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Overview of Five Techniques Used for Security and Privacy Insurance in Smart Cities

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Abstract

Digitization and technological transformation in providing various services have become a goal for many countries in light of the current digital revolution to implement the concept of a smart city. Given the great importance of the smart city concept by researchers, the overriding concern is how to maintain data security and user privacy. These two criteria can or directly represent the strengths and weaknesses of such technology projects. This paper included a comprehensive study of the smart city, its concept and components. The research also included a detailed study of the most important applications included in smart city services and their working mechanisms and uses. The diversity of applications and services provided under the smart city environment is proof of the importance of this model. The paper also reviewed the security risks of data in all stages of work, data collection, data transfer and processing. Finally, the paper reviewed the five most important technologies used in a smart city to maintain information security and data privacy, their advantages, their internal methodology and algorithms. In the end, this paper aims to give a clear picture of all the details of the smart city and the technologies used for the purpose of ensuring information security and data privacy.

1. Introduction

Improving the lifestyle is considered one of the most important goals of smart cities and the goal for which smart city applications were built. And to get that Sensors interact with practical management algorithms and data. Upgrading the way of work and the mechanism of providing services as a means to improve the way of life of citizens [1]. A wide range of applications and services are provided in the smart city environment, from traffic to the legal administration of the city, which makes cities more efficient, reduces resource consumption and much more. Many cities of the world are now heading across different continents to work according to the ideas of modern technology and the smart city environment [2]. Although certain services have completely turned to work according to the technology principle and have left their old classics irreversibly, we can say that in the near future we can see a comprehensive shift towards technology and a wide change towards the uses of the smart environment for administrative and service work in the cities of the world. Economy and trade are two important aspects that will lead the others toward this wave of technological revolution because they are the foundation and the nerve of life, so everyone believes and the evidence on the ground proves this belief that there is no escape from smart cities that will be sooner or later a way of advanced life [3]. This approach and this revolution are not without challenges, especially security. And that this smart environment is threatened by a set of threats that must be cautious and be careful to avoid them. One of the most important areas of concern in this environment are the huge amounts of data and how to obtain, preserve, protect and potential impact on the privacy of citizens, that hostile access to this data and tampering with it or its penetration will lead to serious consequences easier, stop service and stop the city [4]. Significant repercussions that societies can face if we do not properly manage data conservation and do not plan for major protection projects. These



problems and repercussions may lead to collective disruption of services, and this means paralysis of community life [5].

2. Smart city definition

There is no specific definition of the concept of a smart city as a result of the great diversity and variety of technologies and methods that can be described as smart. However, as a general description according to the procedural path, it is every city based and dealing with technology for the purpose of enhancing and developing its functions starting from collecting information from various sources and in multiple formats and analyzing it according to a large spectrum of algorithms and then reusing this data to improve an important set of services [6]. There is no doubt that improving life and digitizing measures that increase the efficiency of services provided to citizens is the primary goal of smart cities, because it falls under this goal other sub-goals by taking advantage of the latest technological developments in conjunction with data visions [7]. The most important of them is always striving to improve the lives of citizens, enhance productivity and efficiency, reduce costs as well as reduce consumption of available resources, and develop services to be more compatible with the challenges of the time [8]. Due to series of related improvements and optimization of resources, the Smart City environment provides its desired goal for a better life for citizens. This technology will provide important and highly efficient capabilities to meet the challenges and difficulties resulting from the booms in population ratios and environmental impacts [9]. The following components are essential for smart cities to function effectively:

2.1 Data collection

The fact that it deals with digital data of different origin is a feature that distinguishes it from the ordinary city and is therefore called smart. That is, it requires data from a variety of sources in order to carry out its work and provide its services. These sources vary, but a standard definition can be given to the source, which is that each port can be a passage or a way to obtain digital data. These data are collected from people on their smartphones, sensors, surveillance cameras or any other means that are a source of digital data. Monitoring reality and communicating with events is through a series of sensitivities that serve the smart city environment. It is used to make certain decisions that lead to better results. This means that the collected data is used within smart city components in later stage to make more accurate decisions. This means that the story begins with information and treatment of a decision, and the desired result [10] [11] [12].

