



Video intelligence as a tool of implementing the smart city concept

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ABSTRACT

Smart City is nowadays the most modern and advanced form of a city's development. It is based on ICT exploitation in six key areas, i.e.: economy, transport and communication, city governance, environment governance, people's living space and quality of living. Development of innovative technologies, including video intelligence, creates wide opportunities to convert individual cities and agglomerations into intelligent, safe and sustainable places of living from the social, economic and environmental perspective. The issue of video intelligence systems will be the subject matter of the paper. It will also present the possibilities of complex implementation of the systems into the key areas of smart cities.

Keywords: smart city, smart solutions, ICT, video intelligence

1. Introduction

The twenty first century is characterized by intense urbanization. The world's population living in cities is expected to be doubled by 2050. By 2030, six out of every ten people will live in a city and by 2050 this figure will run to seven out of ten. It actually means that the number of urban residents is growing by nearly 60 million people per year [10].

As the planet becomes more urban, cities need to become smarter. Major urbanization requires new and innovative ways to manage the complexity of urban living. It demands new ways to target problems of overcrowding, energy consumption, resource management and environmental protection [6].

Consequently, it becomes necessary to organize urban space in which it is possible to implement processes to prevent negative phenomena, optimize the use of resources of the city through a network of cyber connections using equally advanced technologies and social capital. Hence there are formed smart and sustainable living environments with social, economic and environmental point of view, called "smart cities" [A. Dewalska-Opitek: Smart City Concept – the Citizens Perspective]. Municipal authorities do realize that the implementation of smart solutions is not only a matter of

higher comfort of living of urban residents, but an instrument of global fierce competition in attracting human and financial capital to the cities. It is even said, that contemporary cities are condemned to being smart and intelligent [8].

In the view of the challenges associated with the growing urbanization, the Europe 2020 Strategy [3] incorporates a commitment to promote the development of Smart Cities through Europe and to invest in the necessary ICT infrastructure as well as its intelligent tools.

The role of video intelligent systems as a part of business intelligent solutions is the subject to a closer identification in this paper. It will also present the possibilities of complex implementation of the systems into the key areas of smart cities.

2. Smart cities and smart solutions

The Smart City concept has emerged among others, such as: "intelligent city", "information city", "virtual city", "ubiquitous city" or "digital city". The characteristics of these concepts are presented in Table 1.

Table 1. The characteristics of types of advanced cities [7]

CONCEPT	DESCRIPTION OF CHARACTER
Digital city	Refers to a connected community that combines broadband communication infrastructure and innovative services to meet the needs of government and their employees, citizens and business. Its goal is to create an environment for information sharing, collaboration, interoperability and seamless experiences for all entities.
Intelligent city	Emerges at the crossing of the knowledge society (a society which knowledge and creativity have great emphasis and intangible, human and social capital are considered the most valuable asset) with the digital city. It has all the infrastructure and infostructure of IT, the latest technology in communications, electronic and mechanical technology.
Virtual city	Refers to a city that functions are implemented in a cyberspace. Nowadays some cities are constituted within virtual and material spaces simultaneously, and are called "hybrid cities".
Ubiquitous city (U-city)	Means a further extension of a digital city concept in terms of ubiquitous accessibility and infrastructure. Its aim is to create a built environment where any citizen can get any services and anytime through any devices. The U-city is different from a virtual one – while the virtual city reproduces urban elements by visualizing them within the virtual space, U-city is created by the computer chips or sensors inserted to those urban elements.
Information city	Refers to digital environments collecting information from local communities and delivering it to the public via web portals. It is also an urban centre for commerce, social and civic services, and social interactions among people, businesses and government institutions.

However, the Smart City concept has become predominant and is widely used to describe the currently most advanced form - a city that uses information and communication technologies in order to increase interactivity and efficiency of urban infrastructure and its constituent components, and to raise awareness of residents [11].

Tracing the genealogy of the word smart can contribute to defining the Smart City. We may notice some differentiation due to specific approaches [7]:

- In marketing, that is centered on a user perspective, smart means use-friendly, capable of adopting to the user needs and providing customized interfaces;
- In the urban planning field, smart entails strategic decisions and distinguishing new policies, strategies and programs of sustained development, economic growth and better quality of life for the citizens; in this context, smart means achieving policy success in the jurisdiction;
- From technological perspective, smart means intelligent; technologies had permeated into commercial application of intelligent-acting products and services, artificial intelligence and thinking machines creating a smart place perceived both from the personal perspective, as well as the larger community and entire city.

Harrison et al state that a city is smart when “it manages to connect the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city” [4].

Other definition focuses almost exclusively on the fundamental role of ICT in making a city smart: “the use of ICT makes the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected, efficient, and adapted to the contemporary needs of its citizens. [6].

