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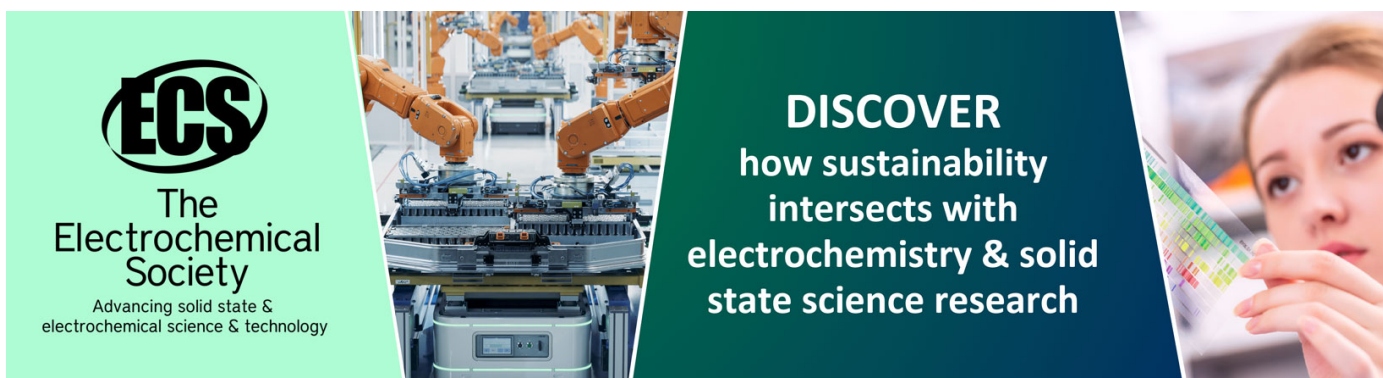
Systems for intelligent parking of trucks at motorway rest areas as part of Construction 4.0

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Systems for intelligent parking of trucks at motorway rest areas as part of Construction 4.0

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Abstract. The Road and Motorway Directorate of the Czech Republic is introducing a system of smart truck parking at motorway rest areas. Thanks to the use of detection technologies in the place of rest and connection with NDIC, where traffic information is collected and processed, it is possible to include this technology in the Construction 4.0 concept. The subject of this article is a brief description of these systems, including examples of use. With the help of SWOT analysis, the strengths and weaknesses, respectively opportunities and threats of these systems will be identified with the help of experts.

1. Introduction

Anyone who has ever been frustrated driving a car in search of a parking space would like to find a seat quickly. A possible solution is to streamline intelligent parking processes through wireless monitoring and interconnection devices and the Internet of Things (IoT). In the form of Construction 4.0, this information is one of the possible bases for the effective expansion of the rest network on the basis of data on their use.

2. Construction 4.0

Digital and technological innovations, which have been developing rapidly in recent years, are often referred to as the 4th Industrial Revolution or Industry 4.0. It seems as if the construction industry is standing aside. A big topic is BIM (Building Information Modeling), but this is only one of the components of the considered Construction 4.0. Other topics, if they are not completely neglected, are minimally delayed. Nevertheless, it is important to address them. These include virtual and augmented reality, 3D printers, advanced building materials, prefabricated and modular designs, Big data and predictive analytics, 3D scanning and photogrammetry, autonomous vehicles and drones, cloud collaboration (real-time collaboration), the Internet of Things or wireless monitoring and interconnection devices. [1]

3. Internet of Things

Internet of Things as a part of Construction 4.0 consisted of:

Intelligent transport: With the help of sensors built into vehicles or mobile devices and devices installed in the city, it is possible to offer optimized route designs, easy parking reservations, economical street lighting, telematics for public transport, accident prevention and autonomous driving. [2]



Environmental monitoring: Wireless sensors create the perfect infrastructure for a wide range of environmental monitoring. Barometers, humidity sensors or ultrasonic wind sensors can help create advanced weather stations that can make it easier to monitor the weather for planning work on them. [2, 3]

Logistics and supply chain management: With intelligent RFID tags, machines or goods can be easily tracked from production to import to the construction site, which can reduce costs and time. Information from sensors reduces the risk of a critical phase of a construction project, prevents project delays and is a catalyst for leaner modes of operation. Any downtime from an occasional inventory provider or employee performance failure is expensive for construction companies. There is no depletion of resources or depletion of resources and employees would like help. [2, 4, 5]