2.2 Data communication

Communication between different parts and data source points is very important in the smart city environment to enable the flow of information from known parties to known goals as well. This idea is based on facilities from important technologies such as the Internet of Things (IoT) and a wide range of technologies related to managing and making networks that organize communication procedures between devices and servers and important smart city points. As a result, the data is sent to the central processing units and servers that process data and take the appropriate commands according to their work algorithms and send the desired result to the peripheral devices concerned to urge them to take specific action. The process is similar to the five senses of the body and their connection via sensory nerves to the source of brain decision [10] [11] [12].

2.3 Data analysis and action

Multiple set of data and from different parties and senses combine to reach the center of management and analysis. As different flows of data help to convey a realistic and more vital picture of what is happening in the corridors of the city. Passionate on these flowing data, which includes real-time data and through a central analysis of it and mix it with a series of archived historical data to reach final decisions. In simple terms, recalling the saved historical information, which is based on the flowing data, is done through a series of algorithms for the purpose of making the right decision that leads to the appropriate procedure. The human decision also interferes with some of the details of these

algorithms to reach the goal. So, the decision-making depends on the collected data, the saved data, and human intervention according to a series of algorithms and techniques to give the final result after the treatments [10] [11] [12]. After the issuance of the final decision, according to the information that has been clarified, this decision is transferred to the relevant parties and agencies for the purpose of making the appropriate decision for the situation. This means that a decision has been taken to make a situation according to an event, and this is what makes the city smart. Traffic lights were set according to the timing, regardless of the reality of the situation, and the signal may change, but the situation does not require that, and thus the signal has become worse for congestion or in other words, the signal change is not smart. Figure (1) illustrate the flow path of collected data in the smart city [13].

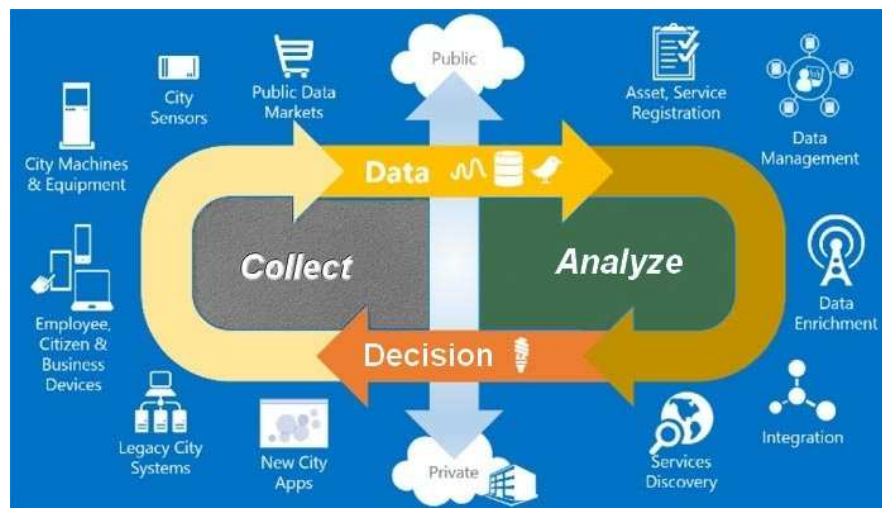


Figure (1): Data Flow in Smart City

The efficiency of making appropriate decisions according to the mechanism that was explained comes from the city's ability to see and follow all its parts and details of its various services. By aligning the information provided with algorithms and historical data based on real-time information, services are improved and real life is developed with the lowest costs and better use of available resources [14][15].

