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"Artificial Intelligence for Engineering/Engineers (KMC-201)"_

UNIT-5: APPLICATION

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UNIT-5

“Artificial Intelligence for Engineering/Engineers (KMC-201)”

By SHWETA TIWARI

Artificial Intelligence for Engineering/Engineers (KMC-201)”

UNIT-5: APPLICATION

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5.1 Image and face recognition

Image Recognition is the ability of a computer powered camera to identify and detect objects or features in a digital image or video. It is a method for capturing, processing, examining, and sympathizing images. To identify and detect images, computers use machine vision technology that is powered by an artificial intelligence system. Image recognition is a term for computer technologies that can recognize certain people, animals, objects or other targeted subjects through the use of algorithms and machine learning concepts. The term "image recognition" is connected to "computer vision," which is an overarching label for the process of training computers to "see" like humans, and "image processing," which is a catch-all term for computers doing intensive work on image data.

Image recognition is done in many different ways, but many of the top techniques involve the use of convolutional neural networks to filter images through a series of artificial neuron layers. The convolutional neural network was specifically set up for image recognition and similar image processing. Through a combination of techniques such as max pooling, stride configuration and padding, convolutional neural filters work on images to help machine learning programs get better at identifying the subject of the picture.

Image recognition has come a long way, and is now the topic of a lot of controversy and debate in consumer spaces. Social media giant Facebook has begun to use image recognition aggressively, as has tech giant Google in its own digital spaces. There is a lot of discussion about how rapid advances in image recognition will affect privacy and security around the world.

How does image recognition work?

How do we train a computer to tell one image apart from another image? The process of an image recognition model is no different from the process of machine learning modeling. I list the modeling process for image recognition in Step 1 through 4.

Step 1: Extract pixel features from an image

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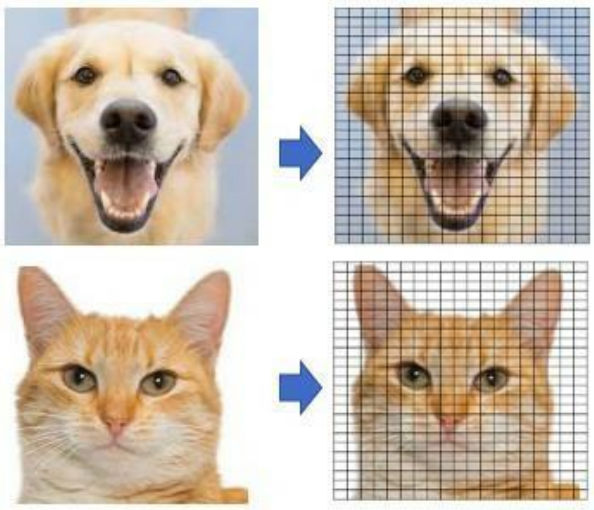

Figure 5.1: Image Recognition

Step 2: Prepare labeled images to train the model

Step 3: Train the model to be able to categorize images

Step 4: Recognize (or predict) a new image to be one of the categories

Face Recognition

Face recognition is a method of identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time. Law enforcement may also use mobile devices to identify people during police stops.

But face recognition data can be prone to error, which can implicate people for crimes they haven't committed. Facial recognition software is particularly bad at recognizing African Americans and other ethnic minorities, women, and young people, often misidentifying or failing to identify them, disparately impacting certain groups.

Additionally, face recognition has been used to target people engaging in protected speech. In the near future, face recognition technology will likely become more ubiquitous. It may be used to track individuals' movements out in the world like automated license plate readers track vehicles by plate numbers. Real-time face recognition is already being used in other countries and even at sporting events in the United States.