Security and surveillance systems: Smart cameras can gain video input through the streets. With real-time visual object recognition, intelligent safety systems can identify suspects on the construction site or prevent dangerous situations. If an emergency situation occurs on a construction site, the foreman or general contractor does not have a precise way to evacuate the number of people present on the construction site. With Internet of Things on the construction site, the contractor monitors people on the spot at room level to create the task of rescuers. [2, 6]



Figure 1. Internet of Things in Construction [7]

Starting with increased security and reduced operating costs, IoT promises several ways to improve key phases of the construction plan and also reduce overall project delays. Intelligent construction sites, connected devices and sensors can control new and more efficient and safer methods of work (Figure 1). [2]

4. Smart truck parking system for highway rest areas

The aim of the intelligent parking project is to develop services focused on heavy goods vehicles that assess the needs and conditions of organizing and directing road traffic in the Czech Republic. The project aims to provide real-time quality information for truck drivers. The basis is the collection of relevant data, their processing, subsequent creation of information and its dissemination through the National Traffic Information Center (NDIC). [8, 9]

5. The principle of operation of the system of smart parking of trucks at highway rest areas

An integrated wireless sensor is located in the asphalt pavement in the parking place. An example of what the built-in sensor looks like is shown in Figure 2.



Figure 2. Built-in sensor [10]

The sensor detects whether the parking space is occupied or not and transmits this information. This is captured by a repeater and passed information to the gateway, which serves as an interconnection of the physical parking space infrastructure with information and communication technologies - NDIC. There, this information is processed and evaluated [8, 9]. The data collection scheme is shown in Figure 3.



Figure 3. Data collection scheme [10]

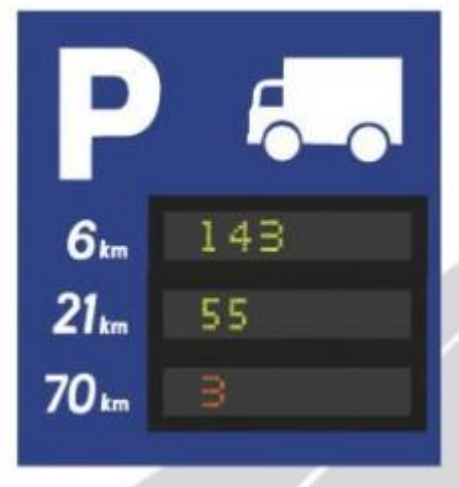


Figure 4. Information boards [10]

The current numbers of vacancies are displayed on information boards (Figure 4) or in the mobile application [11].

Drivers can see in advance on the information board how many free parking spaces are available at the nearest rest areas and can thus better plan where to park.

6. SWOT analysis

The possibilities and possible problems of intelligent parking systems in relation to SWOT analysis were discussed with other experts. The following information was determined on the basis of a survey. In addition, a search of previously published articles was also performed.

6.1. Strengths and opportunities

- The system can detect blocking vehicles or even driving in the opposite direction [12]
- Individual mandatory breaks can also be better planned for drivers based on the current occupancy of the motorway rest area [12]
- Possibility to obtain data on the occupancy of individual rests for effective planning of their development and expansion [13]
- Reduction of the frequency of parking and parking of vehicles during forced breaks in places not primarily intended for this purpose (safety bays, connecting and turning lanes, etc.) [14]
- In the case of the use of RFID tags (high frequency identification) in vehicles and in the intelligent parking system, it is easier to find a stolen vehicle [15, 16]
- Possibility of visual surveillance of the car park and detection of long-standing vehicles, which block the possibility of short-term rest for other drivers (Figure 5) [12]
- Ability to monitor unauthorized parking in places not reserved for parking or charging stations for electric vehicles
- The Tinynode B4-H sensor has a battery life of 10 years and a degree of protection IP68. It is therefore perfectly suitable for outdoor installations, as it can withstand adverse weather conditions or when transporting heavy trucks. [17]

