EasyChair Preprint

№ 4246

Design of Railway Accident Analysis System Based on Artificial Intelligence

Zhihan Wang

September 22, 2020

Design of Railway Accident Analysis System based on Artificial Intelligence

Zhihan Wang

School of Electronic and Information Engineering, Beijing Jiaotong University, Beijing, China

Email address: 11274025@bjtu.edu.cn

ABSTRACT: Since railway traffic has come into people's life, it has been acting as a very important role in people's daily living. The major content of this research is to build a railway accident analysis system based on Artificial Intelligence (aliased as AI) which has the function of railway accident reproduction and traffic data analysis, based on Microsoft Train Simulator (aliased as MSTS) platform, taking the train crash happened on 29th June, 2009 in Chenzhou for example. This research reproduces the environment scenes when the accident in Chenzhou happens with the help of MSTS, including the longitude, the latitude, the landform, the buildings, the platforms, the traffic and the track installment of that time, and represents the real situation at a driver's visual angle. Besides, the research also build a railway traffic data collecting and analyzing system based on C#, with the help of Cheat Engine, Access and Visual Studio 2010. The system can automatically track and analyze the traffic data in MSTS. This reproduction procedure is with great significance for analyzing the real accident.

KEYWORDS：Artificial Intelligence; Rail traffic; Accident reproduction; Accident analysis

1 INTRODUCTION

Since railway traffic has come into people's life, it has been acting as a very important role in people's daily living. As for its flexibility in climate and natural features, also great advantages in capacity and low costs，as well as its various types of carriages, railway traffic has the ability to carry almost all kinds of goods, including people. With the development of social economy, rail transit has become the country's economic

lifeline. It stands in a very high position in transportation area, and playing more and more important roles in the field. However, railway accidents have been come to happen for times recent years, which greatly endanger people's life and property safety and cause potential security problems to people's daily life. Therefore, building an emulational virtual scene to reproduce and analysis railway accidents has become an urgent case to be solved. A mature emulation system will help people to reproduce and analyze accidents, also to find causes of the accidents. What is more, rail traffic accident reproduction system shall also be useful in seeking the accident responsibility, rail traffic safety education, accident forecast and accident avoidance.

There are two ways to reproduce traffic accidents. One is to deduce the state before the accident from the state after the accident. This method is called analysis method. The other method is to assume the state before the accident, and then simulate the possible accident results under the conditions, compare the results with the actual accident, and take the hypothesis closest to the actual result as the real state before the accident, which is called the simulation method. In practical analysis, the two methods are generally combined, and the final analysis result is obtained by repeated comparison. Most of the existing accident reconstruction systems adopt forward simulation and repeated iteration on the basis of experiments to infer the actual situation of the collision by verifying the degree of coincidence between the simulated trace and the on-site trace, so as to reproduce the accident at the data level. By the influence of the development of AI technology in recent years, the concept of Intelligent Transportation is beginning to take hold. Promoting the intelligent development of transportation mode is becoming an important trend. With the help of AI technology and the Internet of Things (aliased as IoT), we can conveniently achieve the function of train operation monitoring, track condition detection, accident forecast and warning, as well as railway accident analysis system. By the means of data and message collecting and analysis, the IoT over AI can build a real-time and accurate network, which can monitor and adjust the train movement in real time, handle failures online and timely warning, so that to ensure the safety and stability of the train running.

The train crash happened in 2009 at Chenzhou station on the Beijing-Guangzhou railway is also known as the June 29 major traffic accident on the Beijing-Guangzhou railway. It happened at 2:34 am on June 29, 2009 near The Chenzhou station of Jingguang Railway in China's Hunan Province. Three people were killed and 63 injured. Six of them were seriously injured. According to a government spokesman, the accident

happened because the train K9017 failed to brake and jammed another fork, causing the locomotive to derail. There are many reasons for the failure of the brake, including the reasons of the equipment or the fault of the system itself. The specific reasons are still to be investigated. This project mainly uses the software of MSTS to study and develop the rail traffic accident analysis system, taking the train collision accident of June 29 in Chenzhou, Hunan province as an example. It includes the simulation and restoration of the scene at the time of the accident, and the recording and analysis of driving data at the time of the accident. Through the realization of this subject, the operator can feel the actual situation of the accident at that time personally, and have a more intuitive understanding of the specific process of the accident. At the same time, the indicators and parameters in the reconstruction process will also help to analyze the cause of the accident from a scientific perspective.

