

BIOMETRICS in SMART CITY

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1

Types of Biometric Authentication

◆ Types of Biometrics

- Iris, retina, face, fingerprint, DNA, signature, finger geometry, voice, hand geometry, vein pattern, biometric recognition

◆ Biometric Authentication

- Getting access, privacy protection, authentication, biometric data security, car smart recognition

Types of biometric authentication



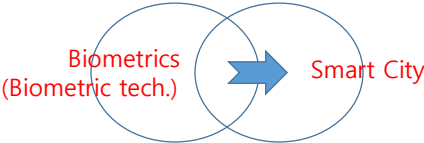
(source: <https://www.techtarget.com/searchsecurity/definition/biometrics>)

2

Biometrics in Smart City

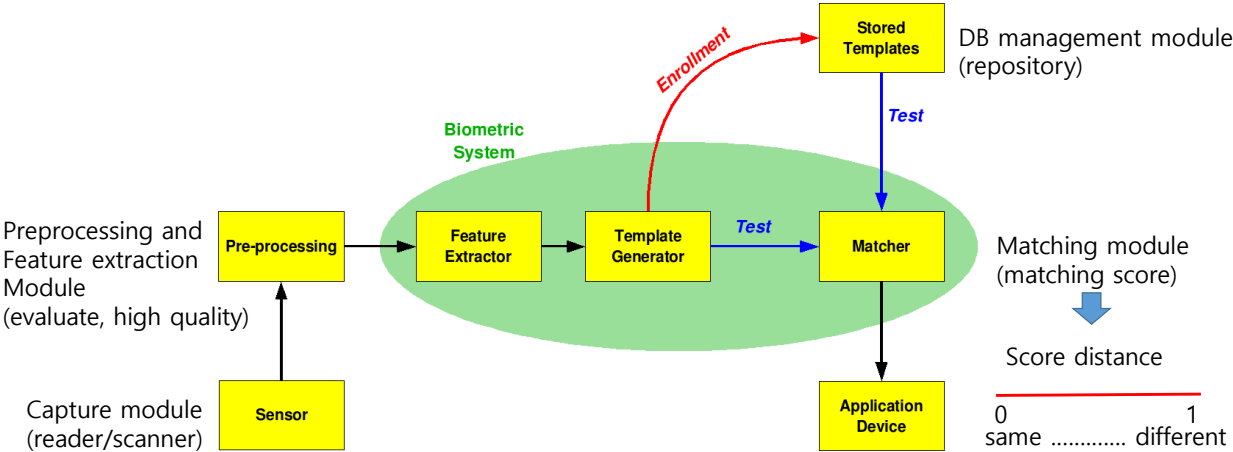
◆ **Why Biometrics (Biometric techniques) in Smart City? → Huge trend**

- Citizens' expectation of urban life is very different compared to the past
- Essential to satisfy human's requirements and ensure human's safety within cities
- A smart city is a solution to improve the quality of life and governing the city in an efficient and systematic manner
- The significant advances have been raised in biometrics technologies, which have made many aspects of urban life easier, more efficient, and more secure
- To be compliant with the demands of a smart city in the future, biometrics-based technologies will certainly play a significant role from now on

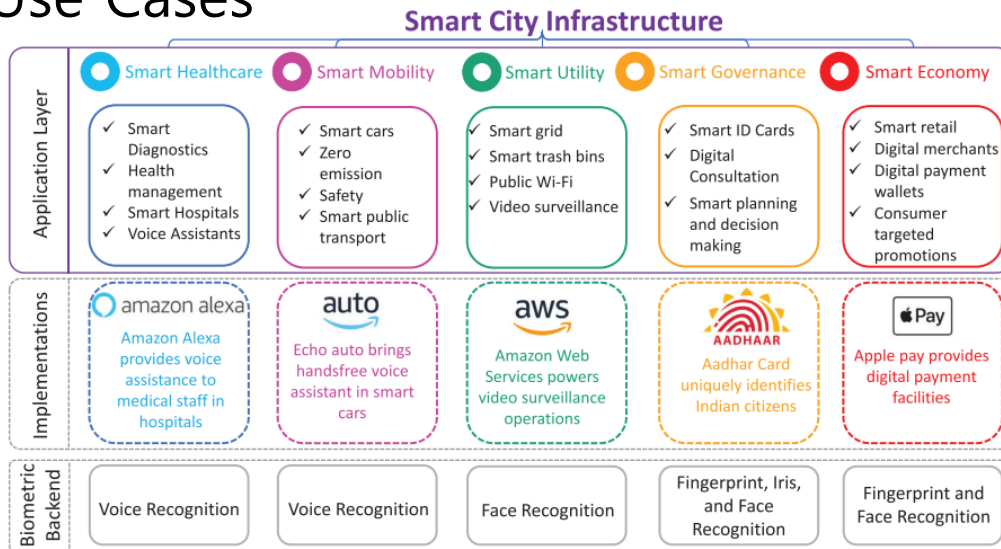


- The potential biometrics systems employed in smart cities : **facial recognition, age estimation, gender detection, facial expression detection and sentiment recognition, and gait recognition**

