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Analysis Experimental Intelligent Railway Level Crossing System

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***Abstract*- In recent years, in spite of increased population in the world, it is necessary to prefer railway travelling for passengers. Nowadays, rail-way crossing system are very important parts of railway systems. Uncontrolled railway crossing; it becomes very dangerous for car drivers; because of railway conditions and fast passing. This paper presents an investigation on intelligent railway and crossing design and analysis with intelligent sensor and control technology. Firstly, the prototype were designed with all instruments and conditions. Secondly; the prototype of system was set-up as designed conditions. The train system was tested with different working speeds. However, the system's vibrations were analyzed for different working speeds. On the other hand the closing and opening times were changed with different speeds of railway systems. A research framework on the development of Railway Level Crossing safety assessment model. Even though Railway Level Crossing accidents can be considered as a rare event, the impact is often severe. Since Railway Level Crossing safety systems are complex and dealing with at least two transport modes. The components of basic concept of safety engineering; engineering infrastructure, level crossing surrounding environment and human factors will be also considered in the model.**

***Keywords*-- rail-way level crossing, train system, vibration analysis**

I. INTRODUCTION

There are some research results that have been investigated by other researchers. Railway level crossing (RLC) accidents is one of the major contributing factors of railway related fatality problems in many countries. In Turkey, safety issues at RLC are very serious relative to those of developing countries. However, RLC accidents have continuously become a problem in railway industries in especially when it involved fatalities. RLC is considered as a unique intersection. The systems are complex and dealing with at least two mode of transport. Therefore collision between motor vehicles and trains is likely to happen at RLC and cause catastrophic consequences [1], [2].

Safety and the operational problems at RLC can be further classified into highway and railway.

The highway component comprises drivers, pedestrians, vehicles and roadway segments, whereas the train component is classified into train and track at crossing locations. The functions and characteristics of the two components and their corresponding elements represent the risk at RLC locations. Various studies have been conducted in many countries, based on a range of issues associated with safety level at RLC. Accident at RLC may be caused by a single factor or by the combination of many other factors. There is a growing realization of the need to consider contributory factors involved in accidents at RLC. Caird [3] has recommended that emphasis need to be focused on the multiple contributors to accident at RLC rather than looking at a single factor only. As in basic safety engineering studies; there are at least three basic contributing factors need to be considered. There are engineering infrastructure, level crossing surrounding environment and human factors. To address these issues, Caird discussed the angle and visibility aspects at RLC while other researchers studied factors associated with RLC due to familiarity, misjudgment and distraction. Additionally, the works of Caird [3], and Harwood [4] also argued the technical contributing factors related to the configuration and design of RLCs.

Various accident prediction equations and risk indexes were developed in order to cater for the problems at RLC. Study conducted by Saccomanno [5] revealed two basic perspectives of model developed in the United States during 1950 to 1970. These were absolute model and the relative risk model. The absolute models denote the expected number of collision at a given crossing for a given period of time as developed and the US Department of Transportation (USDOT). Meanwhile the hazard index yield the relative risk of one crossing compared to another. Several relative risk indices have been developed; the Mississippi Formula (1970), the New Hampshire Formula (1971), the Ohio Method (1959), the Wisconsin Method(1974), Contra Costa Country Method (1969), the Oregon Method (1956), The North Dakota Rating System(1965), The Idaho Formula(1964), the Utah Formula (1971) and the City of Detroit Formula (1971).

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The US DOT model was generally recognized as the industry standard. The analysis methods used range from Multiple Linear Regressions to techniques including special statistical distributions such as the Poisson and Negative Binomial distribution [6]. However, past data is vital for analysis purposes. The lack of data in some countries is a drawback of traditional approaches and leads to leave the problem of RLC untreated [7].

II. THE PROPOSED EXPERIMENTAL ANALYSIS

There is a continuing need to improve safety at Railway Level Crossings particularly those that do not have gates and lights regulating traffic flow. A number of Intelligent Transport System interventions have been proposed to improve drivers' awareness and reduce errors in detecting and responding appropriately at level crossings. However, as with other technologies, successful implementation and ultimately effectiveness rests with the acceptance of the technology by the end user.

The parameter considered will be categorized according to various factors. There are engineering infrastructure, level crossing surrounding environment and human factors as in Fig. 1.

In this section, design methodology development in assessing the level of risk at RLC locations is shown in Fig. 2. The purpose of the design is to give good background on real time systems. There are three phases involved in this modeling process. Firstly, model creation phase requires an understanding on the RLC operation, current practice and tools available for analysis.

