Computer Vision and Facial Recognition

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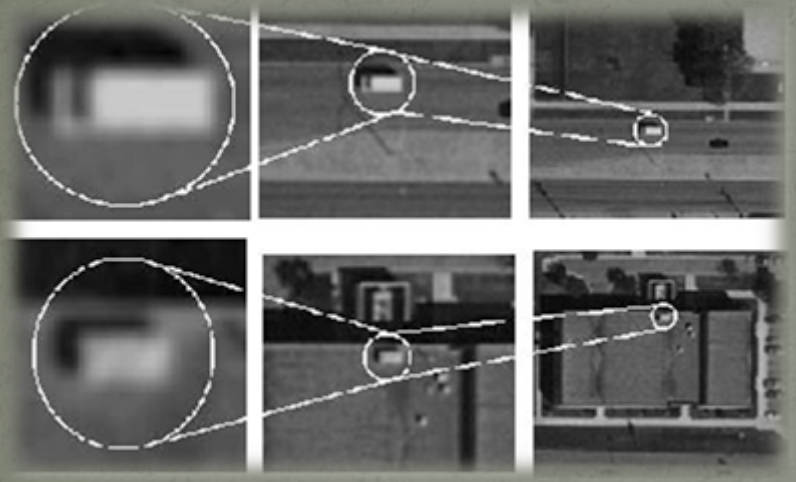
CSE 352

Computer Vision

- Computer Vision is the technology that enables machines to "see" and obtain information from digital images.
- It is seen as an integral part of AI in fields such as pattern recognition and learning techniques.
- Still in its infancy, with work starting in the late 1970's.
- No existing system can come close to emulating the capabilities of the human eye.
- Most computer scientists agree that true Computer Vision can be achieved, they just don't know how to achieve it yet.

