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Professional paper

APPLICATION OF ARTIFICIAL INTELLIGENCE WITHIN THE „SAFE CITY“ CONCEPT

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Abstract

Urbanization is a global trend, that is, the settlement of cities because of all the possibilities they offer. A large influx of population into cities also requires an increase in security. Safe City is a concept that, using modern technologies and artificial intelligence, should help governments, communities and businesses to reduce the possibility of crime and create an environment where people feel safe and comfortable. The aim of the paper is to present the possibility of using modern technologies and artificial intelligence in order to increase the safety of city dwellers. The paper explains the analytical tools that can be used within the Safe City concept, which aim to increase safety, prevention and rapid response to emergencies.

Keywords: *Safe city, Artificial intelligence, Smart city, Safety*

INTRODUCTION

A safe city is a concept based on the idea of increasing the safety and security of the inhabitants of a city by using various technologies. Today, some 56% of the world's population – 4.4 billion inhabitants – live in cities. This trend is expected to continue, with the urban population more than doubling its current size by 2050, at which point nearly 7 of 10 people will live in cities [15].

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Enormous urbanization, a large influx of people into cities, creates an environment that is vulnerable and subject to various influences. Migrant crisis, conflicts at many points in the world, thefts, and physical conflicts are just some of the examples that create a feeling of insecurity in people. Therefore, a concept is needed that will improve the safety and security of citizens.

We are witnessing the great rise of technologies and artificial intelligence. It is necessary to take advantage of the opportunity that this growth provides to facilitate people's daily lives, to make them feel comfortable and safe in their daily duties. The development of technologies should also be used in order to improve ecology, that is, to improve the environment and reduce negative effects on the planet, preserve nature and create healthier surroundings.

A comprehensive approach to security in the urban environment that includes technology, infrastructure, critical situations management, cooperation between different actors and a focus on preventive measures and education of citizens is presented as the Safe City concept.

The concept of a Smart City was heard for the first time at the end of the 60s of the last century. However, it was not until 2010 that the rapid development of the Smart City concept began. One of the basic and most important parts of the concept is the Safe City. The primary goal is to create a safe and secure environment that helps prevent and respond to potential threats and emergencies.

The Safe City concept is permeated by a combination of new technologies, artificial intelligence and the human factor. Advances in digital technologies, data collection and artificial intelligence have made it possible to collect and use data obtained from cameras placed in public areas, drone footage, sensor information and access control. The data obtained in this way provide great opportunities for analyzing the movement and behavior of people in the city and the possibility of predicting unwanted events. The concept of 'smart' cities is to create a better, more sustainable city where the quality of life for people is improved, the environment in which they live is of higher quality, and their economic prosperity is increased, all with the assistance of modern technologies [1]. The challenges of climate change, population growth, demographic change, urbanisation and resource depletion mean that the world's great cities need to adapt to survive and thrive over the coming decades [16].

As mentioned earlier, the Safe City concept relies, above all, on the possibilities offered by artificial intelligence.

The development of the artificial intelligence system is directly related to the development of neural networks and expert systems. Expert systems are constructed with the aim of simulating human thinking through symbols, while neural networks strive to achieve this from a biological perspective, approaching the structure of the human brain with the help of genetic algorithms. Neural networks are used both in complex security systems, and in industrial plants, and in improving the quality of life by the appliances that almost the entire humanity uses in everyday life [2]. In multilayer neural networks, we apply the decision-making functions to recognition problems of multiclass patterns, regardless of whether classes are separable or not. These networks consist multiple layers of perceptron computing elements [3].

The most commonly used artificial intelligence applications in the Safe City concept are automatic license plate recognition (ALPR) and face recognition (FR-Face recognition). Evolving secure cities necessitates the integration of facial recognition systems, ANPR technology, and urban management systems to efficiently govern urban safety [4].