It can be noticed that what makes a city smart is the use of ICT. It influences each element (also called a characteristic) of a Smart City, which is presented in Table 2.

Table 2. Overview of the ICT influence on the six Smart City characteristics [6]

CHARACTERISTIC	DESCRIPTION
Smart economy	<ul style="list-style-type: none"> • enables cities achieve high productivity, innovation climate and labour market flexibility due to e-business and e-commerce, ICT enabled and advanced manufacturing delivery of services, ICT-enabled innovation, as well as new products, services and businesses; • establishes smart clusters and eco-systems (i.e. digital business and entrepreneurship) • entails local and global inter-connectedness and international embeddedness with physical and virtual flow of goods, services and knowledge.
Smart governance	<ul style="list-style-type: none"> • consists in appropriate system of city management involving various city stakeholders due to appropriate infrastructure, hardware and software, smart processes and interoperability ; • enables transparency and access to open data; • reinforces the functioning of e-government.
Smart mobility	<ul style="list-style-type: none"> • makes a network of high-speed links connecting all the resources of the city due to the integrated transport and logistics systems; • encompasses trams, buses, trains, metros, cars, cycles and pedestrians integrated into sustainable, safe and interconnected transportation systems.
Smart environment	<ul style="list-style-type: none"> • enables cities achieve optimization of energy consumption, use of renewable energy sources, and based on the principle of sustainable development; • entails metering, pollution control and monitoring, green buildings, green urban planning, resource use monitoring that enables achieving the city efficiency.
Smart people	<ul style="list-style-type: none"> • enables access to education and training, human resources and capacity management; • reinforces e-skills; • enhances creativity and fosters innovation; • enables people and communities to input, use, manipulate and personalize data through analytic tools and dashboards, improves the decisions making process.
Smart living	<ul style="list-style-type: none"> • ensures a friendly environment providing broad access to public services, technical and social infrastructure, healthy and safe living.

Recognizing the growing and indeed critical importance of technologies (especially ICT), Smart Cities can be nowadays viewed as interactive intelligent systems joining up diverse elements and actors to improve a city’s competitiveness, as well as ensuring a more sustainable future, across network of people, technologies and infrastructure. Overall, ICT enables a Smart City to [6]:

- Make data, information, people and organization smart,
- Redesign the relationships between government, private sector, non-profits, communities and citizens,
- Ensure synergy and interoperability within across-city policy domains and systems (e.g. transportation, energy, education, healthcare, utilities, etc.)
- Drive innovation.

Most studies on practices of smart city address issues of technological infrastructure and enabling technologies. The focus on infrastructure and technology stresses accessibility and availability

of systems. Contrasting with human infrastructure, technological infrastructures have other names such as physical infrastructure or technoware [7].

Washburn *et al* views smart city as a collection of smart computing technologies applied to critical infrastructure components and services. Smart computing refers to “a new generation of integrated hardware, software, and network technologies that provide IT systems with real-time awareness of the real world and advanced analytics to help people make more intelligent decisions about alternatives and actions that will optimize business processes and business balance sheet results” [9].

Mobile, virtual, and ubiquitous technologies gain importance. Those technologies offer benefits to city dwellers in mobile lifestyle. Smart city application evolves from smart places to networked inhabitants. While the wireless infrastructure is a key element of digital city infrastructure, it is only a first step. A set of technological requisites for smart city comprises network equipments (fiber optic channels and wi-fi networks), public access points (wireless hotpots, kiosks), and service-oriented information systems. A ubiquitous/pervasive computing infrastructure is a key technological component in the build out of a digital city. A smart city provides interoperable, Internet-based government services that enable ubiquitous connectivity to transform key government processes, both internally across departments and employees and externally to citizens and businesses. [7].

Technology is a key driver of smart city development IT infrastructure requires citizens with their social capital as well as public authorities with the governance, polices and regulations, which was show In Figure 1.

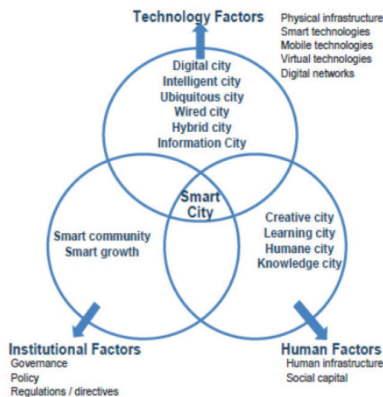


Fig.1. The Smart City concept [7]

City authorities are aware that implementing smart solutions is not only a matter of high quality and standard of living of city residents, but also an effective tool in the global competition in attracting human and financial capital.

3. Video intelligence as a smart solution for smart cities

Smart cities use smart solutions, especially these consisting in information technologies. According to the ThinTank Report

on Smart Cities [8], ICT plays an active role, that is shown in the Figure 2.

