railway transport.

Fig.3 European Starling bird

Fig.4 Self organizing behavior of Starling bird

IV. PROPOSED SOLUTION

In this project inspired by self-organizing behavior of swarm of starling birds, a simp le algorithm is proposed for controlling train traffic and to avoid accidents due to signaling hardware malfunction. Proposed solution does not require any track mounted infrastructure instead it requires continues cooperation between trains by controlling their speed with respect to Master train using RF wireless communication.

V. SYSTEM DESIGN

This project is implemented using PIC microcontroller, IR sensor, Relay, DC Motor and RF transmitter and receiver module.

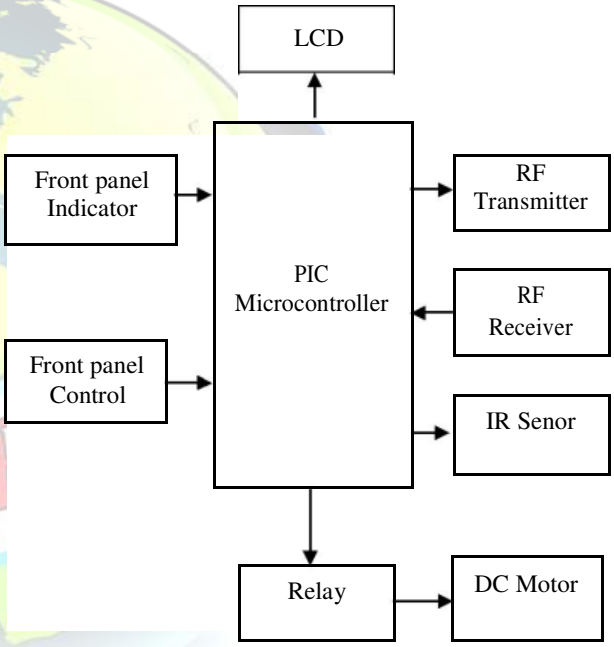

Fig.5 Block diagram of proposed system

In the block d iagram shown above, RF transmitter is used for transmit the current network status that is speed and track id details of master train to the slave trains. RF receiver is used for receiving the speed and track id details sent by master train. PIC 16F877A microcontroller is used to compare the speed of master train with slave trains and to control the speed of slave train with respect to master train.IR sensor is used to maintain a safe distance between trains. Relay is used to convert the 5v from PIC to 12v for running the DC motor.

VI. METHODOLOGY

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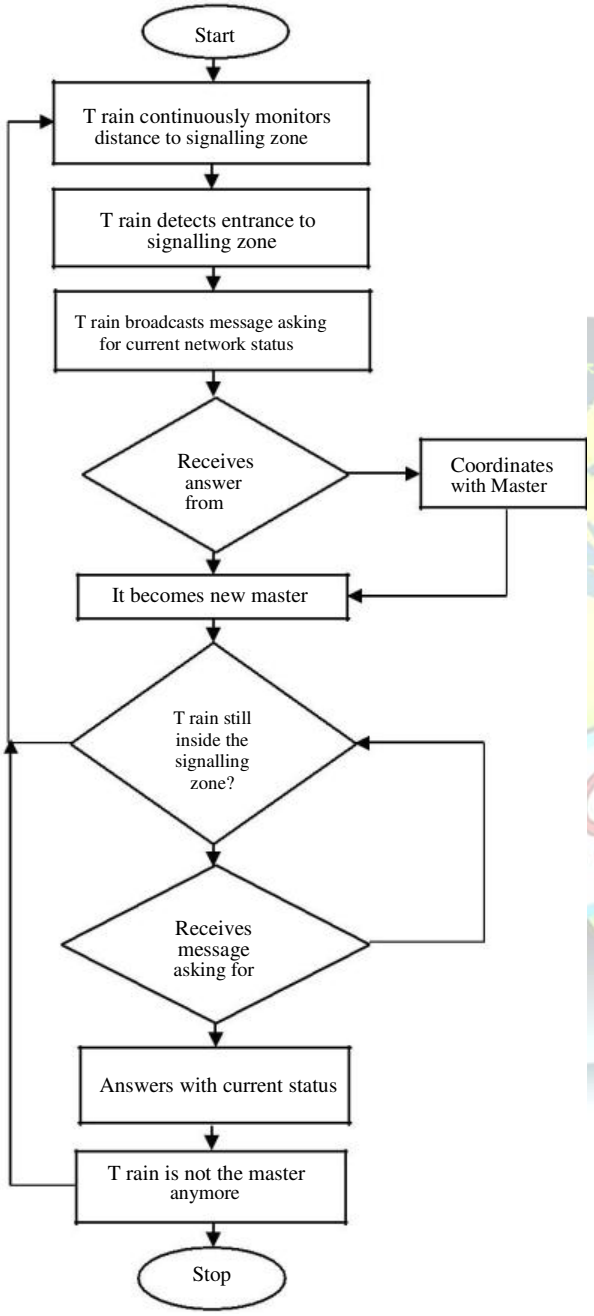

Fig.6 Proposed Master – Slave algorithm to control train t raffic

In the Fig.7 shown above, Train 1 is the a first Master because it first co mes to the signaling zone. After it arrives at the Signalling zone, T1 b roadcast message asking for Network status. Before T1 there is no train in the signalling zone , So it receives no status message.