3. Applications of smart city technology

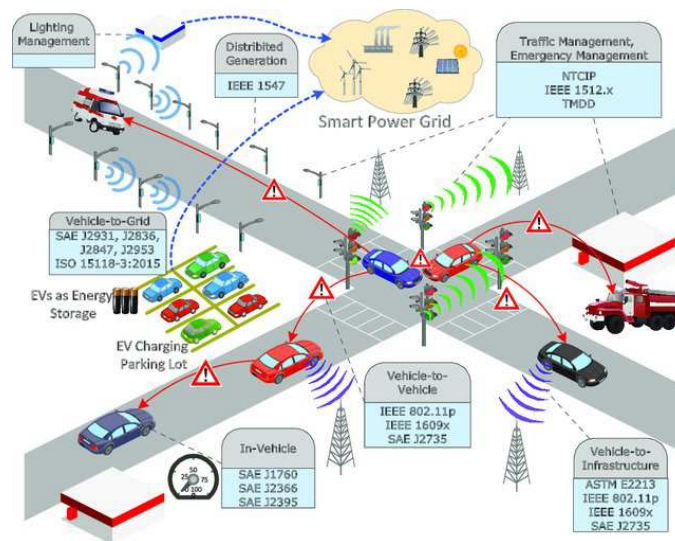
A wide range of applications, events and services that fall within the scope of smart cities' work. Measures that improve performance and improve work are provided by the smart city to solve a wide range of urban problems as shown in figure (2), as many of these services fall under the following main categories [16] [17]:



Figure(2): Smart City Applications

3.1 Transportation

The resort to smart solutions in the field of transport and traffic did not come from a vacuum. With the passage of time, the increase of the population, and the resort to the use of many types of personal and public transportation, traffic congestion has become a cause of an unfair list of problems that the citizen suffers from, whether psychological or economic. Here, the smart city helped to improve the public performance and solve the problems of this important sector in a way that included improving the ways of life and limiting the effects that the problems of this sector have on human life[18]. Where smart city solutions provided a smart recipe for optimal use and improving transportation services by organizing the mechanisms of using roads without the need to spend large amounts of money to construct or expand those roads. This means that management technology solutions have contributed to improved performance and problem solving while preserving resources. These solutions were provided through multiple means of collecting information and with various examples, but in the end, they are meant for one purpose and are making the right decision at the right time. An example of this is data coming from cameras, license plates, devices for reading license plates, street sensors, parking sensors, drones, satellites, and other multimedia in the field of information delivery[19]. Figure 3 illustrate an example of smart transportation system. The availability of information gives a comprehensive view of transport in the city and leads to important decisions, for example warning about accidents and proposing a list of roads that lead to the same destination and helping ambulances and fires to open roads for them to forestall their missions .



Figure(3): Intelligent Transportation Systems and the smart grid in a smart city.

Rent by smart applications of bicycles and cars in a participatory way and electric scooters other services to improve the transportation sector in the smart city environment. Improving parking systems based on smart sensors and how to manage them are in the same goal as improving the transportation sector [20].

3.2 Energy and resource management

Under the smart city environment and its management approach are great potentials for multiple applications in the field of energy management and its various resources. Monitoring household consumption using smart meters. The citizen and the government are now able to follow up on the immediate consumption of electricity, and this has become a driver for rationalization in energy consumption. The lighting control and brightness control levels also contributed to good energy management according to an intelligent solution. In the same way, smart solutions deal with the water management environment and its sources and how it sprinkles its consumption [21].

3.3 Waste management and pollution control

The waste problem and how to manage it are no less than the transportation problem, as the smart city environment offers an impressive array of smart applications that contribute to improving life and preserving the environment. The topic is not about ugly scenes and the well-being of the place, but rather more complex matters, especially those related to the health of citizens. Smart waste management and pollution control offer another way to reduce these problems. Internet waste boxes and sensors are a great example of these solutions. Once the weight or odor is detected, its alarm will be transmitted, according to the smart application, to the appropriate department to remedy the matter. The application relates to the mechanics of transportation, the path of which is smartly determined according to the cans to be unloaded before others to prevent an unfavourable accumulation of waste. Other metaphors related to air or water pollution play the same role in alerting the authorities, which leads to important decisions that contribute to solving the problem and preventing other impacts [22].