The case study of this research will cover active types of RLC in Turkey. Therefore, the understanding of the overall concept of active types of RLC operations is needed. The basis of understanding of RLC operation obtained from the Turkish Standard. All instruments of the prototype system is drawn and outlined according to category as illustrated in Fig. 3. There are few studies using SPN and its extension dealing with safety study at RLC. By referring to the research gap, an improvement will be made in terms of the parameter consideration and categorization. The engineering infrastructure, level crossing surrounding environment and human factors will be the factors considered. The prototype of the rail way and intelligent crossing system is shown in Fig. 4.

The system was tested with different working speeds for analyzing vibration conditions of railway. However, the purpose of this analyze is to predict opening and closing time of bars of railway crossing system.

The proposed railway crossing system was tested with different operating speeds and points for performance and vibration analysis. For each test, four acceleration sensors having identical technical characteristics were used to analyze the system.

These sensors were firstly placed on the right side of the system taking the level crossing as the reference, and vibration data were obtained for three different speeds (low, average high). Then the acceleration sensors were placed on the left side of the system and, again, vibration data were obtained for three different speeds (see Figure 5). In both test groups, the acceleration sensors were placed on exactly opposing positions, just next to the level crossing, on the bend start, on the straight line and on the bend end. The results of these approaches were outlined in the Figures 6-8 for the case of right side of the system. The results indicates results of 4 sensors measurements. As can be seen from figure there is accelerations between 15 and 20 seconds.

On the right system, unlike in the left, the distance on the point where the rails unite where the second accelerometer was placed is slightly more. Therefore, higher vibration peak point values were obtained compared with the left system (see Figure 9). A switch line exists just next to where the third accelerometer is located in the right system. The results of these approaches were outlined in the Figures 10-12 for the case of left side of the system. The results indicates results of 4 sensors measurements. As can also be seen from figure there is accelerations between 15 and 20 seconds This resulted in higher, compared with the left system, peak values in all speeds. Besides, in all tests, the peak point values obtained from all vibration sensors increased in parallel with the increase of vibration frequency as velocity increased.

A complete tour time of the train for low, average and high speeds is 32.5, 18 and 13 seconds, respectively. The opening and closing times of the level crossing varies accordingly.

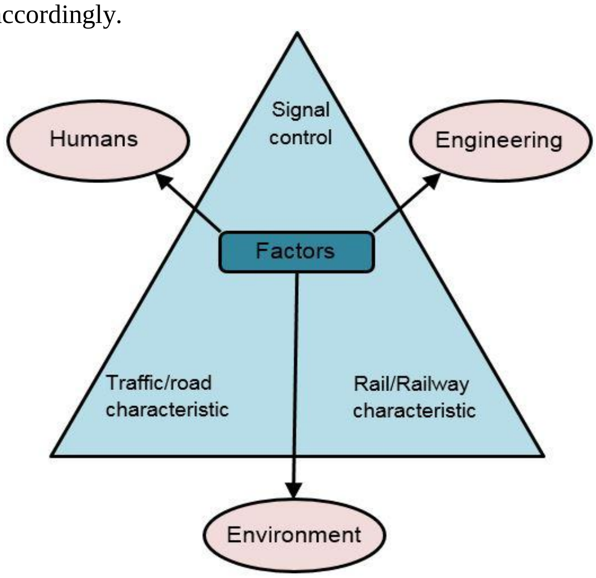

Fig. 1. The effects of railway crossing system. [8]

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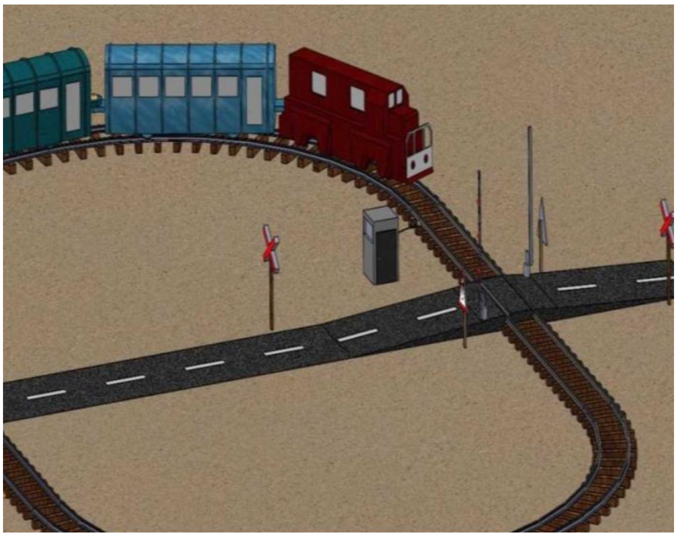

Fig. 2. Designed railway level crossing system.

