9th INTERNATIONAL CONFERENCE
''TOWARDS A HUMANE CITY''
Reshaping Mobility
Novi Sad 19th and 20th October 2023

Milica Miličić[1]
E-mail: mmilica@uns.ac.rs
Pavle Pitka[1]
E-mail: pitka@uns.ac.rs
Tatjana Kovačević[1]
E-mail: savkovic.t@uns.ac.rs
Milica Majstorović[1]
E-mail: milicamajstorovic@uns.ac.rs
Andrijana Jović[1]
E-mail: andrijana.jovic@uns.ac.rs
[1] Faculty of Technical Sciences in Novi Sad
Trg Dositeja Obradovića 6, 21000 Novi Sad

INTERNET OF THINGS (IOT) APPLICATION IN TRANSPORTATION

Keywords
Internet of things
Road transport
Logistics
Public transport

Abstract

Internet of things (IoT) enables the interconnection of the objects that surround us. The implementation of IoT-based technologies has led to great opportunities in technological progress for various aspects of people's lives. Solutions based on the IoT technologies application in the transport sector, which represents one of the most important prerequisites for the overall development of society, are particularly significant. The paper presents application of IoT technologies in the transport sector with the aim of introducing the reading public to current technologies that are applied to improve the transport sector. The application of smart sensors, collection and messaging tools in the transport environment are used like strategic means to improve transportation management. IoT technologies make it possible to avoid crowds, find parking spaces faster and reduce travel times. Also, the demands of users in the logistics chain are increasing, so accordingly, the application of IoT in smart cargo transportation, delivery and storage should respond to the rapid changes in customer expectations. There is a great impact of the IoT environment on the public transport system, so new frameworks of the intelligent public transport system are being developed accordingly.

1. INTRODUCTION

According to (Pretz, 2013), the Internet of things (IoT) is a network in which things are wirelessly connected through smart sensors. The IoT will increase internet ubiquity by integrating every object for interaction across embedded system, leading to highly distributed network of connected devices. In the next few years, the IoT technologies growth will be large and it is expected that over $125*10^9$ IoT devices will be connected [1]. Thanks to rapid progress in basic technologies, the IoT opens up enormous opportunities for a large number of new applications that promise to improve the quality of life [2].

Internet of things technology is different from traditional information technology because it includes a large number of digital devices with their complicated hardware and software components, but scientists believe that IoT makes our world smarter and more connected, which leads to drastic changes in lifestyle, way of working and learning [3]. IoT technologies have a great impact in various domains, including healthcare [4], education [5], transportation [6], smart cities [7], engineering [8], agriculture etc [9]. Due to the significant potential in innovation and benefits for the population, IoT technologies are assumed to be the key pillars of the fourth industrial revolution.

The very approach to solving problems in various areas, including transport, was greatly influenced by current technical achievements. Intelligent transportation systems help a lot to improve the transport process. In that area, there are certain IoT-based solutions in terms of data collection, processing and data transmission in the transport environment. In this way, some problems that are present every day in the transport sector should be improved, concerning traffic safety and congestion [10]. IoT technologies can also be used in the existing infrastructure to design and improve an efficient system of public passenger transportation [11]. In addition, IoT has great promising opportunities in solving certain complexities in the field of supply chains (long delivery times, interruptions in the raw materials supply, high operating costs, etc) [6].

The paper presents the IoT technologies application in the transport sector, analyzing the logistics areas, transport of goods and transport of passengers.

2. INTERNET OF THINGS (IOT) APPLICATION IN TRANSPORT SECTOR

In our daily life, we face many problems related to the transportation system. There are many challenges that need to be acted upon in various ways, and one of them is the application of Intelligent Transportation Systems in order to improve them, such as: managing traffic congestion, improving traffic safety, providing the data accessing in the transport environment, environmental protection, provision of financial resources, etc [12]. Adopting cutting-edge digital technologies such as IoT smart transportation, fleet management and more can provide a range of opportunities and productivity gains [13].