3.4 Public safety

This type of problem is very sensitive to being related to illegal criminal activities. Under the smart city environment, smart solutions diversified through important applications related to improving public safety. Surveillance and tracking systems and early crime detection provides a smart recipe to

help the authorities in the administration and reduce security risks and facilitate the detection of penetrators of laws and regulations such as the most prominent:

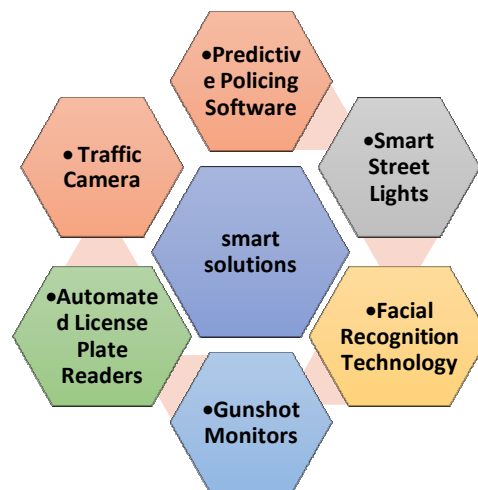


Figure (4): Public Safety Smart Solutions

As shown in Figure (4), this is just the tip of the iceberg of those requirements that relate to public safety and the security of individuals and citizens and their property. A very important issue in this type is identification, unlike other applications that include pre-use identification of the user's identity [23].

3.5 Governance and services

The concept of a smart city changed the way citizens interact with their governments, so smart direct communication, which is not limited to time or place, has become the dominant feature of this relationship. The e-government system has enabled citizens to participate in decision-making and express their views clearly and clearly. The axes of social services, care systems, health and security matters, and others are the axes of smart service applications under the e-governance environment and the smart city. The primary goal is to simplify steps and direct status to deal with services and activate different payment mechanisms. And all of the aforementioned falls under the applications and solutions of the smart city, which we have already explained its primary goal in improving the way of living and improving the quality of life through improving the general performance [24] [25] [26].

4. Smart city security risks

We have briefly reviewed the applications and benefits of the smart city and the improvements that can occur in many services in the lives of urban and even non-urban residents, but on the other hand there are great risks and challenges. Where these risks can fall under two major headings are system failure resulting from attacks or malfunctions, and widespread data breaches [27]. Figure (5) explained the sources of risks.

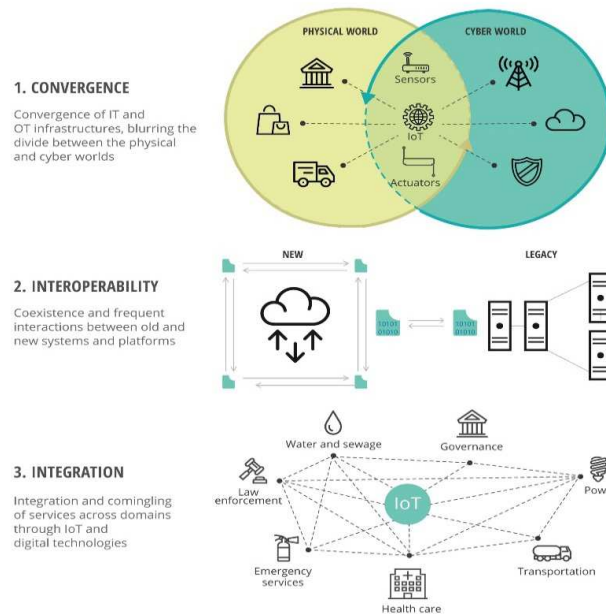


Figure 5: Factors affecting the security of smart cities

4.1 System attacks and failures

The sources of danger in the smart city come from several aspects, the most important of which is the Internet and its connection to it, which is the main driver for the work of any smart city. Centralization in some practical aspects of a city that can be a source of danger also smart cities generally combine several aspects that also make them vulnerable. If the attackers can use the Internet connection as an outlet for their attack, it may have serious consequences. Centralization represents the point of arrival for attackers and the ability to perform any service that may lead to complete paralysis in the lives of the residents [28]. The quality of the attackers in the classic, traditional cities differs over any vital facility that provides an important service. For example, attackers must approach geographically the buildings of that facility in order to attack or tamper with, for example. In smart cities it is different, complicated and more dangerous because the attackers may be from other countries or from other far continents [29]. That is why we have begun to hear about disrupting trains, extinguishing water stations, closing bridges, and other attacks that affect stopping an entire system for long hours that lead to negative impacts on people's lives and many economic aspects. Therefore, cybersecurity has become an urgent necessity to preserve the gains of smart solutions. Reviewing specific problems in this field is not propaganda against the smart digital transformation, on the contrary, reviewing these risks supports the idea of enrichment for the purpose of potential confrontation and preparing for attack scenarios [30].