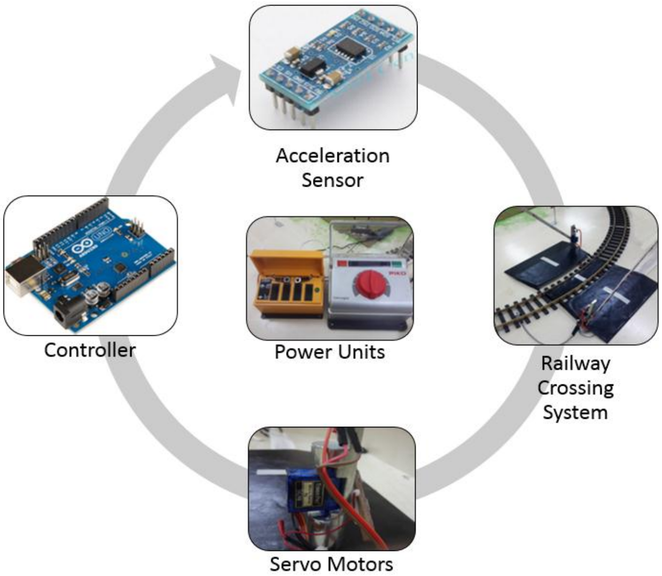

Fig. 3. Schematic representation experimental approach of railway level crossing system

Fig. 4. View of experimental set-up prototype

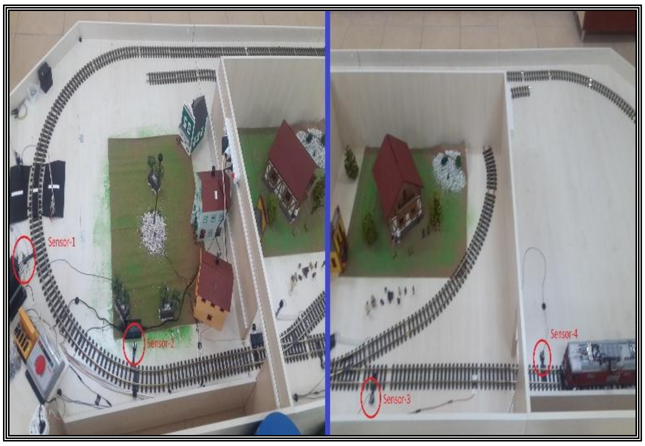

Fig. 5. View of vibration sensors on the right side of the system

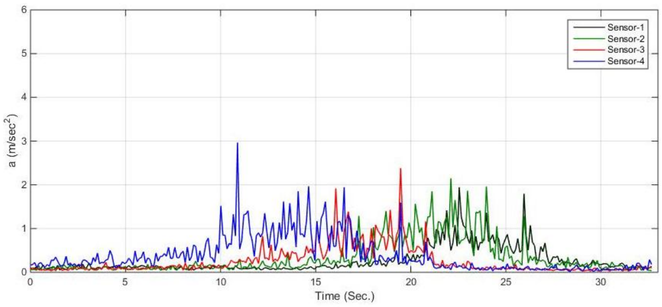

Fig. 6. Acceleration variation train system with 0,35 m/sec speed for right side

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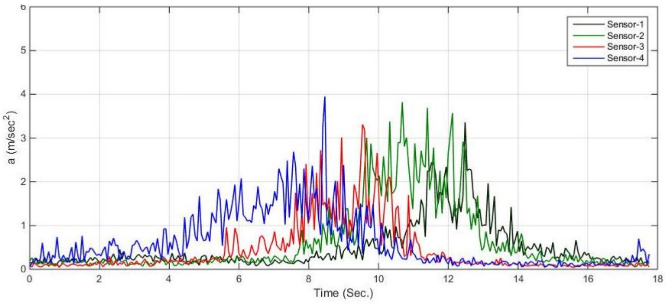