2.1. Internet of Things (IoT) in Road Transportation

In modern cars, as much as 30% of the total costs go to electronic components. This trend will be further enhanced when cars become capable of communicating and autonomously gathering information about their surroundings. For example, if there is a traffic jam, the cars at the beginning of the queue can inform the cars at the end of the queue if there is an accident, or they can notify about the congestion itself. The cars can help the driver keep a safe distance from the car in front, and can prevent dangerous actions like speeding if the weather conditions are unsafe or overtaking if the oncoming car is going too fast. Cars can enable autopilot driving on highways reducing the risk of driver fatigue as well as reducing the number of traffic accidents [14]. Furthermore, automotive industries have been established where there is a plan to use the new features of the Android platform to accelerate the adoption of the Internet of Vehicle (IoV) paradigm [15]. The IoT industry improves the functionality of ordinary cars. Smart cars integrated with IoT technology offer the same functionality as any regular car, in addition to improvising the features of a traditional car. Smart cars have sensors that register changes in the environment and provide real-time information about roads and traffic, thermostats to automatically adjust the temperature, child lock features and more. Figure 1. shows the transmission of vehicle information in real time [16].

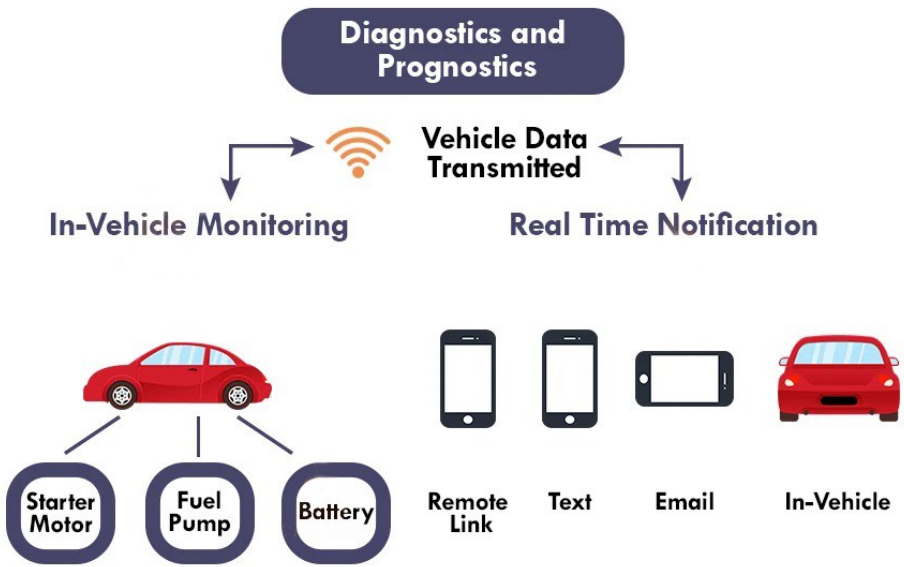

Figure 1. Vehicle information transmission in real time [16]

Shao (2019) [17] states that modern technology in road freight transport can provide accurate real-time information, tracking of goods as well as execution of routing

plans using IoT technology. In addition, it was discovered that IoT can be used to monitor environmental conditions such as humidity, gas concentration, and temperature, which ultimately helps in eliminating dangerous and unwanted situations and possible accidents.

2.2. Internet of Things (IoT) in Public Transportation

Within the framework of new information technologies, it is necessary to provide methods and advanced theories of management, which will be introduced and applied in public transport to overcome certain difficulties [18]. Many uncontrollable events or variations, such as extreme weather, fluctuating passenger flow, vehicle breakdowns, can cause dynamic changes in traffic conditions. Likewise, difficulties in controlling and managing system processes lead to failure in implementing established scheduling plans and resource allocation plans.

Kiriazis presented an IoT application related to public transport control that aims to use different resources such as environmental and traffic [19]. Zhang and Chen proposed an IoT-based on congestion index system in public transport, and their system can be used to evaluate the vehicle congestion status based on a wireless sensor network node [20]. Zheng introduced a developed intelligent public transport system with some application of IoT technology [21]. Du and Chen presented the design of a public transportation emergency management system, which uses IoT technologies to monitor traffic and critical transportation infrastructure on road networks and uses a geographic information system (GIS) to facilitate emergency operations [22]. Puiu presented an application for a public transport system that provides route recommendation and incident notifications to the user by real-time data processing [23].

2.3. Internet of Things (IoT) in Logistics

Modern logistics is based on information and communication technologies that support the implementation of business processes and enable the connection of users in supply chains. Technologies in this field have led to the existence of smart containers, pallets, packaging, forklifts, infrastructure, ports, terminals and other significant elements. The systems that are widely used in logistics are: RFID (Radio frequency identification), GPS (Global Positioning System) and WSN (Wireless Sensor Network). In addition, advanced technologies such as 4G and 5G networks are also used. According to [24], various parameters must be frequently monitored in logistics activities, which requires a large number of sensors.