2 THE PLATFORM BUILDING

A. MSTS Development

The Microsoft Train Simulator (aliased as MSTS) is an analog railway software that runs on Windows operating system, developed by UK studio Kuju Entertainment. MSTS is a very open simulation train development platform. The installation disc provided by Microsoft is actually an open tool that integrates production platform and simulation platform. The user may modify railway-related facilities such as production lines, locomotives, signals and tracks to suit his own needs. Based on the above characteristics, the development platform of train simulation software also has the potential to become a very suitable and advantageous tool in the process of rail transit accident reproduction. This project is based on this development platform, which makes the railway environment around Chenzhou Station and simulates the scene of June 29 accident, so as to reproduce the accident scene and analyze the traffic data.

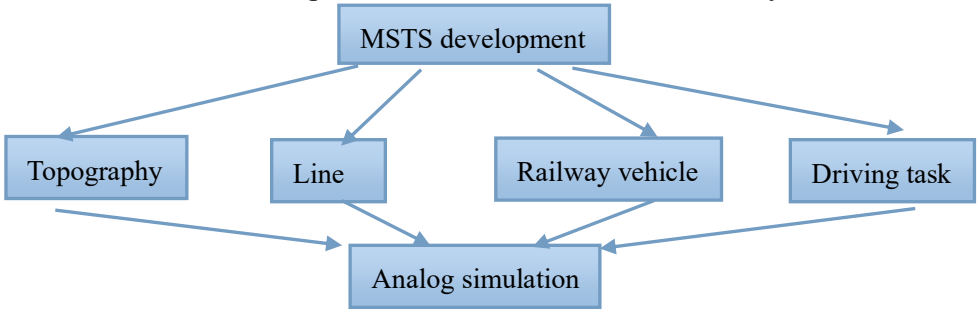

Fig.1: MSTS development process

B. June 29 Train Collision Accident Simulation

With all the prep work done, it's finally time to actually start the simulation. The following picture is the operation interface of the train simulation.