4.2 Data breaches risks

We have clarified at the beginning of this article that data is the important element in the idea of a smart city, which collects in different ways and means to reach decision-making headquarters according to what has been collected from the data. As the digital nature depends on the different data that goes through the stages of analysis, storage, modification, and others. The sensitivity and importance of data varies from application to application, some of which are related to the location and data of people and their financial accounts. A breach that leads to the disclosure of a person's data

can pose a real danger if his location data and his movement limits are used in planning the theft of his house or his work site according to his penetrated data [31] [32].

5. How to mitigate the risks of smart cities

Since the trend towards the concept of smart cities has become a preoccupation for many cities around the world, so the work must be parallel to the intensification of research, studies and innovations in the field of protection, security and privacy. Continuous ideas and high-level projects should be the main guarantor of achieving safe service [33]. Figure 6 illustrate the approaches of smart city risks mitigation. The primary goal of designing smart cities is to improve the lives of the residents, so there must be high coordination around security concepts and privacy with the residents to be supportive in maintaining the security and safety of the smart city. Also, transparency in the smart transformation and the way to deal with the needs of citizens can be an important social factor in maintaining the security of the smart city [34].



Figure (6): Smart City Risks Mitigation Approaches

Maximizing the privacy of citizens in smart city projects is an end that must be pursued through effective and possible solutions, and we must know that the key to piracy and hacking is personal data. Therefore, the smart city authorities seek to apply certain limitations related to the collection of personal data such as collect data only when absolutely necessary, approving the anonymity of the data source as possible, use the data for the purpose of which it was shared only and avoid transferring data. Therefore, many smart cities have now adopted new strategies in dealing with those covered by the smart service without accessing their privacy[35]. For example, dealing with a metro user that is managed in a smart way does not require knowing accurate details about their privacy and their data, but rather it has become a statistical work to know their numbers for the purpose of ensuring the provision and continuity of the service. The most important preparations that can face security challenges in the smart city environment are cyber security considerations that are important due to the huge amounts of data. Smart cities should be able to operate with the least amount of risk as long as cybersecurity policies and appropriate technical measures are in place. But security planning must be launched with the beginning of work, meaning that it gradually grows with the growth of the service

and the multiplicity of its users. Punitive deterrents are also important to reduce the privacy and security breaches suffered by smart cities [36]. Accountability is another fundamental aspect of a smart, functional city. Since there are so many dangers in smart city systems, there must be a strong process in place to ensure that offenders are held accountable for their actions. Which leads to the deterrence of the similar actions. All that has been mentioned and other matters should be transformed into regulations that raise the concept of protection and privacy, and unite efforts to reach a smart and safe society. The warnings that we touched upon do not mean dissuading or criticizing the global desire for smart transformation but rather evaluating it and clarifying its risks to rise in order to overcome it [37].

6. SECURITY AND PRIVACY PROTECTION TECHNOLOGIES

In the previous section, we have reviewed some administrative procedures that contribute to security, protection and privacy protection from a purely administrative side. In this section, we will illustrate technically and technologically on the most important ideas and leading technologies that are currently used as a means of blocking and firewall against security breaches and privacy violations that may be exposed to applications or services in the smart city environment [38]

6.1 CRYPTOGRAPHY

Cryptography algorithms are considered one of the most important techniques used in data protection in all stages of collection, processing and archiving. Rather, it can be considered as the backbone of the protection techniques used in the smart city environment. As shown in figure (7), cryptography includes many very important algorithms.