The most significant effects of the IoT concept in the field of logistics are [25]: a) Real-time tracking of transport and transshipment vehicles, logistics units, goods and people; b) Resource performance measurement and planning according to the current state; c) Analysis of all data and information in order to analyze the current situation and identify opportunities for new business promotions. Automating business processes by eliminating manual work while improving quality and reducing

costs; d) Optimization of people, systems and resources and their coordination and integration.

3. CONCLUSION

The field of transport in the coming years is waiting for big changes. An increasing number of electric vehicles and vehicles powered by alternative fuel will be in use. The application of IoT technologies has found application in this area in the sphere of smart cars [26], infrastructure [27], autonomous vehicles [28], security [29], smart parking [30].

With the help of IoT technologies, certain negative external effects produced by traffic, such as congestion or traffic accidents, can be detected. The use of intelligent transportation systems, i.e. by collecting certain data in real time, accurate traffic estimations can be made. In addition, in freight transportation, the application of IoT technologies enables cost management, reduction of CO2 emissions, avoidance of congestion by using alternative routes, etc.

The current application of IoT technologies in the public passenger transportation system leads to a better service that the system provides to its passengers. Providing data for each bus line in real time that IoT technologies provide is of significant benefit to decision makers in this area as well as to passengers.

High speeds, low latency, greater coverage, lower power consumption and real-time execution of actions are essential factors for IoT implementations success. IoT is becoming the key to the future development of logistics because a major challenge for logistics is the visibility of the supply chain. Without good monitoring, condition or location information, goods will be lost.

ACKNOWLEDGMENT

This research has been supported by the project „Development and application of modern methods and technologies in education and research in traffic and transportation“, founded by the Department of Traffic Engineering, Faculty of Technical Sciences in Novi Sad, University of Novi Sad, Republic of Serbia.

REFERENCES

[1] Web source: https://www.techradar.com/news/rise-of-the-internet-of-things-iot

[2] F. Xia, L. T. Yang, L. Wang and A. Vine, “Internet of Things, School of Software, Dalian University of Technology”, International Journal of Communication Systems, Vol. 25, p. 1101-1102, Sep. 1. 2012.

[3] M. J. W. Lee, Guest Editorial: “Special section on learning through wearable technologies and the Internet of things”, IEEE Transactions on Learning Technologies, Vol. 9, pp. 301-303, Oct.-Dec. 2016.

[4] S. Salagare, R. Prasad, ”An overview of the internet of dental things: new frontier in advanced dentistry”, Wireless Pers. Commun.: An International Journal, Vol. 110, pp. 1345-1371, Feb. 2020.

[5] M. Kassab, J. F. DeFranco, and P. A. Laplante., “A systematic literature review on Internet of things in education: Benefits and challenges”, Journal of computer assisted learning, Vol. 36, pp. 115-127, Apr. 2020.

[6] N. Farquharson, J. Mageto and H. Makan, “Effect of internet of things on road freight industry”, Journal of Transport and Supply Chain Management, Vol. 15, pp. 11, Nov. 2021.

[7] K. Ahmad, H. Khujamatov, A. Lazarev, N. Usmanova, M. Alduailij, and M. Alduailij, “Internet of Things-Aided Intelligent Transport Systems in Smart Cities: Challenges, Opportunities, and Future”, Wireless Communications and Mobile Computing, Apr. 2023.

[8] A. A. Zaidan, B. B. Zaidan, “A review on intelligent process for smart home applications based on IoT: coherent taxonomy, motivation, open challenges, and recommendations”, Artif. Intel. Rev. Vol. 53, pp. 141-165, Jan. 2020.

[9] MS. Farooq, S. Riaz, A. Abid, T. Umer, YB. Zikria, “Role of iot technology in agriculture: A systematic literature review”, Vol. 9., p. 319, Feb. 2020.

[10] A. Thakur, R. Malekian, and D.C. Bogatinoska, “Internet of things based solutions for road safety and traffic management in intelligent transportation systems”. In ICT Innovations 2017: Data-Driven Innovation. 9th International Conference, ICT Innovations 2017, Skopje, Macedonia, Proceedings 9, Springer International Publishing, September 18-23, 2017, pp. 47-56.

[11] P. Patel, Z. Narmawala, and A. Thakkar, “A survey on intelligent transportation system using internet of things”, Emerging Research in Computing, Information, Communication and Applications: ERCICA 2018, Vol. 1, pp. 231-240, Jan. 2019.

[12] RB. Vaidya, S. Kulkarni, V. Didore, ”Intelligent transportation system using IOT: A Review”, Department of Computer Science and Information Technology, Vol. 6, pp. 80-87, Apr. 2022.