T3 is the second train arriving to the signaling zone. After arriving, T3 sends message asking for network status. T3 receives status message fro m master train. This status message has speed and track details of the master train. A fter receiv ing this status message, T3 reduces its speed with respect to mas-ter train to avoid collision with master train T1.

Then T2 arrives to signaling zone, T2 sends message as k-ing for network status. At this time T1 is not the master train because it crosses the signalling zone.T3 co mes next to T1, so T3 beco mes Master Train. T2 now receives message from master train T3. T2 is not sharing track with T3 so it does not changes its speed. T2 moves with same speed.

VII. SOFTWARE SIMULATION

This project is simulated using PROTEUS (PROCESSOR FOR TEXT EASY TO USE) Software. PROTEUS ISIS Professional software is PCB design software. This software is integrated with simu lating the electronic circuit and also for checking whether the circuit we designed works properly or not. Using this software we can check our test code (program) by loading hex file in the circuit.

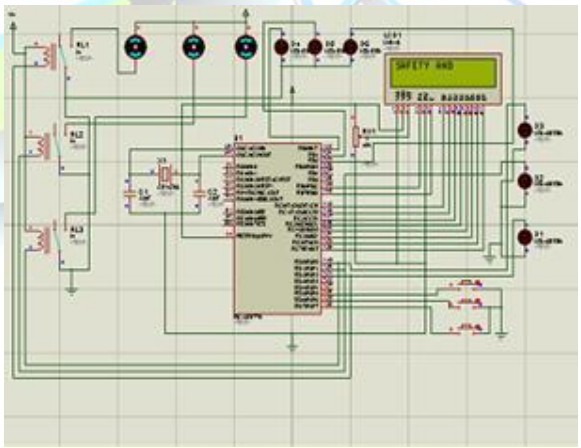

Fig.7 Complete simulation circuit diagram

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Simulat ion of the circuit shown above in fig 3 is carried out by loading the C program. In this simulation circuit three motors are used, these three motors are assumed as three trains T1, T2 and T3. Fro m these three trains, one train is manually turned on. when the train is turned on timer count for that respective train starts and it keep on increasing. Then the remain ing trains are turned on one by one and their respective timer count starts. PIC microcontroller co mpares the three timer count values of the three trains and the train with larger count value moves with h igher speed compared with other trains.

VII. HARDWARE IMPLEMENTATION

The Proposed system was designed by using PIC Microcontroller and all the sub co mponents controlled through the PIC M icrocontroller. This project includes PIC microcontroller circuit, LCD circuit, Motor circuit, IR sensor circuit and RF Transmitter and Receiver module circu it. All these circu its are simu lated and tested using PROTEUS ISIS professional Software before hardware implementation.

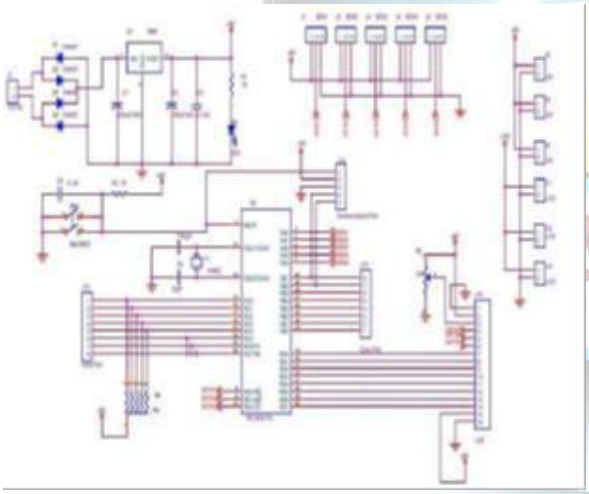

Fig.8 Complete PCB circuit diagram for PIC 16F877A

VII. RESULT AND DISCUSSION

This project does not require installation of any track equipment in contrast to the current signaling safety system used in train traffic control. So the imp lementation and maintenance cost of this proposed system is less compared to existing infrastructure based signaling safety system. This can lead to reduction in the travelling cost of train. Majo r causes of train accidents are signal failure and human error.

In signaling safety system, signal failure may occur due to control of the slave trains with respect to master train occurs in the proposed system automatically so possibility of occurrence of accidents due to human error is also less.

System is placed inside the train so the malfunctioning of the system can be easily detected and corrected before occurrence of hazardous accident. In signaling safety system, if two trains need to share the same track means trains are stopped at signaling zone but in this proposed system speed of trains are varied, not the trains are stopped so the travelling time is reduced and also energy efficiency is achieved.

VII. CONCLUSIONS

Railway transport is an energy efficient means of transportation. Hence it is used more co mpared to other modes of transportation. However, the safety system used in railway transportation is costly, the possibilities of occurring train accidents due to hardware error, failu re on the electrical supply and robbery of hardware is large. In this paper, a new safety system for trains is proposed. This new safety system is cost effective and also increases time and energy saving in railway transportation.

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