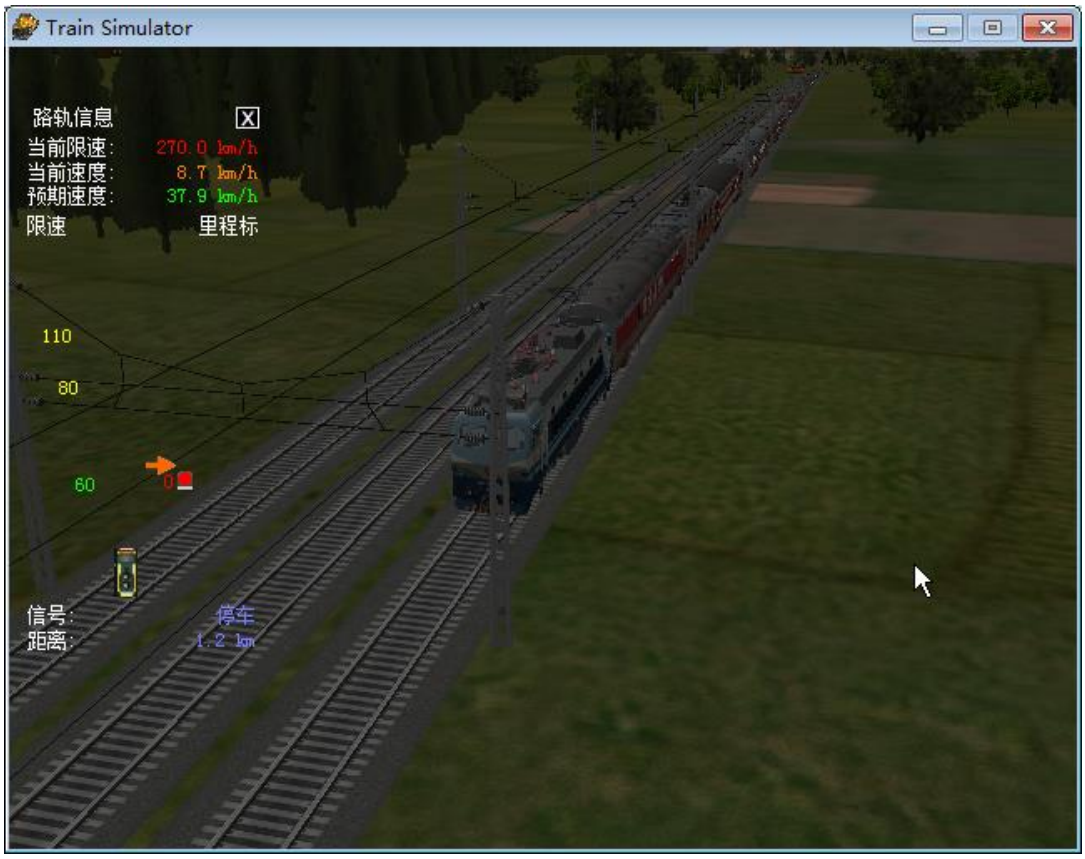

Fig.2: Top view of simulated train operation

During the simulation process, train K9017 ran from Chenzhou station north road, received a slow pit stop signal at the speed of 80 km/h, but couldn't stop in time because of brake failure (simulation cases, used only 10% of the air brake to simulate the situation of insufficient), in the end crashed in the station at a speed of 55 km/h with an outbound train K9063, and forced to stop by the side collision.

3 TRAFFIC DATA ACQUISITION

The purpose of collecting traffic data is to read the parameter data in the running process of the train in real time, so as to monitor the running condition of the train and give early warning in time. Due to the limitations of MSTS software and the limitation of research time, only the most representative three parameters, namely running speed,

track speed limit and distance from the target, are selected here for monitoring and analysis. We mainly used Cheat Engine to collect the traffic data from the MSTS process, to gain the real-time data of the three parameters: speed, speed limit, and distance to the station. The data is automatically obtained and stored in an Access file, with the help of a data-collecting system based on C#.