Basic Structure of Biometric Systems



Use Cases



(Source: Arun Ross, Sudipta Banerjee, Anurag Chowdhury, Security in smart cities: A brief review of digital forensic schemes for biometric data, Pattern Recognition Letters)

5

Facial Recognition in Smart City

- Since **the beginning of 1970**, face recognition has received so much attention from researchers and companies, as it has great potential in many commercial and governmental applications
- In the face recognition systems, the system is trained using an enrolment part in which N images are captured from the detected face and stored in a database with a name
- Then, every time that a face is detected, the system finds a face, searches in the database, and matches them using a similarity threshold to minimize the chance of false positives
- There are **different techniques and algorithms** for facial recognition and **more accurate and reliable methods** are being offered every day, which with the combination of good quality cameras and better processing powers their performances are noteworthy
- There are different approaches for face recognition, such as **statistical-based approaches, appearance-based holistic approaches, feature-based graph matching approaches, and artificial intelligence-based approaches**

6

Applications for Facial Recognition

- The most common application of facial recognition is **identification**
 - Innovative applications : **unlocking smartphones, computer systems, access controls** etc.
- Some of these applications : **smart TVs, groceries payment by face, prevent shoplifting and violent crimes in retail shops, ATM withdrawals, catch the trains, pass through airport security gates without showing passports and waste the time, identify suspects and dead bodies by forensics and law enforcement, attendance systems, and any place where needs access control with any level of security**
- In general, human-based identification methods require **great physical efforts**, also employees can make errors in overloaded situations or by some distractions.

7

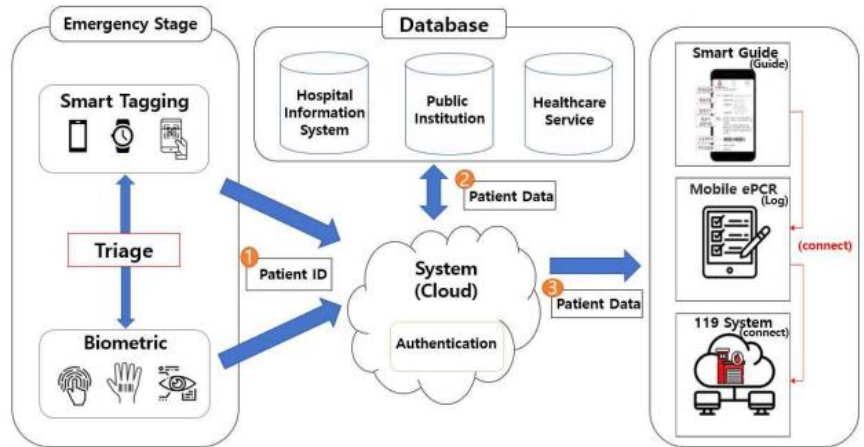
Health Care by Facial Recognition

◆ Health Care

- Medical applications of facial recognition may provide the basis for **improved diagnosis** and could be the end to **ethical discrimination**
- For example
 - In many emergency cases, time is very short to help the patient
 - Sometimes the person is not able to talk, his ID card is not available, and contact with his relatives is not possible for identifying him and knowing his medical backgrounds such as medications, and MRI
 - Face recognition comes to the aid of the medical team and provides the patient's medical records
- Facial recognition systems can help in detecting and identifying people with a history of drug addiction

8

Health Care by Facial Recognition



<Emergency Information Flow>

Age Estimation by Facial Recognition

- **Facial age estimation** can be described as the estimation of the age of an individual based on the biometrics facial features based on facial images
- The categorize the face images into only three different age groups: **babies, young adults, and seniors, using the craniofacial development theory and skin analysis**
- Many applications
 - Finding missing people, forensics, a criminal investigation, modelling suspects' faces, automatic updating of biometric systems, age normalization in face recognition systems, cosmetic surgery, the facial transplant planning, visual arts, movie special effects in the film industry, and high-risk lifestyle behaviours prevention etc.

Facial Aging Modelling-1

<Finding Missing Person>

- The facial ageing process is for **identification**
- "Facial ageing modelling is the illustration of an individual's facial appearance in the bygone or the forthcoming years, by simulating the alterations caused by facial ageing trajectory and by using the biometric facial features" (Farazdaghi, 2017).
- Face ageing models
 - **"Predictive Facial Ageing Models"** which model the ageing process and show the face in the coming years or decades
 - **"Reconstructive Facial Ageing Models"** that intend to rejuvenate the facial images from old adult to young adult or from adult to the child

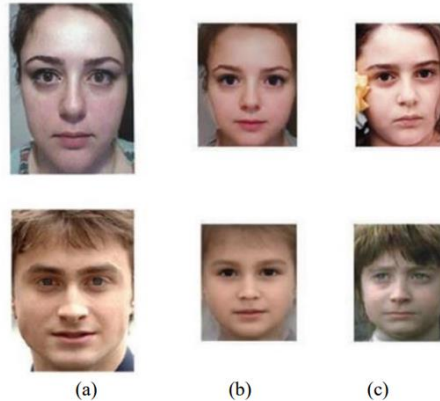


Figure 1. Results of the reconstructive facial ageing model (a) Original image - young adult. (b) Result (c) Reference image in approximately the same age as the result, for comparison. (Farazdaghi and Nait-ali, 2017) (Nait-Ali, 2019).