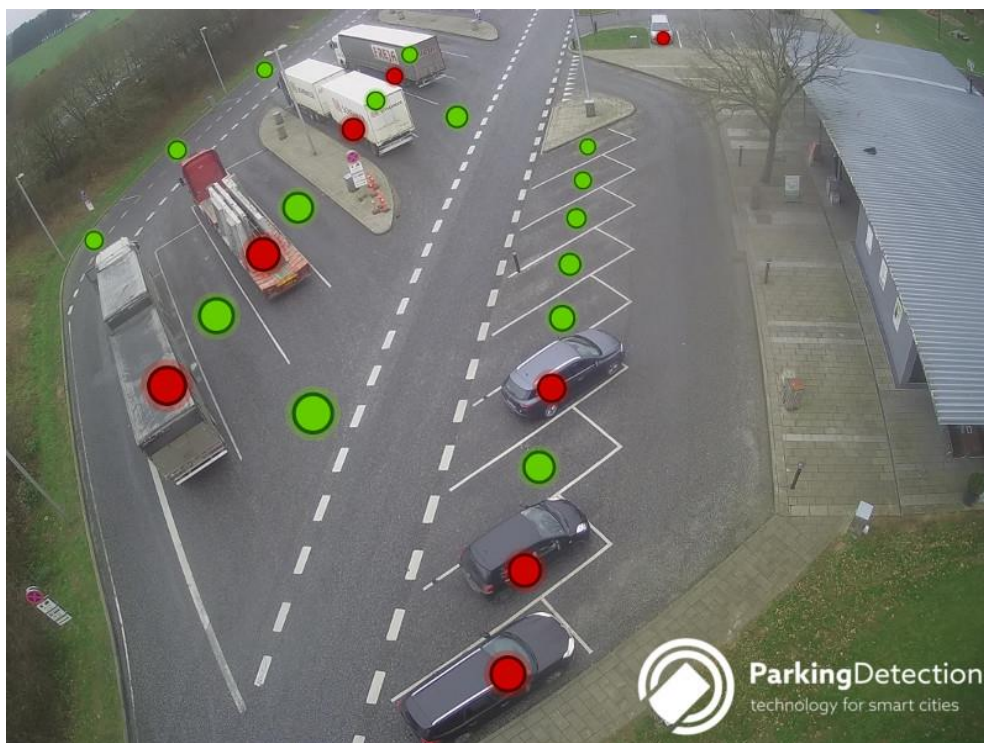


Figure 5. Visual supervision of the car park [18]

6.2. Weaknesses and threats

- Insufficient capacity of parking spaces for trucks. If all parking spaces are occupied at the nearest rest areas, then such a system is unnecessary

- Parking at rest areas is free, and therefore there is no direct return on investment compared to a paid parking lot, for example in the city [11]

7. Conclusion

At present, systems for intelligent parking of trucks at motorway rest areas are already being implemented. However, it will take some time for these systems to be extended to all rest areas. The administrator of motorways in the Czech Republic, the Directorate of Roads and Motorways of the Czech Republic, is preparing to install these systems or has recently implemented them, for example, at motorway rest areas on the D1 Střechov and Mikulášov, or on the D35 motorway at the Dolní Roveň rest area.

The capacities of parking spaces also play an important role in the use of these systems. At present, due to the lack of parking spaces for trucks, the system is still difficult to use to the full extent intended. However, the planned expansion of rests also includes the installation of these systems, which should lead to the fulfillment of the primary function of this system. Even so, this system will play an important role in Construction 4.0 in terms of obtaining data on the real current load of highway rests.