Distinguishable to the human eye – Not to a computer

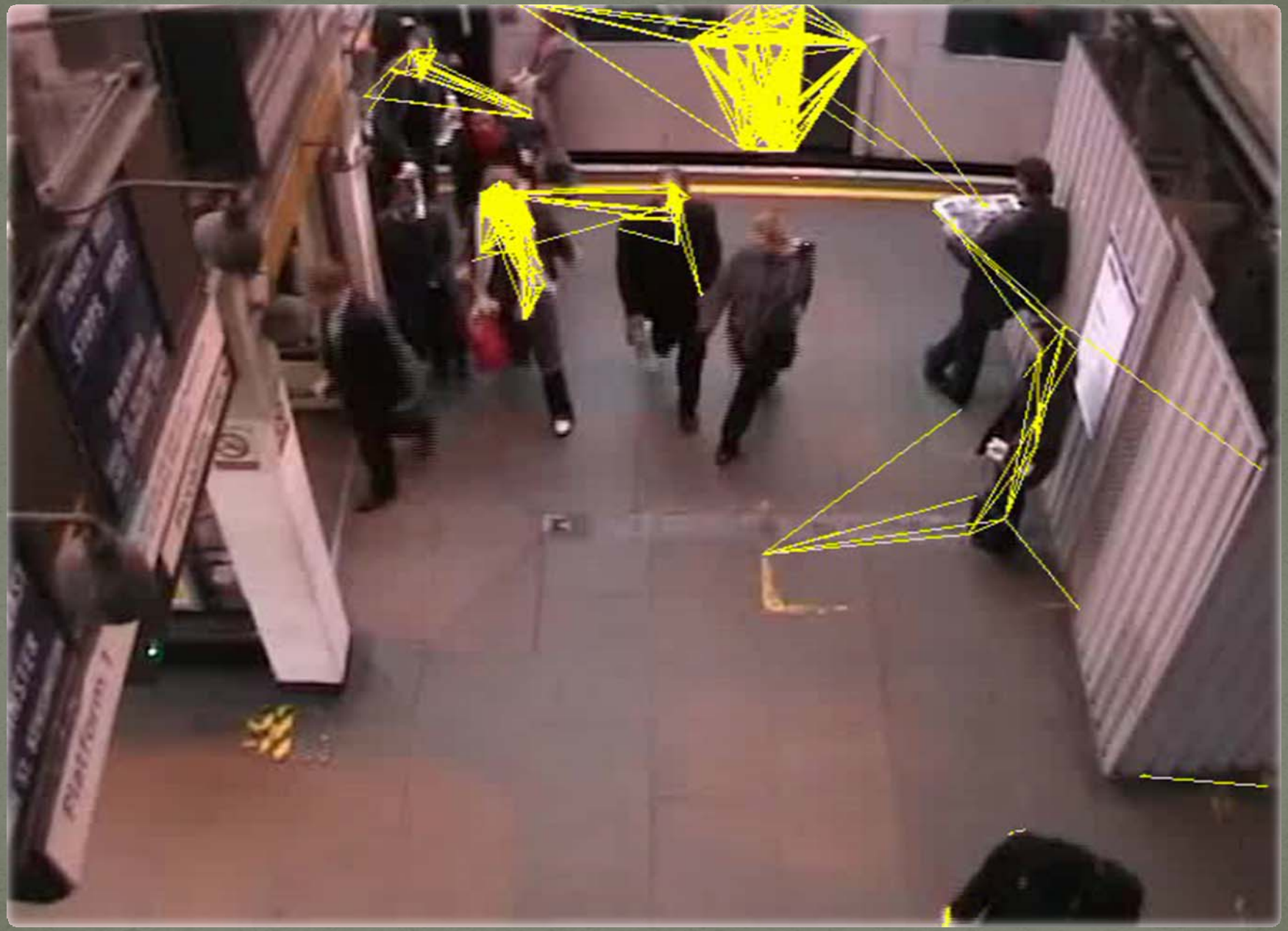


- Both objects on the left look identical.
- Classification strategies based on the gray levels in each image would classify them as the same object.

- Knowledge and context can influence visual interpretation.
- Analyze each object in the context of the bigger picture.
- Our knowledge about roads, cars and building structures now tells us that the top image is a car, while the one below it is a roof vent on top of a building.

Applications of Computer Vision

- Medical Computer Vision and Medical Image Processing.
- Extraction of information from image data for the purpose of making a medical diagnosis.
- Military applications.
- Newer missiles are sent to a general area rather than a specific target.
- Once the missile reaches the area, target selection is automatically made based on locally acquired image data.



Pattern Recognition

- Pattern recognition is a form of machine learning.
- It is the technique of taking raw data as input and taking an action based on the category of the data.
- Statistical Pattern Recognition is based on statistical characterizations of patterns.
- Used if the patterns are generated by a probabilistic system.
- Syntactical Pattern Recognition is based on the structural interrelationships of features.
- Used if there is a clear structure in the patterns.

Applications of Pattern Recognition

- Automatic speech recognition.
- Automatic recognition of handwritten postal codes on mail being sorted.
- Automatic recognition of images of human faces.

Facial Recognition Systems

- A facial recognition system is a computer application that is designed to automatically identify or verify a person from a digital image or a video.
- The most common way to do this is by comparing selected facial features from the image and a known facial database.
- Typically used in security systems.
- Constantly evolving and improving recognition algorithms and techniques.

Facial Recognition – The Challenge

- The same persons' face may differ a lot under different shades, poses, expressions, and illuminations.
- Subjects may be wearing makeup, hats, or sunglasses, which makes it a lot harder to identify them with a known face in the database.
- For certain sources, videos contain motion blur and are usually in lower resolution than still images.

The Effect of Shading

The Effect of Expressions

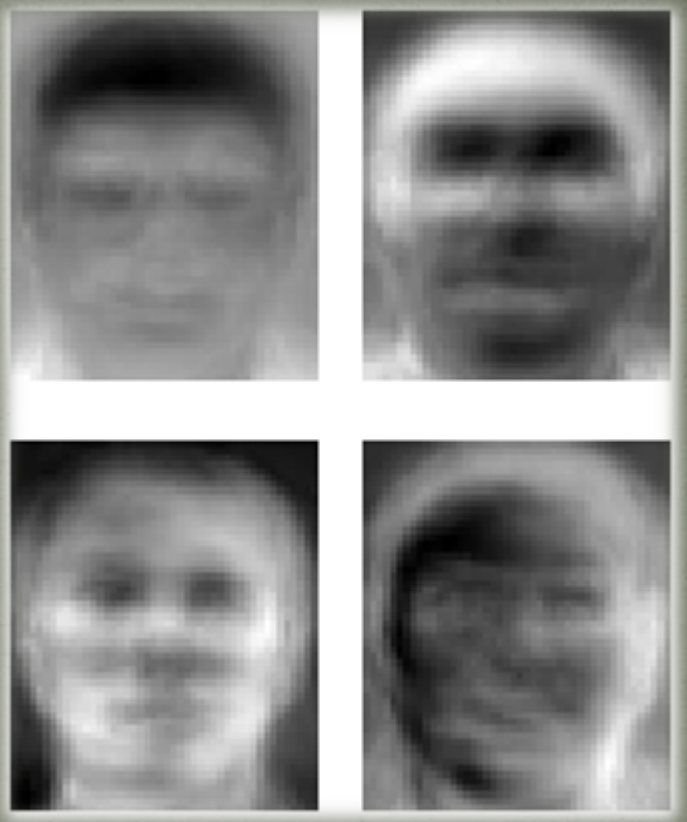
The Effect of Lighting

Facial Recognition – The Traditional Technique

- Eigenface Technique
- Developed by Sirovich and Kirby in 1987, and first used by Mathew Turk and Alex Pentland in face classification.
- To generate a set of eigenfaces, digital images of human faces are normalized to line up the eyes and mouths.
- They are all resampled at the same pixel resolution.