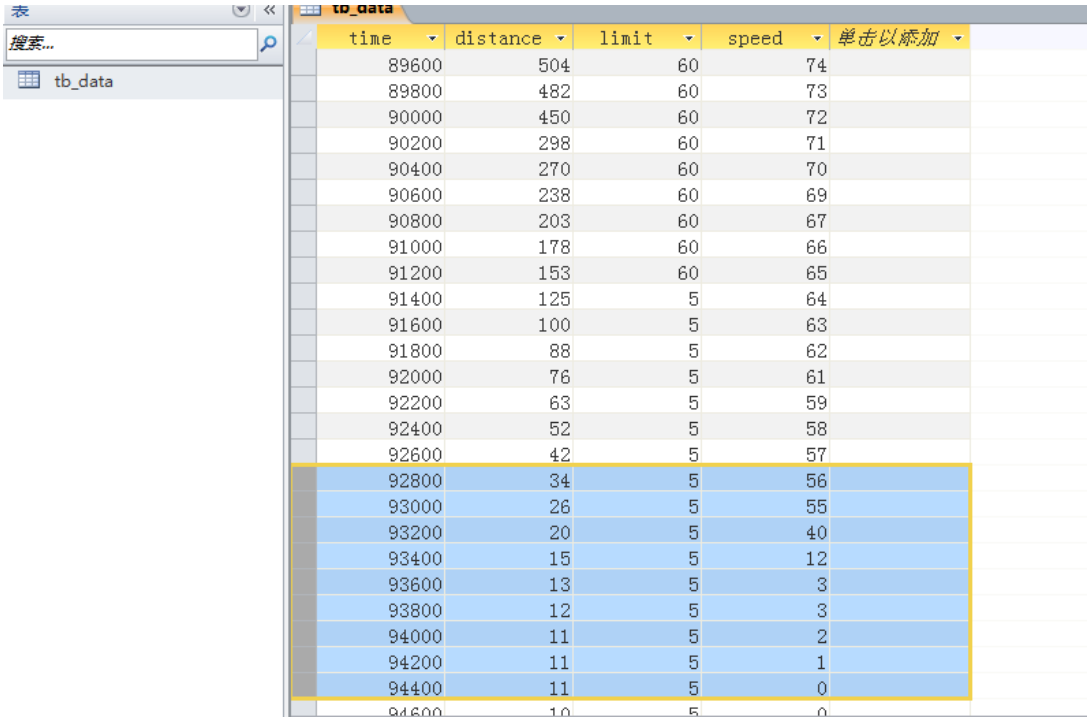
表
搜索...
tb_data
tb_data

time	distance	limit	speed	单击以添加
89600	504	60	74	
89800	482	60	73	
90000	450	60	72	
90200	298	60	71	
90400	270	60	70	
90600	238	60	69	
90800	203	60	67	
91000	178	60	66	
91200	153	60	65	
91400	125	5	64	
91600	100	5	63	
91800	88	5	62	
92000	76	5	61	
92200	63	5	59	
92400	52	5	58	
92600	42	5	57	
92800	34	5	56	
93000	26	5	55	
93200	20	5	40	
93400	15	5	12	
93600	13	5	3	
93800	12	5	3	
94000	11	5	2	
94200	11	5	1	
94400	11	5	0	
94600	10	5	0	

Fig.3: Traffic data collected in June 29 train accident simulation

Part of the data selected in the figure is the driving data during the crash. As you can see, the speed limit of 5 km/h sections (now actually in Chenzhou station the station, the train reservation here should stop) the driving speed of the train K9017 time remained above 50 km/m, and in time = 93000 (accident simulation task scheduled crash time) after rapid deceleration to 0 (not normal brake to slow down, but because the train was forced to slow down). At the same time, the program interface always displays the overspeed alarm after entering the deceleration zone to remind the operator to pay attention to the train running speed, and the purpose of specific traffic data analysis during train running is basically achieved. The program achieved its intended goal.

There are many benefits to having traffic data (only the speed, track limit, and target distance) in an Access database. By saving the data, it is equivalent to a real-time record of the running condition of the train. When it is necessary to know the running condition

of the train, the data can be used to get a very intuitive feeling. If it is necessary to analyze or simulate the running of the train in the future, these data will become important reference materials. The running speed, speed limit and other information will also reflect the running state of the train in detail, and the simulation through the exact data will be more real and reliable. If enough data items are recorded, it can be said that through these data alone, the scene of the train operation can be reconstructed almost completely and truly.

4 TRAFFIC DATA ANALYSIS

The reading and display of driving data have been completed. In order to further achieve the effect of accident analysis, it is necessary to compare driving data with target data and provide a prompt interface that can warn users. For example, whether the current speed exceeds the current speed limit, if so, prompt "overspeed", etc. Based on this purpose, the program has been modified and upgraded, so that it is no longer just a data reading and display program, but has the function of recording and analyzing driving data, and then interactive feedback to users.

The design idea is that the first still according to the previous method reads MSTS inside the traffic data of the train, the difference is that in order to realize the real-time monitoring, click once to obtain a data this way is too cumbersome, and therefore there is no longer per click a button on a read, but to every certain time interval, automatically data read display at a time. When the program is running, click on "start" button, the data acquisition system will start automatically and display the real-time display of the train operation parameters in the text box (three data also show) at this time, click the "stop" button, the program will stop the traffic data reading process, the text box will keep the latest read data. In addition, the program also has data recording and analysis functions. At the same time of reading and displaying data, the data acquisition system also stores each group of data obtained into Access database for the convenience of data search, analysis and comparison in the future. If hidden trouble is found through data analysis during operation (for example, "current speed" is higher than "current speed limit"), relevant warning information will automatically pop up to remind users of the abnormal running state of the train and urge them to make timely adjustment.