[13] Web source: https://www.biz4intellia.com/blog/how-iot-became-a-one-stop-solution-for transportation-industry/

[14] Internet of Things in 2020 a roadmap for the future", INFSO D.4 Networked Enterprise & RFID INFSO G.2 MICRO & Nanosystems in co-operation with the RFID Working Group of the EPOSS, 05 September, pp. 19-20.

[15] Open Auto Alliance. Web source: http://www.openautoalliance.net/ Accessed April 2016.

[16] Web source: https://techvidvan.com/tutorials/role-and-applications-of-iot-in-transportation/

[17] S. Shao, G. Xu, and M. Li, “The design of an IoT-based route optimization system: A smart product-service system (SPSS) approach”, Advanced Engineering Informatics, Vol. 42, p. 101006, Oct. 2019.

[18] X. Luo, H. Zhang, Z. Zhang, Y. Yu, K. Li, “A New Framework of Intelligent Public Transportation System Based on the Internet of Things”, IEEE Access Vol. 7, pp. 55290-55304, May 2019.

[19] D. Kyriazis, T. Varvarigou, D. White, A. Rossi, and J. Cooper, "Sustainable smart city IoT applications: Heat and electricity management & Eco-conscious cruise control for public transportation, IEEE 14th International Symposium on "A World of Wireless, Mobile and Multimedia Networks" (WoWMoM), pp. 1–5, June 2013.

[20] S. J. Zhang and S. Y. Chen, "Design & implementation of real-time broadcast system of urban public transport crowding index based on the Internet of Things," Adv. Mater. Res., Vol. 1049–1050, pp. 1753–1758, Oct. 2014.

[21] F. Zheng, S. Chen, J. Zhang, and F. Qiu, "Internet of Things technologies for urban public transport systems: A case application in Chengdu, China," in Proc. 5th Int. Conf. Transp. Eng., Amer. Soc. Civil Eng., 2015, 2015, no. Sep. 2015, pp. 513–519.

[22] P. Du, J. Chen, Z. Sun, and Y. Li, "Design of an IoT-GIS emergency management system for public road transport networks," in Proc. 1st ACM SIGSPATIAL Int. Workshop GIS Emergency Manage., 2015, 2015, no. Nov. 2015, pp. 1-4.

[23] D. Puiu, S. Bischof, B. Serbanescu, S. Nechifor, J. Parreira, and H. Schreiner, "A public transportation journey planner enabled by IoT data analytics," in Proc. 20th Conf. Innov. Clouds, Internet Netw. (ICIN), 2017, 2017, no. Mar. 2017, pp. 355–359.

[24] Discover Delivered by DHL (2/3/2020). 5G and what it means for logistics. DHL. https://discover.dhl.com/business/productivity/5g-and-logistics

[25] G. Radivojević, N. Bjelić, D. Popović, “Internet of things in logistics”, 3rd Logistics Internacional Conference, 25-27 May 2017, no. May 2017, pp. 185-190.

[26] R. Jain, M. K. Chakravarthi, P. K. Kumar, O. Hemakesavulu, E. Ramirez-Asis, G. Pelaez -Diaz, and R. Mahaveerakannan, “Internet of Things-based smart vehicles design of bio-inspired algorithms using artificial intelligence charging system”. Nonlinear Engineering, Vol. 11, pp. 582-589, Oct. 2022.

[27] A. A. Ouallane, A. Bahnasse, A. Bakali, and M. Talea, “Overview of road traffic management solutions based on IoT and AI”, Proceedings of Computer Science, Vol. 198, pp. 518-523, Jan. 2022.

[28] K. Dev, Y. Xiao, TR Gadekallu, JM Corchado, G. Han, and M. Magarini, “Guest Editorial Special Issue on Green Communication and Networking for Connected and Autonomous Vehicles”, IEEE Transactions on Green Communications and Networking, Vol. 6, pp. 1260-1266, Sep. 2022.

[29] R. Hasan, and R. Hasan, “Pedestrian safety using the Internet of Things and sensors: Issues, challenges, and open problems”, Future Generation Computer Systems, Vol. 134, pp. 187-2013, Apr. 2022.

[30] L. F, Luque -Vega, D. A. Michel-Torres, E. Lopez- Neri, M. A. Carlos-Mancilla, L. E. Gonzalez-Jimenez, “IoT smart parking system based on the visual-aided smart vehicle presence sensor: SPIN-V”, Sensors 20 (5). Article number 1476.Vol. 20, Mar. 2020.