Application of artificial intelligence in "Safe city"

The ALPR algorithm represents a vehicle license plate recognition technology. The license plate recognition algorithm works by recognizing the region of interest (identifying the part of the image that contains the vehicle's license plate by applying the technique of edge detection, color segmentation or applying predefined license plate shapes). After determining the zone of interest, the algorithm detects characters (numbers and letters), then analyzes each character and determines its value, whether by comparing it with already defined templates or using machine learning for character recognition and classification. Finally, the algorithm reconstructs the recognized characters in the form of a license plate.

This type of algorithm is used in traffic control systems, parking lot controls, automated road toll systems, and other applications that require automatic license plate detection. This technology significantly helps improve efficiency and security, and reduce human error in the vehicle identification process. ANPR technology is crucial for identifying vehicles associated with criminal activities in urban environments [5].

The installation of cameras on access roads provides the possibility of detecting the license plates of vehicles entering or leaving the city. The installation of such cameras in the city provides the possibility of monitoring the trajectory of vehicles and a detailed review of the movement of vehicles through the city. Additionally, if there is a search for a vehicle, advanced analytical tools provide the possibility of detecting the requested vehicle in real time. If we put the vehicle on the Black List, every appearance of the vehicle in the city will activate an alarm, which will provide information to the dispatcher about the location of the detection of the requested vehicle.

The system offers the possibility of searching for vehicles by certain criteria such as vehicle type, vehicle brand, or color.

Driving in the opposite direction is something that has become more and more common. Such systems provide the possibility of detecting movement like that, and with the installation of signs on the roadside or connecting the system with information systems, it is possible to provide information to traffic participants to be careful, and the police to react quickly and prevent unwanted consequences.

Systems that are part of the Safe City concept provide the possibility of detecting traffic violations. Namely, the system enables the automatic detection of traffic violations such as running a red light or exceeding the speed limit, not wearing a seat belt, not letting pedestrians at a pedestrian crossing, driving on a yellow lane, entering a zone where it is not allowed, illegal parking, and detection of unregistered vehicles of participants in traffic.

We have witnessed that today, while driving, you will find a large number of people driving a car and using a mobile phone. This concept allows the system to recognize the use of the phone and let the careless driver know that such behavior in traffic is not allowed, either through smart signaling or through traffic lights.

In addition to the LPR algorithm, such systems, in countries where it is legally regulated, offer the possibility of using algorithms for detection and recognition of faces.

The introduction of facial recognition technology into urban security brings new challenges



and opportunities for effective management of public spaces [6]. The Face Recognition (FR) algorithm is a technology used to recognize and identify faces in photos or videos. The facial recognition algorithm relies on a combination of computer vision, machine learning and image analysis to identify facial features and compare them to a database of faces. It works by first detecting a face in an image or video using Haar-cascade or deep learning method. After face detection, the algorithm extracts characteristic points, which can be represented as vectors or descriptors that describe the patterns present on the face. Once the facial features are extracted, the algorithm compares the detected features with facial features previously entered into a database. Matching is done either by comparing character feature vectors or using machine learning methods, such as neural networks. Finally, identification or verification of the detected person is carried out. Face recognition through neural networks enables sophisticated identification of individuals in urban environments [7]. There is a wide spectrum of use of this algorithm in increasing the security of the city. . A case study of City X demonstrates that the implementation of facial recognition systems contributes to the reduction of thefts and incidents in public spaces [8].

Placing cameras at the entrances to sports facilities, such as stadiums or sports halls, is a key step in improving security and controlling access to these locations. This not only enables the detection of persons who are banned from entering, but also provides the possibility of identifying persons who are marked as a potential threat. Cameras can also be installed in other public places such as airports, bus and train stations, shopping centers, where it is necessary to monitor the movement of a large number of people.