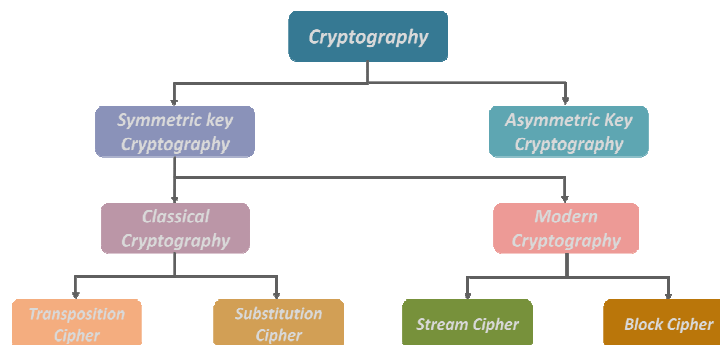


Figure (7): Cryptography Algorithms Classification

The protection system can also be composed of several techniques and is not limited to one technique, but mostly, Cryptography algorithm is essential in many of the ideas and methods of protection [39] [40] [41] [42].

6.2 BLOCKCHAIN

Research has proven that this technology has a great future in regulating services provided under the smart city environment. Its positive qualities have made it an important research point that appeals to researchers, specialists, and those looking for technological innovations. Blockchain in a brief explanation, it is a technology that derives its name from the nature of its work. It is a digital transaction log which has an interrelated structure in which the individual records are related to each other, which are called blocks in a unified list called the chain. One of its most important applications is cryptocurrencies, which it uses in transactions involving a smart environment for decentralized transactions. Being based on the peer-to-peer network, there is no centralization, and everyone shares monitoring and performance analysis. Monitoring ensures that there are no suspicious or invalid

transactions. The new block added to the chain is related to the previous block via an encryption algorithm based on partial encoding of the contents of the previous block. This is the secret of the interconnection between the blocks, which gives security strength and high-level protection for this type of application, as it guarantees very clearly not to tamper with or change the saved transactions. As shown in figure (8), the layering architecture of blockchain technology shows the details of entire processing [43] [44] [45] [46].

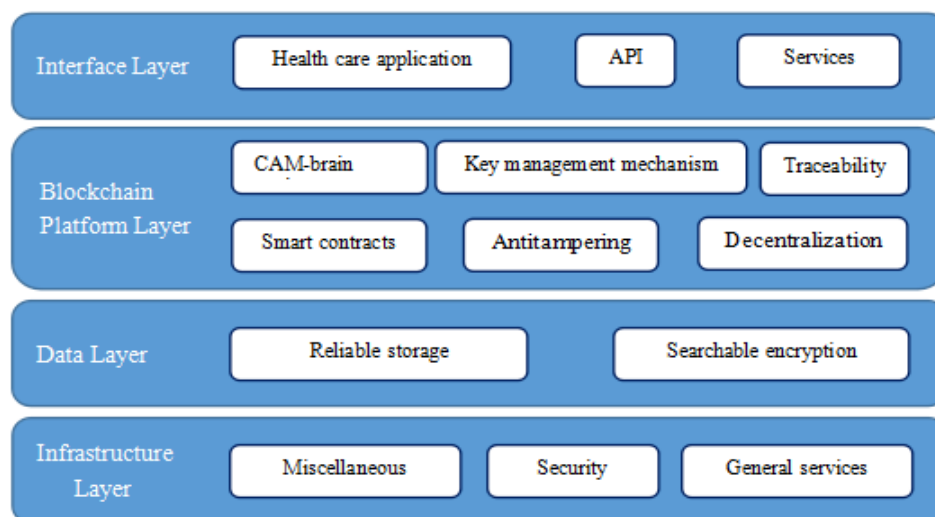


Figure (8): Blockchain Layers

6.3 BIOMETRICS

This technology can be used to automatically recognize a person through the unique behavioural and biological characteristics of IoT-based systems. It is used for the purpose of authenticating transactions in stages that require high privacy and a high level of security. This data includes several forms that start with fingerprints, faces, sounds, and handwritten signatures. It may include eye prints, DNA analyses, and genetic engineering in high-risk applications. This type of protection technology not only effectively protects against security attacks, but also maintains acceptable communication cost and overhead compared to other related systems. Figure (9) illustrate the steps of any biometric technique used in smart city environment protection [47] [48].