Fig. 7. Acceleration variation train system with 0,65 m/sec speed for right side

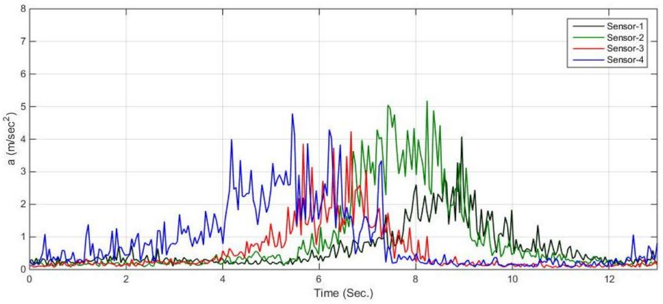

Fig. 8. Acceleration variation train system with 0,95 m/sec speed for right side

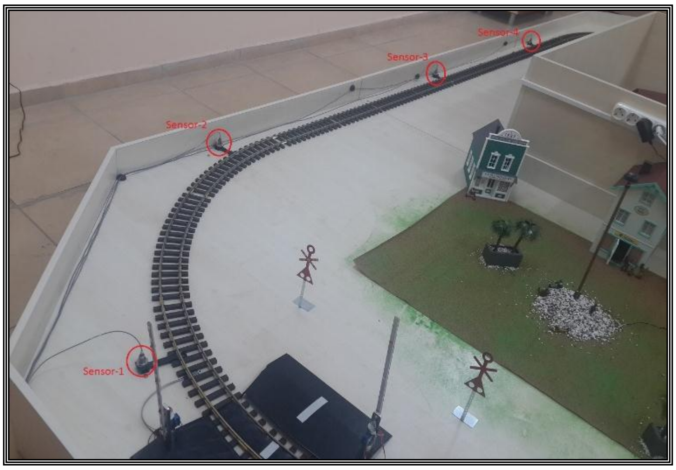

Fig. 9. View of vibration sensors on the left side of the system

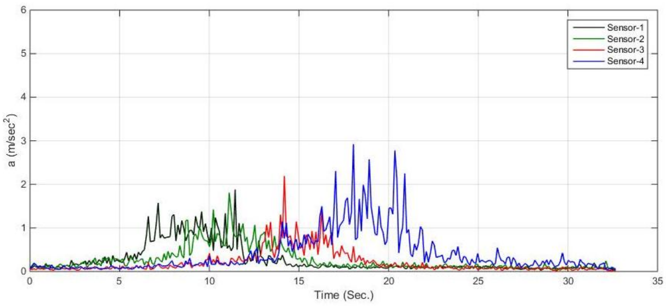

Fig. 10. Acceleration variation train system with 0,35 m/sec speed for left side

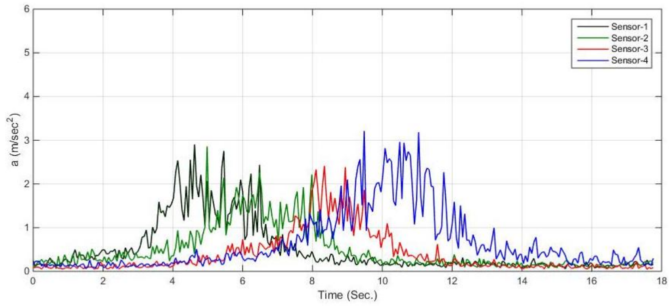

Fig. 11. Acceleration variation train system with 0,65 m/sec speed for left side

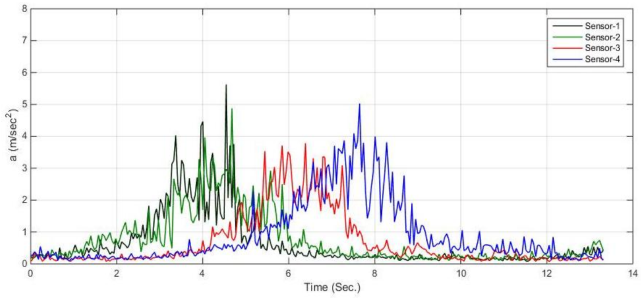

Fig. 12. Acceleration variation train system with 0,95 m/sec speed for left side

III. Conclusions And Discussion

In the world, in spite of advanced technology, railway level crossings (RLC) accidents and fatalities are still continuing and become the great concern in railway industries and passengers in especially when it involved fatalities. This paper describes an experimental prototype research framework in developing RLC safety systems specifically for Turkey's as a case study. The proposed research design in developing a risk index is outlined. The parameter considered will be justified during the model development stages. Since RLC safety systems is complex, the used of intelligent control approach in reliability safety engineering studies will be applied in order to have better understanding on the behavior of the systems. The components such as engineering infrastructure, level crossing surrounding environment and human factors considered in the prototype model can help in selecting a sound alternative for selected location for further improvements.

On the other hand, it is not easy and cheap to make real time experimental set-up for such systems.

The main motivation and purpose of this experimental work is to identify low-risk, low-cost, accidents and fatalities railway level crossings solutions.

In principle, there are a number of possible strategies for reducing crashes at railway level crossings. These include: Improving the conspicuity of the train, in order to increase the probability that the driver of the road vehicle will detect the train. Providing active control at the crossing, eliminating the need for a driver to make a decision. Providing some form of direct communication between the train and the road vehicle which would warn the driver of the approaching train. Improving crossing signing, markings and other forms of passive warning. Education, training or enforcement programs aimed at road vehicle drivers. Improving sight distance or reducing the speed of trains and/or road vehicles. Closing the crossing.

The future stage of this investigation will use a rail-way traffic simulation approach with behavioral models developed for evaluating the short-listed systems. The tools developed in this study will provide rail authorities and researchers with the means to evaluate railway level crossings protection systems to improve safety at level crossings.

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