These cameras are essential for identifying blacklists of terrorists or criminals. When these persons are identified at the entrance to a public facility, information about their presence is immediately sent to the competent authorities or security personnel. Placing these persons on black lists enables continuous monitoring of their activities and helps prevent re-entry into facilities where they would pose a risk to security and public order. In addition to security information, video surveillance can provide valuable information for analyzing mall operations and planning staffing, scheduling, and marketing activities.

Photographs of faces that are more than 20 years old do not pose a challenge for this type of algorithm, since these algorithms demonstrate the ability to successfully identify a face, independent of the temporal age of the image.

By connecting such systems with relevant records and databases, such as Records in the area of issuing personal documents, Records of persons and events related to sports events, Records in the area of border control, movement and residence of foreigners and asylum, Operational criminal records, Records of data on terrorism and organized crime, Records in the field of road traffic safety, [17]. as well as the creation of databases on missing persons and stolen vehicles, it is possible to obtain real-time information on persons involved in an incident, offense or being searched for. This kind of integrated approach can be crucial in the quick response of competent authorities and efficient management of security situations.

Implementation of face recognition and ANPR systems requires strict regulations on data protection and misuse penalties to contribute to citizen trust in institutions [9].

In addition to these two algorithms, which are the most widely used and which represent the basis of the concept, there are other algorithms that influence the maintenance of discipline and increase the safety of participants both in traffic and at gatherings in public spaces. Such systems enable the detection of many deviations from normal behavior. Placing cameras in



city squares, in cultural centers, on promenades, halls, and museums provide the possibility of detecting unusual behavior.

In this regard, there are several types of analytical tools used throughout video surveillance systems:

1. Behavior analysis, i.e. analysis of events in the surveillance camera area:
 - a. Intrusion detection - used to identify unauthorized entry or activity in a certain area that is in the surveillance camera zone. In other words, when a suspicious movement or entry is detected within a defined zone, the system can automatically generate an alert
 - b. Detection of abandoned objects and objects removed to a marked zone - every time an object is left or removed from the marked zone of interest, the system will generate an alarm
 - c. Crowd detection - by marking the zone of interest, it is possible to monitor and detect crowds. Defining the occupancy of a zone allows the system to generate an alarm and a warning when the occupancy of a zone increases;
 - d. Detection of aimless movement is an extremely useful analytical tool that can be crucial in maintaining safety and preventing potential incidents. Tracking people without a specific target near important infrastructural and institutional facilities or business centers can reveal potential threats such as terrorist attacks, thefts or vandalism. In this way, persons who may pose a risk of unauthorized access or attempted burglary can also be detected.
2. Video search – it is used to search for video material in a certain zone or direction of movement according to the given criteria: by type of object, i.e. whether it is a person or a vehicle, by the color of the object, direction of movement, crossing a given line,
3. Video synopsis – it allows the automatic generation of a summary overview of the events that take place in the videos. It uses advanced video content analysis algorithms to identify key events, objects, or activities in video material, enabling easy viewing of large amounts of video material and identification of key information.

Placing cameras at intersections and along roads provides the ability to monitor the flow of traffic in the city and potential congestion. Connecting the traffic light signaling system to the system is a step towards solving the problem of congestion in the city and improving traffic safety. In this way, it is possible to better manage traffic, reduce traffic incidents and improve the flow of vehicles and pedestrians. Traffic light signaling systems can be connected to sensors that detect traffic density. Based on the data obtained, traffic lights can be dynamically adjusted to optimize vehicle flow and reduce congestion. Pedestrian crossing priorities at intersections and pedestrian crossings can also be enabled, especially near schools and parks, and in this way, along with the previously mentioned traffic violation detection system, safety in the city can be significantly increased. In case of detection of a traffic accident, traffic lights can change the mode of operation and thus enable a faster response of emergency services and reduce the risk of additional incidents. Also, during special events in the city, such as sporting events or public gatherings, these systems can adjust signaling to better cope with increased traffic and pedestrian flows.



