

INTELLIGENT AGENT MODEL IN TRAFFIC

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Abstract: Improving business in railway companies involves the modernization of infrastructure and transport capacities in the service quality segment. Modernization has its advantages but also disadvantages that can be an obstacle in terms of employees' willingness to accept it. The solution lies in the application of advanced Internet technologies, where intelligent agents are created that can completely replace employees in the implementation of work tasks. In this way, the introduction of new digital e-business systems also involves the parallel application of innovative advanced Internet technologies that have the task of monitoring, controlling and implementing preventive measures. Intelligent agents based on computer systems and artificial intelligence have the task of improving the quality of service. This paper presents a model of an intelligent agent in railway transport, which increases safety and the quality of service itself.

Key words: Railway transport, quality of service, advanced internet technologies, intelligent agents, artificial intelligence

1. INTRODUCTION

Railway transport is a complex system that involves the transport of passengers and goods. In order for the railway to meet the needs of users safely and securely from point A to point B, it is necessary to apply modern available technologies where employees have less and less participation in business tasks. Intelligent agents have the ability, with the available computer infrastructure and network, to increase the quality of service in railway transport, which is based on artificial intelligence technologies. Artificial intelligence is the basis for the emergence of intelligent agents because it is currently the most current opportunity within advanced information technologies. Its application is increasingly represented in the implementation of business processes in all areas where computers connected to the Internet are used. In the professional literature, one can see a large number of works dealing with traffic regulation [1], locomotive power quality [2], and the application of advanced internet technologies [3], [4], [5].

This paper presents a model of an intelligent agent that can be implemented in railway transport in order to increase the quality of service.

2. RELATED RESEARCH

Traffic has always been a problem in our society. The increased number of cars on the roads has significantly increased traffic congestion, which pollutes the environment and causes stress and anxiety for commuters in traffic jams. The existing fixed traffic control system, although widely used, lacks adaptability and operates on predefined signal timers. The lack of adaptability can lead to inefficient traffic flow, especially during heavy traffic jams. To solve this problem, a more adaptable and intelligent system is proposed that uses adaptive timer control and gives priority to emergency vehicles such as ambulances [6].

With the rise of intelligent devices within industrial cyber-physical systems that include applications in traffic signal control, the vulnerability of devices such as in-vehicle and roadside units to data spoofing attacks is becoming a critical issue. Congestion attacks pose a significant threat to traffic safety, capable of causing traffic jams by manipulating traffic signal control methods in the Internet of Vehicles. One such method is the supervised phase optimization algorithm, which is susceptible to congestion attacks. An approach for security enhancement is proposed that integrates the advantages of actor and critic reinforcement learning with a long-term memory network. The paper extends the application of security enhancement methodologies to the context of intelligent traffic

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systems, which synchronously detect and remediate attacks, ensuring physical security and reliable operation [7].

There is an urgent need to maximize the efficiency of our transportation systems in light of the increasing rate of urbanization and traffic congestion. The goal of today's urban traffic management systems is to maximize the efficiency of the road network, and this is where real-time traffic signal control comes in. Managing a large, complex traffic network in real time poses a huge distributed control problem. Recent trends in transportation planning have reduced the importance of traffic signals, adding complexity to the operation of signaling systems. To ensure the smooth flow of traffic on roads and highways, the intelligent traffic management system of the intelligent transportation system faces the enormous challenge of optimizing traffic signals and other control devices [8].

With the rapid development of Internet of Things technology, intelligent traffic signal control systems have become an excellent way to improve traffic efficiency and safety. An intelligent traffic signal control system based on the basic theory of the Internet of Things is modeled. It introduces graph neural networks and principal component analysis to optimize performance. Numerical examples include the relationship between traffic flow prediction or signal control results in the sample library and traffic flows, the relationship with devices in the Internet of Things, the relationship with graph neural networks, and the relationship with the error of principal component analysis. It is found that the intelligent traffic signal control system based on the Internet of Things can more accurately predict traffic flow and optimize signal control using graph neural networks and principal component analysis. It works with the Internet of Things to realize intelligent traffic management [9].

Since 2010, the level of urbanization has gradually improved, the urban population has increased rapidly, vehicles, especially private cars, have also grown rapidly, roads have become increasingly congested, and road congestion has put enormous pressure on urban traffic. The multi-agent intelligent traffic control system consists of multiple autonomous agents, and the agents communicate and cooperate with each other, so that various problems caused by traffic flow changes in the intersection management strategy can be well solved, the traffic speed at the intersection can be improved to some extent, and the utilization rate of traffic road resources can be improved. It reduces traffic congestion, reduces energy consumption and exhaust pollution caused by road congestion, and shortens people's travel time [10].