The operation effect is shown in the figure below:

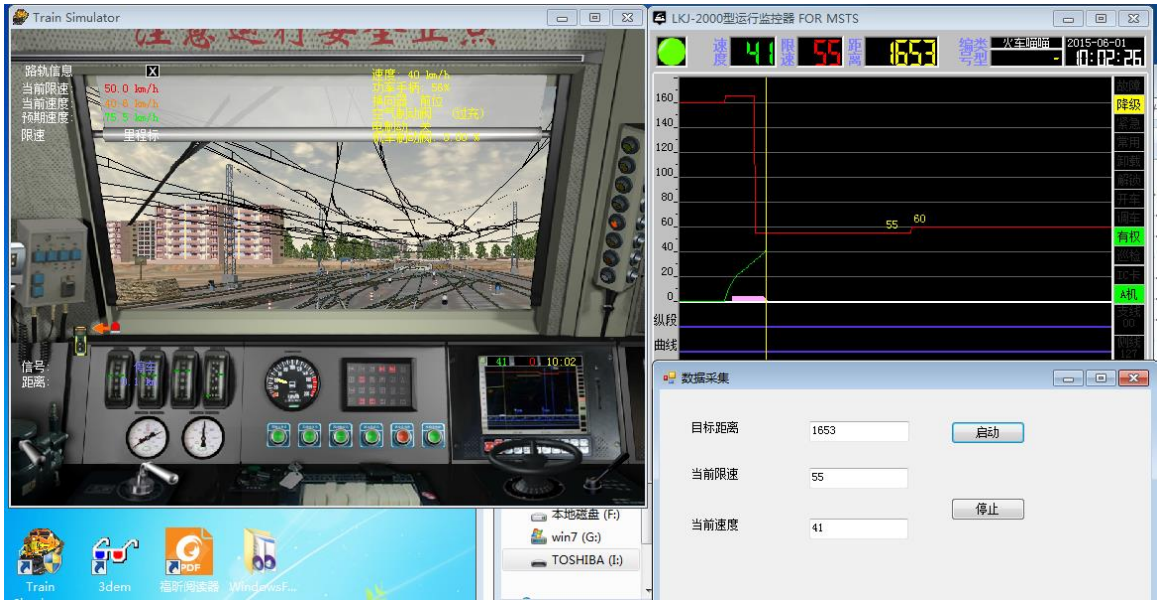

Fig.4: Result demonstration of normal operation

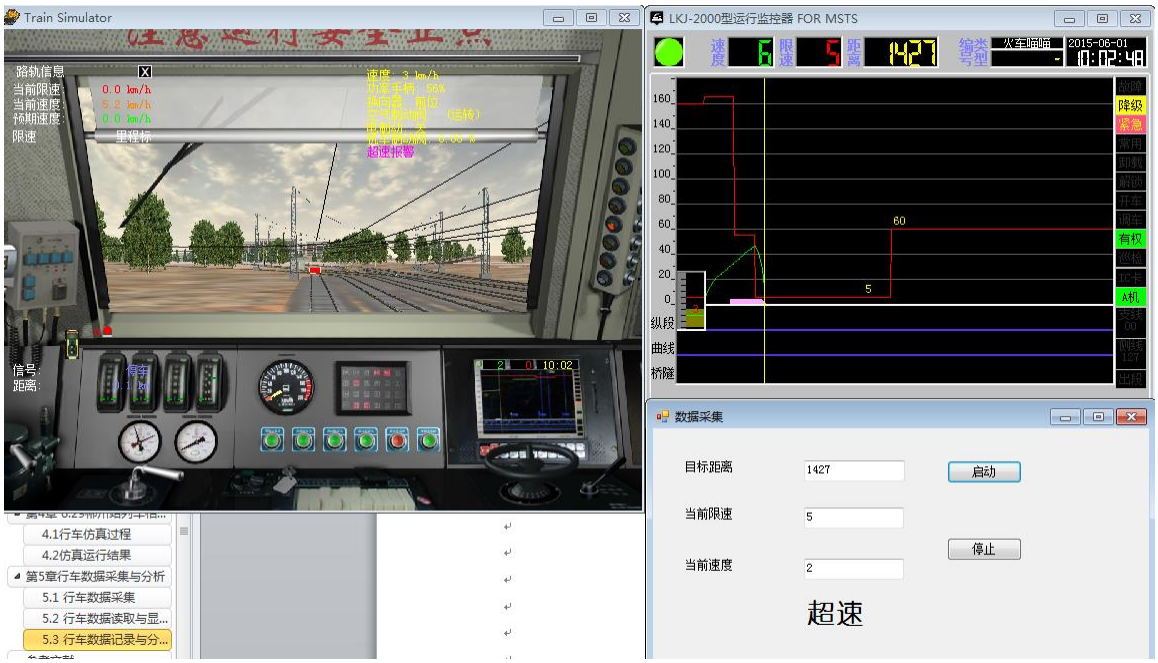

Fig.5: Result demonstration of overspeed operation

In this case, the speed-up is prompted by the fact that the program itself compares the read speed and the speed limit in real time. If the speed value is greater than the speed limit value, the word "overspeed" will be displayed. Otherwise (i.e., during normal operation) it will not be displayed, but only real-time traffic data will be displayed. Due to the limited research time, only the identification and prompt function of "overspeed" is designed here. In order to enrich more functions, it is necessary to

first determine the valuable driving data, then read the memory address of the required data according to the previous steps, and use the data acquisition system to read the data showing this address, so as to realize the storage, analysis and comparison of the specified data. The emphasis should be on the selection of driving data and the methods of recording and comparing the obtained data. The design of this example has similarities with the analysis of other driving data, and other overall design ideas can still follow the situation in this example.

5 CONCLUSION

This project is designed based on the AI monitoring concept, with the help of MSTS train simulation platform, which simulates the real scene of the train collision accident at Chenzhou Station on June 29, and records and analyzes the driving data during the running process. We used C# language in Visual Studio2010 to develop a Windows forms application that can carry out traffic analysis, and can read the data to save to the Access database file, giving an interactive analysis