11

Facial Aging Modelling-2

<High Risk Life Style Behaviors Prevention>

- Bad lifestyle habits, such as drug abuse, alcohol consumption, smoking and extreme sun exposure can change the facial appearance and ageing process
- Integration of the effect of bad lifestyle habits in the facial ageing models, in addition to offering more realistic and personalized results, can demonstrate the **future of a young face in case of choosing the high-risk lifestyle**
- It can be an **alarm** for people specially teenagers to prevent and even advance stopping the addiction to the fatal substances

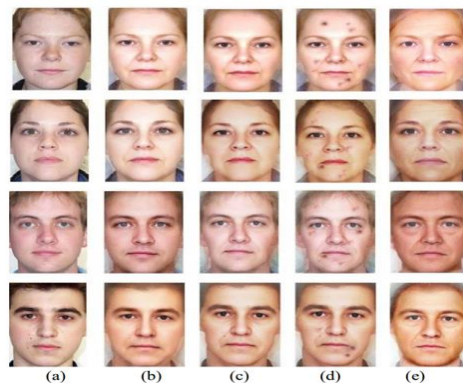
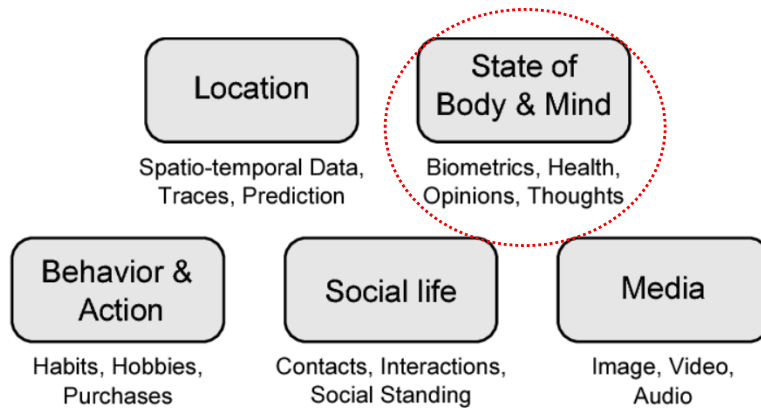


Figure 2. Results of applying predictive models to compare. (a) Input image (b) Output of applying natural ageing model (c) Outputs of applying the behavioural model for Methamphetamine addicts (d) Outputs of applying the behavioural model for Methamphetamine addicts if consumption continues for a longer time. (e) Results of applying the behavioural model for the sun-seeking people – The output age range for all the results is 41-50 (Farazdaghi and Nait-ali, 2017).

12

Privacy Types

- 5 types of privacy to classify privacy risks introduced by different smart city applications and technologies

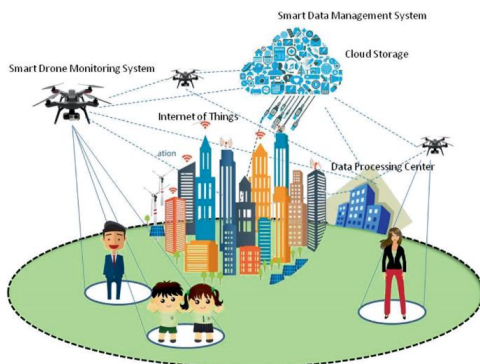


(Source: Published in IEEE Communications Surveys and Tutorials 2018 Privacy in the Smart City—Applications, Technologies, Challenges, and Solutions)

13

Smart Surveillance System

- Biometric technology can significantly enhance surveillance in smart cities
- Facial recognition technology can be used to **monitor public areas and identify individuals** in real-time
- These systems can be critical for maintaining **security, tracking criminal activity, and enforcing laws more effectively**



(Source: Home Machine Intelligence and Data Analytics for Sustainable Future Smart Cities Chapter Artificial Intelligence Techniques in Smart Cities Surveillance Using UAVs: A Survey Narina Thakur, Preeti Nagrath, Rachna Jain, Dharmender Saini, Nitika Sharma & D. Jude Hemanth)

14

Access Control System

- Biometric identification is widely used in smart cities to control access to certain areas or resources
- Fingerprint, iris, or facial recognition can be used to allow only **authorized personnel to access restricted areas** such as government buildings, data center or even certain public transportation systems



(Source: Advantech Edge Intelligence Solutions Propel the Deployment of the Touchless AI Smart Access Control Systems in Smart Cities)

15

E-government

- Many smart cities have adopted e-governance models that rely heavily on digital identity verification
- Biometrics can be used to **verify identities for online voting systems, taxation, public service applications**, and more
- This not only enhances security but also **simplifies these processes for residents**



<e-voting>



<Optimizing tax collection vis Biometrics>

16

Digital Twin, Metaverse

“Metaverse & Digital Twin” for AVATAR



Apple HomeKit

Mark Zuckerberg

“AVATAR Payment – CBDC - ROBOT Delivery”