The objective of the Intelligent Traffic Monitoring and Management System (ITMMS) is to enhance road safety through monitoring measures. It is one of the main building blocks of an advanced traffic management system. This system has the following built-in features such as a user-friendly human-machine interface, a dashboard for configuring, visualizing and analyzing traffic patterns, for monitoring and managing a network of adaptive traffic signal controllers installed at different intersections, a user management system, a centralized module for configuring junctions and remotely controlling traffic signals. It has monitoring functions in various visual formats such as trends, graphs, reports and live animation screens [11].

Large cities struggle with traffic congestion within their road network. Unfortunately, the current traffic control system does not ensure a smooth flow of traffic and has therefore been ineffective in addressing the above-mentioned issue. This is due to the fact that it operates solely on the basis of time intervals of one and a half to two minutes, which leads to an even distribution of flow times. However, equality does not always imply efficiency, as part of the allocated time can be lost due to the lack or low number of vehicles at an intersection. Furthermore, the roads rely heavily on a cash and paper-based toll collection process. This has, despite technological advances, resulted in long queues and a low level of transparency in toll collection. The research aims to develop an intelligent traffic management system based on an efficient (i.e., throughput and latency) traffic control algorithm with artificial intelligence to make dynamic, real-time decisions on traffic control and toll collection using data collected from appropriate sensors [12].

The main focus of the work is to solve the problem of traffic jams that arise at intersections with traffic lights. The aim of the work is to develop a project for an intelligent traffic management system that is able to control the flow of road transport under conditions of stochastic uncertainty. Basic information is given about modern automatic control systems for various types of automobile flows. A

conceptual model of the project for an intelligent traffic management system is proposed. The process of formalizing input and output data is shown on the example of one of the most common types of 4-way intersections. The practical significance of the work is reflected in the fact that the described system is able to provide real-time updates on the state of the roads [13].

Intelligent Traffic Management System (ITMS) is a sophisticated solution designed to address various challenges in urban traffic management. This comprehensive system uses state-of-the-art technologies to ensure helmet compliance, detect traffic signal violations, identify license plates, monitor mobile phone usage, and provide proximity-based alerts to police stations. The system can accurately identify individuals without helmets by applying computer vision algorithms. ITMS uses computer vision and machine learning techniques to detect traffic signal violations in addition to monitoring helmet compliance. The system can identify and record red light violations by analyzing live video from traffic cameras, allowing law enforcement agencies to issue appropriate penalties. Furthermore, ITMS includes a license plate recognition function that extracts license plate information using optical character recognition. This enables efficient and automated tracking of vehicle movements, enabling effective traffic surveillance and identification of vehicles involved in criminal activities [14].

The traffic system has a significant impact on the sustainable development of urban social economy and people's lives. At present, the traffic problem has become one of the major issues of concern to the government and the whole society. The application of GIS in the urban intelligent traffic management system is a breakthrough in the traffic management system. With the gradual maturity of the geographic multimedia information system, the application of the geographic multimedia information system to the urban intelligent traffic management information system and the urban traffic sharing information platform can enable the storage, organization and processing of multimedia information of the entire intelligent traffic management system through a common multimedia information platform, which can realize the unified management and updating of real-time traffic information, and more effectively ensure the accuracy and comprehensibility of data relationships, so as to avoid the redundancy of data relationships, and improve the utilization rate and transmission speed of multimedia information in the system [15].

Urban traffic congestion is becoming a serious problem. An intelligent traffic signal control system based on reinforcement learning can alleviate traffic congestion problems. However, when reinforcement learning faces complex multi-agent decision-making problems, it is difficult for single-agent learning algorithms to realize the complex relationships between multiple agents. Therefore, integrating reinforcement learning with multi-agent techniques in multiple ways becomes inevitable. Based on reinforcement learning, multi-agents obtain optimal regional strategies through continuous interaction and improvement. A new approach to regional intelligent traffic signal control is proposed that combines multi-agent techniques and deep learning with assistance. The method effectively reduces the average trip waiting time (ATWT) and total queue length (TQL) of vehicles in a region while performing better on the reward function compared with the deep network algorithm. The approach improves traffic efficiency and increases resource use efficiency while reducing congestion times, road utilization, and resource waste [16].