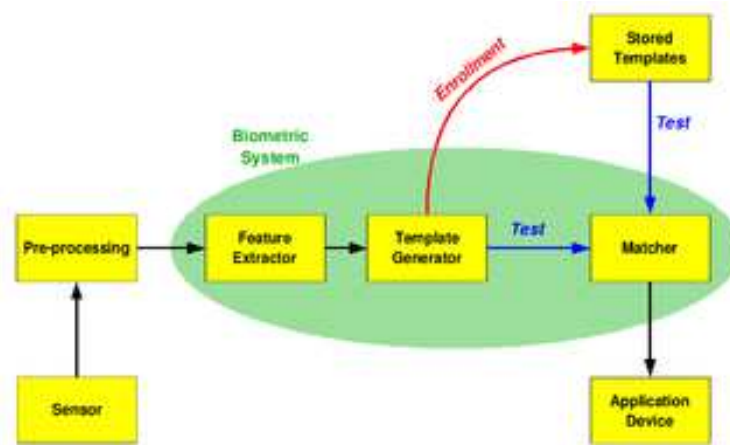


Figure (9): Biometric technique process

6.4 GAME THEORY

It is a powerful mathematical tool that is widely and efficiently used in the areas of cybersecurity and privacy protection. Among its most important advantages compared to other technologies are proven mathematics, reliability of work, work in time, distributed solutions and relying on decentralization to some extent. It has become an important research point in recent years. Several proposals, innovations and researches have emerged regarding the feasibility and effectiveness of this type of technology on applications with a service environment. An example of this is transportation, energy, and water, which has provided many scientific research and articles on the possibility of providing high-level security technical frameworks based on game theory. Technically, the main reason that enhances the capabilities of this technology in the security field is that it is based on mathematics, which is characterized by accuracy [49] [50] [51].

6.5 MACHINE LEARNING

Artificial intelligence techniques of various kinds are considered from the technologies that are widely used in many fields within the smart city environment. Rather, it is considered the main driver of many applications based on artificial intelligence solutions in one of the stages of their procedural steps. Based on the current practical situations, machine learning (ML) technologies have been employed to improve the efficiency of intrusion detection systems, which is one of the most commonly used security infrastructures to protect networks from attacks. Wireless sensor network (WSNs) the key component of the smart world, have received increasing attention [52]. Figure (10) illustrate the applications which based on AI and machine learning in smart city.

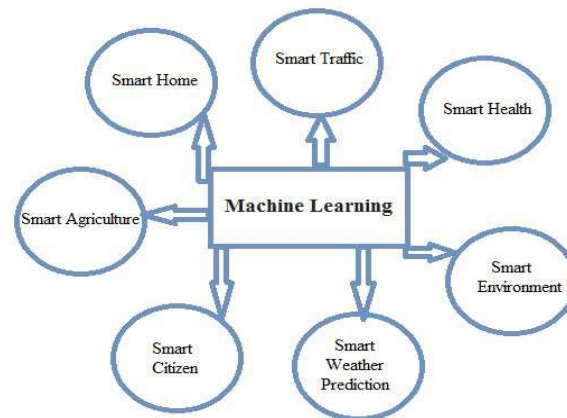


Figure (10): Machine learning based applications in smart city

7. Conclusion

This article has reviewed many details related to privacy and security in a smart city, its importance, and how to ensure it. In light of the technological revolution that the world is experiencing and the continuous gradual transformation to smart solutions in management, services and economy, the issue of security and privacy has become one of the most research topics in recent times. The smart transformation of the provision of services is offset on the other hand by the emergence of real and sensitive problems, especially those related to data security and privacy. Therefore, it became imperative to multiply the technologies used to ensure security and privacy in the smart city and to branch and expand it on the horizontal path. On the vertical track, the same technology is studied many times and is improved several times to reach a state of high security performance with the lowest possible error rate.

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