Acknowledgments

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References

- [1] P. Krupik, Construction 4.0 With A Focus On Transport Construction [online]. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM Volume 2020-August, Issue 5.2, 127-134, 2020. ISSN 13142704. doi:10.5593/sgem2020/5.2/s21.084.
- [2] Z. Fotios, G. Koulouras, S. Karabetsos, and D. Kandris. A Review of Machine Learning and IoT in Smart Transportation. Future Internet [online] 11(4), 2019. ISSN 1999-5903. doi:10.3390/fi11040094
- [3] K. Incki, and I. Ari. Model-Based Runtime Monitoring of Smart City Systems. Procedia Computer Science [online] 134, 75-82, 2018. ISSN 18770509. doi:10.1016/j.procs.2018.07.146.
- [4] F. Hossein, M. Fotuhi-Firuzabad, and M. Moeini-Aghaie. Reliability Studies of Modern Distribution Systems Integrated With Renewable Generation and Parking Lots. IEEE Transactions on Sustainable Energy [online] 8(1), 431-440, 2017. ISSN 1949-3029. doi:10.1109/TSTE.2016.2598365.
- [5] A. Correa, G. Boquet, A. Morell, and J. L. Vicario. Autonomous Car Parking System through a Cooperative Vehicular Positioning Network. Sensors [online]. 2017, 17(4). ISSN 1424-8220. doi:10.3390/s17040848.
- [6] A. Yacine, J. Ding, and M. A. Jeusfeld. Internet of Things Approach to Cloud-based Smart Car Parking. Procedia Computer Science [online] 98, 193-198, 2016. ISSN 18770509. Available online: doi:10.1016/j.procs.2016.09.031.
- [7] R. Agarwal. Applications and Benefits of Internet of Things (IoT) in Construction. In: Technology Research Compiling the knowledge and research acquired different Technology Solutions. [Online] 2018. Available at: <https://iotresearchdotblog.wordpress.com/2018/07/04/applications-and-benefits-of-internet-of-things-iot-in-construction/>.
- [8] Its-knihovna.cz, Poskytování dopravních, cestovních informací a dalších souvisejících služeb řidičům nákladních, užitkových vozidel a dopravcům. ITS KNIHOVNA [online]. Available at: <https://www.its-knihovna.cz/cz/projektove-karty-a-zamery/poskytovani-dopravnich,-cestovnich-informaci-a-dalsich-souvisejicich-sluzeb-ridicum-nakladnich,-uzit> (in Czech).

- [9] TÝC, Filip. Chytré parkování kamionů – URSA Czech Republic [online]. Litoměřice, 2009. Available at: http://forumusteckykras.cz/gis-outdoor/wp-content/uploads/3a_Tyc.pdf (in Czech).
- [10] Strategie Smart City města Pardubice. In: *Pardubice* [online]. Available online: <https://www.pardubice.eu/urad/radnice/zastupitelstvo/zapisy-z-jednani/2018/zapis-z-xl-zasedani-zmp-dne-22-03-2018/?file=39944&page=4454778&do=download> (in Czech).
- [11] J.I., Zhanlin, I. GANCHEV, M. O'DROMA, Z. Li, and Z.A. Xueji. A Cloud-Based Car Parking Middleware for IoT-Based Smart Cities: Design and Implementation. *Sensors* [online]. 14(12), 22372-22393, 2014. ISSN 1424-8220. doi:10.3390/s141222372.
- [12] ParkingDetection.com, Parking detection hledá volná místa na odpočívkách: Efektivní monitorování dálničních parkovišť [online]. Available at: <https://www.parkingdetection.com/cs/parkingdetection-dalnicni-odpocivky/> (in Czech).
- [13] Chytré uliční parkování je základem chytrého města [online]. Available at: <https://www.cdv.cz/file/vice-o-nabidce-chytreho-parkovani/> (in Czech).
- [14] M.Y.I. Idris, Y.Y. Leng, E.M. Tamil, N.M. Noor and Z. Razak. Car Park System: A Review of Smart Parking System and its Technology. *Information Technology Journal* [online] 8(2), 101-113, 2009. ISSN 18125638. doi:10.3923/itj.2009.101.113.
- [15] K. Gandhi, and M. Baratam. A Prototype for IoT based Car Parking Management system for Smart cities. *Indian Journal of Science and Technology* [online] 9(17), 2016. ISSN 0974-5645. doi:10.17485/ijst/2016/v9i17/92973.
- [16] T.N. Pham, T. Ming-Fong, D.B. Nguyen, D. Chyi-Ren, and D. Der-Jiunn. A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies. *IEEE Access* [online] 3, 1581-1591, 2015. ISSN 2169-3536. doi:10.1109/ACCESS.2015.2477299.
- [17] Tinynode A4 and B4 sensors: Product brochure [Online] 2020 Available at: https://www.pdxeng.ch/wp-content/uploads/2020/09/Tinynode_A4-and-B4-product-brochure_2020.pdf.
- [18] ParkingDetection hledá volná místa na odpočívkách: Efektivní monitorování dálničních parkovišť. In: *ParkingDetection technology for smart cities* [Online] 2018. Available at: <https://www.parkingdetection.com/wp-content/uploads/2018/12/hylkedal.jpg> (in Czech).