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ARTIFICIAL INTELLIGENCE
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Section A: Cloud Computing Trends in 2019/2020

FACIAL RECOGNITION

Facial recognition is the process of identifying or verifying the identity of a person using their face. It captures, analyzes, and compares patterns based on the person's facial details

How Facial Recognition Works.

- The ***face detection*** process is an essential step as it detects and locates human faces in images and videos.
- The ***face capture*** process transforms an analog information (a face) into a set of digital information (data) based on the person's facial features.
- The ***face match*** process verifies if two faces belong to the same person.

Companies Using Facial Recognition

a) Academia

The **GaussianFace** algorithm developed in 2014 by researchers at The Chinese University of Hong Kong achieved facial identification scores of *98.52%* compared with the *97.53%* achieved by humans. An excellent score, despite weaknesses regarding memory capacity required and calculation times.

b) Facebook and Google

In 2014, **Facebook** announced the launch of its **DeepFace** program, *which can determine whether two photographed faces belong to the same person*, with an accuracy rate of *97.25%*. When taking the same test, humans answer correctly in *97.53%* of cases, or just *0.28%* better than the Facebook program.

In June 2015, **Google** went one better with **FaceNet**. On the widely used Labeled Faces in the Wild (LFW) dataset**, FaceNet** achieved a new record accuracy of *99.63%* (0.9963 ± 0.0009).

Using an artificial neural network and a new algorithm, the company from Mountain View has managed to link a face to its owner with almost perfect results.

This technology is incorporated into **Google Photos** and *used to sort pictures and automatically tag them based on the people recognized*. Proving its importance in the biometrics landscape, it was quickly followed by the online release of an unofficial open-source version known as ***OpenFace.***

c) Microsoft, IBM, and Megvii

A study done by MIT researchers in February 2018 found that Microsoft, IBM, and China-based **Megvii** (FACE++) tools had high error rates when identifying darker-skin women compared to lighter-skin men.

At the end of June 2018, Microsoft announced in a blog post that it had made substantial improvements to its biased facial recognition technology.

d) Amazon

In May 2018, **Ars Technica** reported that Amazon is already actively promoting its cloud-based face recognition service named ***Rekognition*** to law enforcement agencies. The solution could recognize as many as 100 people in a single image and can perform face match against databases containing tens of millions of faces.

In July, ***Newsweek*** reported that Amazon's facial recognition technology falsely identified 28 members of US Congress as people arrested for crimes.

Facial Recognition in Kenya.

a) Kenyan police launched facial recognition on urban CCTV network

Kenya's National Police Service (NPS) launched a facial recognition system for CCTV cameras installed along major roads and highways as part of an upgrade of its Integrated Command and Control System (ICCS). (Billington, 2019).

b) Facial Recognition System Installed at Moi International Airport

Facial recognition was installed to ensure security threats are reduced.

Challenges Facing Facial Recognition.

Illumination

For instance, a slight change in lighting conditions has always been known to cause a major impact on its results. If the illumination tends to vary, then; even if the same individual gets captured with the same sensor and with an almost identical facial expression and pose, the results that emerge may appear quite different.

Background

The placement of the subject also serves as a significant contributor to the limitations. A facial recognition system might not produce the same results outdoors compared to what it produces indoors because the factors - impacting its performance - change as soon as the locations change. Additional factors, such as individual expressions, aging etc. contribute significantly to these variations.

Pose

Facial Recognition Systems are highly sensitive to pose variations. The movements of head or differing POV of a camera can invariably cause changes in face appearance and generate intra-class variations making automated face recognition across pose a tough nut to crack.

Occlusion

Occlusions of the face such as beard, moustache, accessories (goggles, caps, mask etc.) also meddle with the evaluation of a face recognition system. Presence of such components make the subject diverse and hence it becomes difficult for the system to operate in a non-simulated environment. (Lahasan, 2019).

Expressions

Another significant factor which needs to be taken into account is different expressions of the same individual. Macro and micro expressions find their place on someone's face due to changes in one's emotional state and in the wake of such expressions - which are many - the efficient recognition becomes difficult.

Complexity

Existing state-of- the-art methods of facial recognition rely on ‘too-deep’ Convolutional Neural Network (CNN) architecture which are very complex and unsuitable for real-time performance on embedded devices.