Eigenfaces

- The resulting image will appear as light and dark areas that are arranged in a specific pattern.
- This pattern is how different features of a face are singled out to be evaluated later on.
- There will be a pattern to evaluate symmetry, recognize facial hair, position of the hairline, or evaluate the size of the nose or mouth.
- Also known as eigenimages.



Eigenfaces – Recognition Process

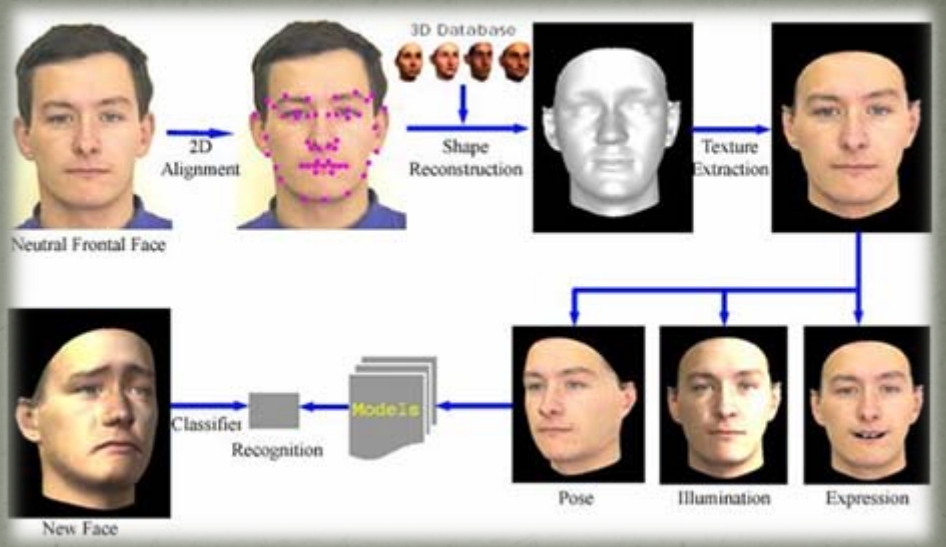
- Most database's need only a few hundred eigenfaces to implement recognition accurately.
- Each face can be expressed very simply using its eigenface decomposition.
- No need to store each face using thousands of pixels.
- Like a simple recipe – where you can construct or compare any face you want.

Facial Recognition – The New Approach

- Three-dimensional face recognition.
- Uses 3-D sensors to capture information about the shape of a face.
- This information is then used to identify distinctive features on the surface of a face, such as the contour of eye sockets, nose, and chin.
- 3-D facial recognition is not affected by changes in lighting, different head poses, or the use of cosmetics, like most 2-D techniques.
- It can also identify a face from a range of viewing angles, including a profile view.

3-D Face Recognition

- Frontal face and feature points are detected.
- 3-D face shape is reconstructed according to the feature points and a 3-D face database.



- The face model is texture mapped by projecting the input 2-D image onto the 3-D shape.
- Based on the 3-D face model, virtual samples with varying expressions are stored in the database.
- Recognition of most expressions can now take place.

- OMRON's "smile detector".
- Measure smiles and give them a percentage reading.
- Integrated on a chip for mobile devices and supports multiple faces.

- Possible expansion for identification theft prevention, building entry management, and access control for age-restricted content.
- Still a few years to go.

Facial Recognition - Criticism

- Facial recognition is not perfect and struggles to perform under certain conditions.
- Good at full frontal faces and 20 degrees off.
- Hats and sunglasses may throw the system off from time to time.
- The London Borough of Newham.
- As of 2004, this system has never actually recognized a single criminal.

Facial Recognition – Future Plans

- 10 times the accuracy in 4 years.
- 100 times the accuracy in 10 years.
- Plans for facial recognition systems in retail stores.
- Cash registers equipped with cameras.
- These cameras are the primary means of identification. If visual identification fails, customer will be required to enter a PIN number.
- Customer can shop without carrying any cash or credit cards.
- Expandable to restaurants, movie theatres, car rental companies, hotels, etc.

Sources

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