conclusion in real time, at the same time the saved data can also be used for future reference analysis. Although the specific function is still to be improved, the basic prototype of the AI rail transit accident analysis system is already available and can be used for simple traffic data recording and analysis. Besides "running speed" and "speed limit", other driving data can also be studied and analyzed in accordance with the idea of this topic.

References

[1] Naomi Dunn, Ann Williamson. Driving monotonous routes in a train simulator: the effect of task demand on driving performance and subjective experience[J]. Ergonomics, 2012, 55(9):997-1008

[2] LIU Zhi-qiang, WANG Peng, ZHANG Jian-hua, WANG Yang, GONG Biao. Review of Traffic Accident Reproduction Technology and Its Developing Trend[J]. China Safety Science Jorunal，2009, 17(4):11--18

[3] R Matthew Brach. Crush Energy and Planar Impact Mechanics for Accident Reconstruction[J]. Society of Automotive Engineers Technical Papers, 1998, (06):110-121

[4] Nicholas S Tumbas, J RollyKinney, Gregory C Smith. Photogrammetry and

Accident Reconstruction Experimental Result[J]. Society of Automotive Engineers Papers, 1994, (0925):1100-1105

[5] Anka de With, Pieter H. Wakker, Marcel L. F. Slootman. Melcor/Visor PWR Desktop Simulor for Accident Analysis and Training[C]. 17th International Conference on Nuclear Engineering, 2009, ICONE17-75881, 705-712

[6] Kwang-Sub Jeong, Ko-Ryo Kim, Won-Dae Jung, Jae-Joo Ha. Development of Severe Accident Management Advisory and Training Simulator[J]. Annals of Nuclear Energy, 2002, 29(17):2055-2069

[7] Okabe K, Yamagishi M, Yoshiki R, Miyake S. Development of a Severe Accident Simulator with a Visual Plant Behavior Display[J]. Transactions of the American Nuclear Society, 1989, 60, 434-435