Video Intelligence (also called video based business intelligence) is a new generation of hardware, software, and network technologies that provide systems with real-time information of the real world and advanced analytics to help people make smart (intelligent) decisions about alternatives and actions [5].

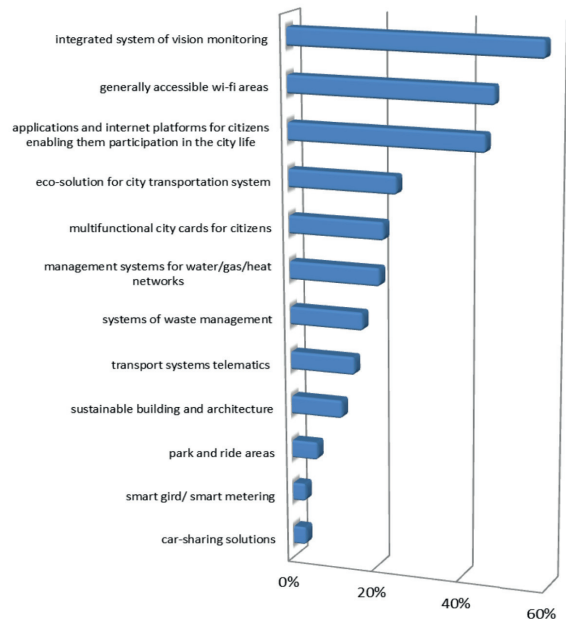


Fig. 2. Smart solutions in smart cities [8]

The basis of the video intelligence is the integrated system of vision monitoring, also placed in the first ranking position among smart solutions, as shown in the Figure 2.

The system may be described as computerized processing and analysis of video streams. Video analytics applications can perform a variety of tasks ranging from real-time analysis of video for immediate detection of events of interest, to analysis of pre-recorded video for the purpose of extracting events and data from the recorded video. Relying on video analytics to automatically monitor cameras and alert for events of interest is in many cases much more effective than reliance on a human operator, which is a costly resource with limited alertness and attention. Furthermore, there is often a need to go through recorded video and extract specific video segments containing an event of interest. This need is growing as the use of video surveillance becomes more widespread and the quantity of recorded video increases. In some cases, time is of the essence, and such review must be undertaken in an efficient and rapid manner.

Through the implementation of various image processing algorithms, video intelligence analytics can detect a variety of events, in real-time, such as: penetration of unauthorized people or vehicles into restricted areas, tailgating of people or vehicles through secure checkpoints, traffic obstacles, unattended objects, vehicles stopped in no-parking zones, highways or roads, removal

of assets, crowding or grouping, loitering and more [2]. Examples of video intelligence applications are shown on Figures 3. and 4.



Fig. 3. Video intelligence applications for smart cities [2]



Fig. 4. Video intelligence application – forensic research [2]

Video intelligence also enables statistical analyses according to the assigned counting rule, as well as graphical presentations of data per day, month or year, comparisons and trends identification. The main areas where video intelligent systems are implemented within smart cities are as listed [2]:

- Retail - shopping centers to secure customer safety and improve operations (people counting, customer management, traffic statistics, heat map for product placement and marketing return, etc.);
- Mass transportation hubs - airports, seaports, train & metro stations and bus terminals to secure passenger safety (crowding, unattended objects, forensic search after incident, etc.);
- Critical infrastructure - power, chemical & nuclear plants, dams and telecommunications stations for higher security at their sites (detection / evidence of perimeter intrusion, post-incident analysis, etc.);
- City surveillance - law enforcement agencies managing security in metropolitan areas (unauthorized entry, loitering, illegal parking, crowding, forensic search, etc.);
- Government & military facilities - government/military buildings to ensure higher security at their sites (detection/evidence of perimeter intrusion, tailgating, post-incident analysis, etc.);
- Highway surveillance - highways and expressways to prevent accidents and optimize traffic flow (traffic obstacles, vehicle counting, stopped vehicles, etc.).

Video intelligence has been growing in strength due to the popularization of the Smart City concept. According to the Intelligent Community Forum (ICF), the number of top smart cities has been constantly increasing for the last 7 years [7]. According to the perceptible trend as well as the IT development in terms of intelligent solutions and their applications, the role of video intelligence will significantly grow in future.

4. Conclusion

Smart city is one that uses smart technologies, with the emphasis on video intelligence. The possible applications are numerous, but it may be assumed, that its functionality will grow in future, creating new quality of life, economy, education, mobility and governance of smart cities and their citizens. The implementation of video intelligence enables to increase safety of every-day-life, improve transport and business efficiency, and facilitate the decision-making process, both of city authorities and citizens.

The paper focuses on the advantages of smart solutions via ICT generally, and video intelligence solutions particularly. However, it may be observed, that big data collection may lead to unreasonable and groundless use of information. This leaves place for a future study on the video intelligence implementation.

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