An ideal Face recognition system should be tolerant to variations in illumination, expression, pose and occlusion. It should be scalable to large number of users with need for capturing minimal images during registration while doing away with complex architecture at the same time.

Section B: Applications of Intelligent Systems

HOME

A smart home is a residence equipped with technologies that include sensors, wired and wireless networks, actuators, and intelligent systems.
Equipped with highly advanced automatic systems, smart homes can monitor and control home activities for convenience, provide occupants with better comfort, and possibly reduce energy use.
Smart home technology collects and analyzes data from the domestic environment.

HOW AI IS USED IN SMARTHOMES

In the aspect of the home automation systems, we extracted six functions of home products with AI in smart homes, i.e., energy management, entertainment system, healthcare, device management, intelligent interaction, and security.

a) Security

Presently, Artificial Intelligence is used in two ways in home security systems.

- Firstly, in video camera systems in which it is integrated. Artificial Intelligence is used in these cameras as a tool for facial recognition. This helps in establishing whether any movement in the premises is caused by a member of the house or a trespasser. In this case, the function of facial recognition serves as an example of a very basic type of Machine Learning, in which a collection of photographs are uploaded in the system and the system uses these images to alarm the house owners in case the facial features of a person entering the house does not match the uploaded photographs.

- Secondly, Artificial Intelligence is used as a voice assistant in home security systems. This allows for a system in which the user can send voice commands to the security system as well as inquire about the security status and other details. Various Artificial Intelligence techniques are used to produce the required skills in the voice assistant to make it user-friendly and to make sure that the communication between the device and the user is seamless. (Mao J, 2018)

- Finally, in order to protect property and personal safety, keeping one's house from unexpected events and accidents is necessary. Artificial intelligence with regard to image recognition can recognize an unusual intruder and warn the house owner. Not all danger comes from criminals, but also from CO2, fire, etc. We can use AI to analyze sensor data and detect alarm sounds. (Zheng S, 2018)

b) Energy Management

In terms of smart home energy management, achieving a sustainable society becomes more and more important and urgent. People from all different fields are working hard to reduce energy consumption and improve energy efficiency. Coordinating the energy

consumption of smart appliances in smart homes can achieve a higher consumption efficiency. Energy consumption patterns and their relationship with environmental factors can be analyzed by AI to predict daily electricity demand. AI can help the smart home gateway in identifying the user's energy consumption behavior in order to support home automation and reduce energy usage. Activity recognition by AI can also help relate activities and existing home appliances, and then give recommendations to users whenever it detects energy waste.

c) Device Management

In terms of smart home device management, with the advancement of technology, the number of electrical appliances in the home is increasing, and operation steps are becoming more and more complicated. It would be convenient if AI could help users automatically manage some devices. Some researchers implemented AI in smart home systems to monitor and manage things in the house by automatically controlling light and temperature conditions. Intelligent control in a smart house can also be realized by analyzing the data from the sensor network, learning the user's previous behavior, or user patterns by applying the logistic classification algorithm based on TensorFlow by AI (Al-Kuwari, 2018). Centralized management can make electronic decisions such as monitoring, improving comfort, convenience, controlling surrounding conditions, and delivering required information.

d) Home Healthcare

In terms of smart home healthcare, with the gradual increase in life expectancy, home healthcare is becoming more and more important. Using machine learning and artificial intelligence methods from sensor data can track and detect changes in individuals' behavioral pattern and lifestyle. By adopting an unsupervised clustering algorithm, recurrent output neural network model, and genetic algorithm, AI systems can constantly monitor the residents in smart homes and send an alert to the hospital if any abnormal activities occur (Saeed F, 2018). To achieve the goal of helping adults with sickness or impairments independently accomplish the activities of daily life, intelligent assistant agents need to recognize adults' goals and reasons behind the further steps desired.

e) Intelligent Interactions

In terms of smart home intelligent interaction, as the number of smart home devices increases, more intelligent interactions can make users feel more comfortable. Most researchers utilized artificial neural networks to classify user inputs to create a natural dialogue, giving users the ability to control appliances by voice or text commands. Voice recognition based on AI provides audio-based interaction technology that lets the users have full control over their home environment. Image recognition also helps AI understand people's gestures Gesture-based human–computer interaction is natural and intuitive. People with speech disorders can communicate with smart home devices through dynamic gestures

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