3. CREATING AN INNOVATIVE INTELLIGENT AGENT BASED ON ARTIFICIAL INTELLIGENCE

The application of advanced digital technologies, which are increasingly present in all business processes today, is in great development both in practical application and in specific computing environments. The development and application of innovative technologies has its own value, which can be reflected as a product or service that is created in controlled digital transactions.

The result of the application can provide, enable the functioning of the entire system in the business model. It is especially worth noting safety and security, which must be primary. The functioning of an intelligent agent in the example of railway transport can be realized by applying artificial intelligence. Basically, an innovative model of an intelligent agent based on artificial intelligence must include (figure 1):

- Architecture and Infrastructure,
- Algorithm Theory,
- Databases,
- Statistics,
- Software Engineering,
- Control Theory,
- Information Theory,
- Computer Graphics and Image Processing, and
- Computer Word Processing.

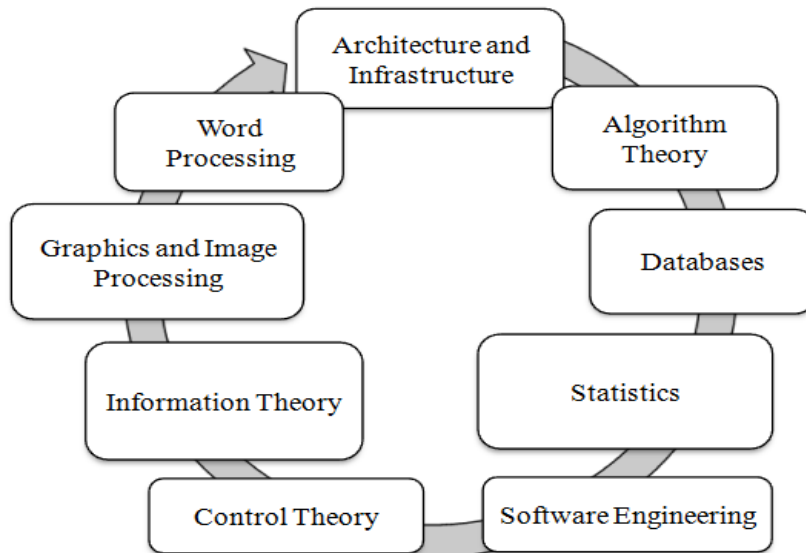


Figure 1 – Elements of an intelligent agent

Intelligent agents in this work on the example of traffic perform activities that are predefined. An intelligent agent is autonomous, receives information using sensors, acts in its environment and directs its activities towards achieving traffic regulation and safety.

- Expert systems and their structure determine the method of use and the area of application through a knowledge base and a conclusion mechanism. In this work, patterns related to railway traffic safety are acceptable.
- The database consists of all relevant collected regulations and instructions.
- Machine learning is directly connected to expert systems and the database where the intelligent agent analyzes the data it needs to accept and how it should react in order to increase safety.
- The next step includes an intelligent agent that, based on sensors and devices, collects information in the form of images that are analyzed in the further process. In order to determine the origin of the image, each mobile and fixed facility should be previously marked with a QR code containing all other relevant data
- Classification is a process that serves to detect irregularities and deficiencies based on a database, while prediction is related to statistics and probability.
- Sensors react to movement, movement and change when automatic marking is performed in the database. Collection and analysis refers to the currently newly created ones.
- An intelligent agent automatically marks and labels all potential problems related to the safety and security of rail transport.
- In the next step, the intelligent agent issues a recommendation and simultaneously sends the data to the database. The last step includes taking appropriate technical and preventive measures in order to prevent traffic accidents.

4. CONCLUSION

This paper presents an innovative model of an intelligent agent in railway transport based on artificial intelligence. The selected literature presents possible models that include the application of advanced internet technologies in each segment. Intelligent agents replace employees in the railway company and therefore their engagement is reduced or completely terminated. The presented model can completely improve the operations of the railway company and, in accordance with the modernization of infrastructure and train capacities, also affect the increase in the quality of service. It should be especially noted that railway companies have additional investments in terms of the necessary artificial intelligence to run the intelligent agent system, but the company already has an existing computer architecture and infrastructure that it applies in digital transactions of electronic business. Future research must be focused on the analysis of real needs in order to include other segments that can also affect the quality of service.

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