Cameras can be placed both on bridges and along the river course, in order to monitor the river course through a city and act preventively in case of an alarm situation. The cameras can be used to monitor vessel traffic, as well as other activities on water. This can help detect and monitor potential problems or incidents such as vessel collisions or irregular navigation, and crime prevention. In this way, information about river water levels and weather conditions along the coast can also be obtained, which is useful for managing flood risks, weather conditions that can affect the safety of people and property, as well as environmental protection.

Covering illegal landfills with a video surveillance system enables detection of perpetrators, protection of the environment and reduction of the negative impacts of illegal waste disposal. Placing thermal cameras in strategic places such as squares, industrial zones, tall buildings, or forests, provides the possibility of quick fire detection. A thermal camera captures images using infrared radiation and quickly identifies thermal anomalies that cause a fire. Artificial intelligence can analyze and identify characteristic smoke patterns that indicate the start of a fire. Also, by integrating various sensors with artificial intelligence, it enables efficient and accurate fire detection. Artificial intelligence uses machine learning to recognize patterns that precede a fire, and based on the collected data, predictions and preventive actions are improved. The integration of thermal imaging cameras with control and response systems is crucial in effective fire prevention and protection of people and property in the city. Thermal cameras integrated into urban traffic management systems provide early detection of vehicle fires and overheating components, contributing to enhanced road safety and incident response [10].

The use of drones can be of great importance in the Safe City concept. The integration of drones into urban security frameworks offers unparalleled flexibility and mobility for monitoring large public events and crowded areas, enhancing overall safety [11]. Drones can provide an overview of the wider city area in unforeseen situations, such as traffic accidents, fires, etc., where they provide a wide angle of recording and the possibility of quick and efficient response. Drones can provide timely information about traffic jams, accidents, and general traffic conditions, which is a great help in effective traffic management. The utilization of drones equipped with ANPR technology enhances urban surveillance capabilities, allowing for real-time monitoring of traffic violations and suspicious activities [12]. What is more, they can be used to monitor public places such as parks, shopping centers, concerts, and sports events, where violations of public order and peace, theft, vandalism, or fights can be detected. Drones can be used to monitor *exhaust gas emissions*, conserve water, monitor and detect illegal waste disposal, identify environmental pollutants, and other environmental problems.

Analysis of data collected through video surveillance is a key tool for gaining deeper insight into pedestrian and vehicle movement patterns in urban areas. This data provides city planners with a rich set of information about how people and vehicles move through urban space during different time periods and conditions. Through the analysis of the obtained data, planners can identify the points of traffic jams, find out where traffic violations or incidents often occur, or recognize deficiencies in the infrastructure, such as the lack of pedestrian crossings or poorly designed intersections. In addition, the analysis of pedestrian movements can help in planning new pedestrian routes or improving existing ones. The use of data collected by video surveillance allows planners to make decisions about urban planning,



infrastructure investments and improvements that will contribute to the safety, efficiency and sustainability of traffic in urban areas.

Conclusion

The Safe City project should be one of the main priorities, the foundation for building a sustainable and prosperous community. Creating a safe environment for citizens increases the quality of life and the feeling of security. The safe city has a positive impact on the economy and tourism. Studying the impact of facial recognition technology on the economic development of the city underscores the importance of investing in modern security technologies to attract investors and enhance the business environment [13]. When a city is perceived as a safe place to live in and do business, there is an increase in investments in that city, the creation of jobs, an increase in the number of tourists, and thus the economic growth of the city itself. It is necessary to increase the awareness among citizens that the establishment of such a concept aims to improve the quality of life. Strategic planning and long-term investments in urban security are key to building sustainable and resilient communities capable of addressing contemporary challenges [14]. It is also necessary to increase the awareness of the operators of such systems about data security and the integrity of security services. Enactment of laws on the way the system is run, conditions for their installation and use, severe punishment of abuse, all of this should contribute to the creation of citizens' trust in the institutions. For that to happen, the participation of every individual is needed in order to realize this concept in the right way.

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