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How Face Recognition Works

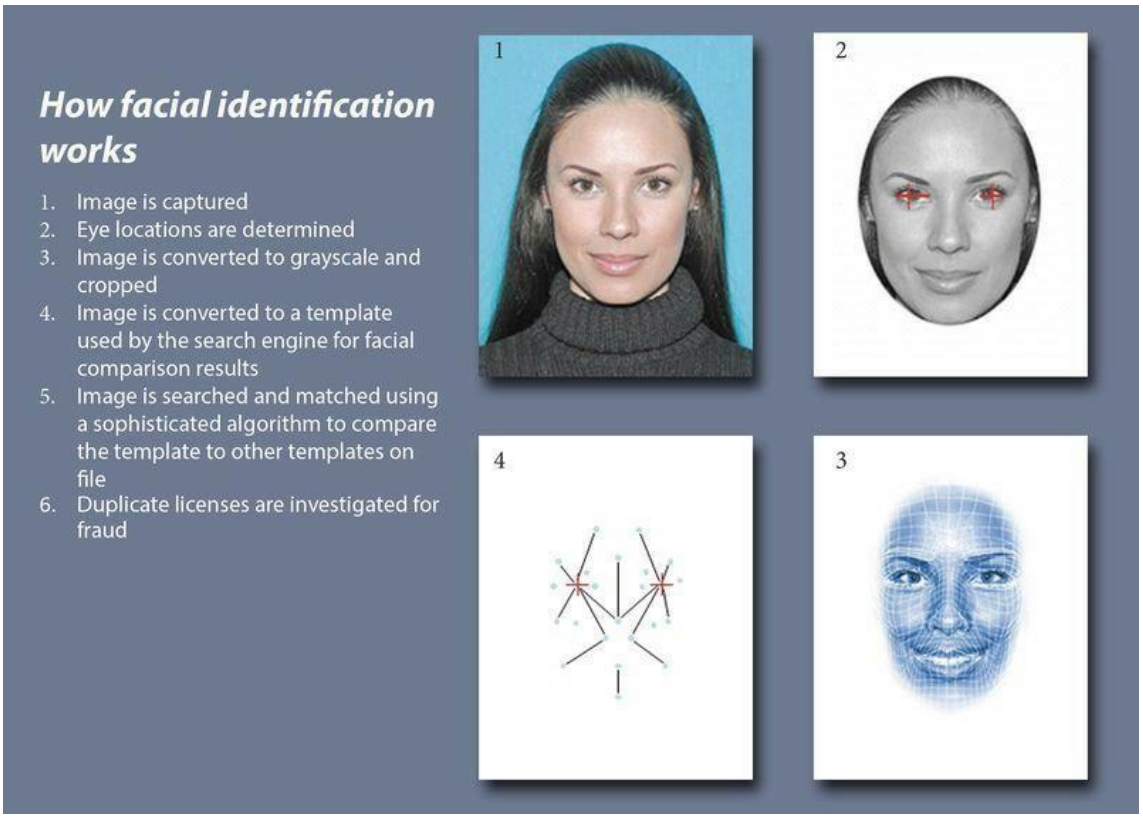

Figure 5.2: Face Recognition

Face recognition systems use computer algorithms to pick out specific, distinctive details about a person's face. These details, such as distance between the eyes or shape of the chin, are then converted into a mathematical representation and compared to data on other faces collected in a face recognition database. The data about a particular face is often called a face template and is distinct from a photograph because it's designed to only include certain details that can be used to distinguish one face from another.

Some face recognition systems, instead of positively identifying an unknown person, are designed to

calculate a probability match score between the unknown person and specific face templates stored in the database. These systems will offer up several potential matches, ranked in order of likelihood of correct identification, instead of just returning a single result.

Face recognition systems vary in their ability to identify people under challenging conditions such as poor lighting, low quality image resolution, and suboptimal angle of view (such as in a photograph taken from above looking down on an unknown person).

When it comes to errors, there are two key concepts to understand:

A “false negative” is when the face recognition system fails to match a person’s face to an image that is, in fact, contained in a database. In other words, the system will erroneously return zero results in response to a query.

A “false positive” is when the face recognition system does match a person’s face to an image in a database, but that match is actually incorrect. This is when a police officer submits an image of “Joe,” but the system erroneously tells the officer that the photo is of “Jack.”

5.2. Object Recognition

Object recognition is a computer vision technique for identifying objects in images or videos. Object recognition is a key output of deep learning and machine learning algorithms. When humans look at a photograph or watch a video, we can readily spot people, objects, scenes, and visual details. The goal is to teach a computer to do what comes naturally to humans: to gain a level of understanding of what an image contains.

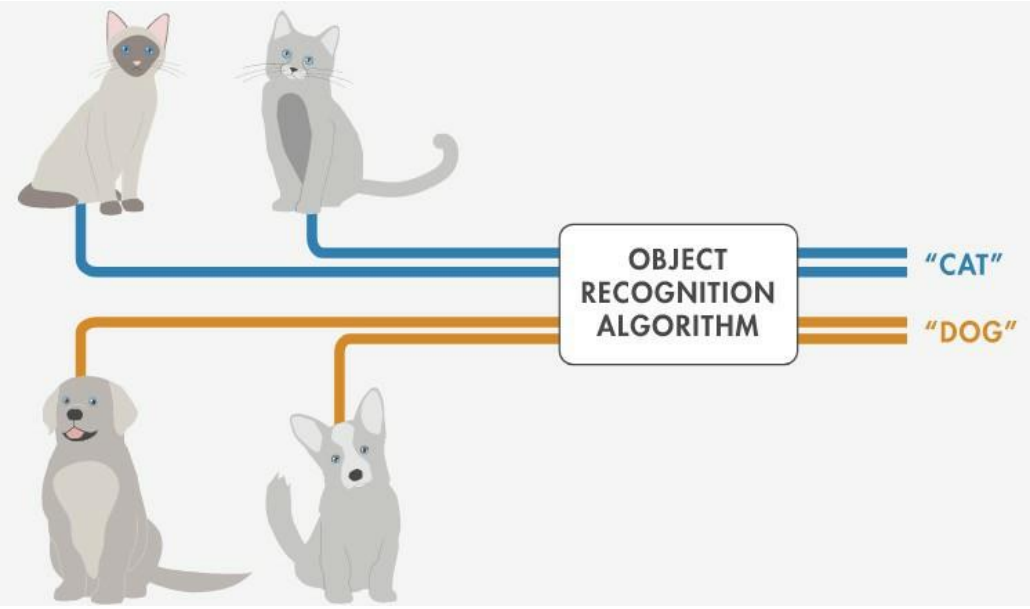

Figure 5.3: Object Recognition

Object recognition is a key technology behind driverless cars, enabling them to recognize a stop sign or to distinguish a pedestrian from a lamppost. It is also useful in a variety of applications such as disease identification in bioimaging, industrial inspection, and robotic vision.

Object detection and object recognition are similar techniques for identifying objects, but they vary in their execution. Object detection is the process of finding instances of objects in images. In the

case of deep learning, object detection is a subset of object recognition, where the object is not only identified but also located in an image. This allows for multiple objects to be identified and located within the same image.

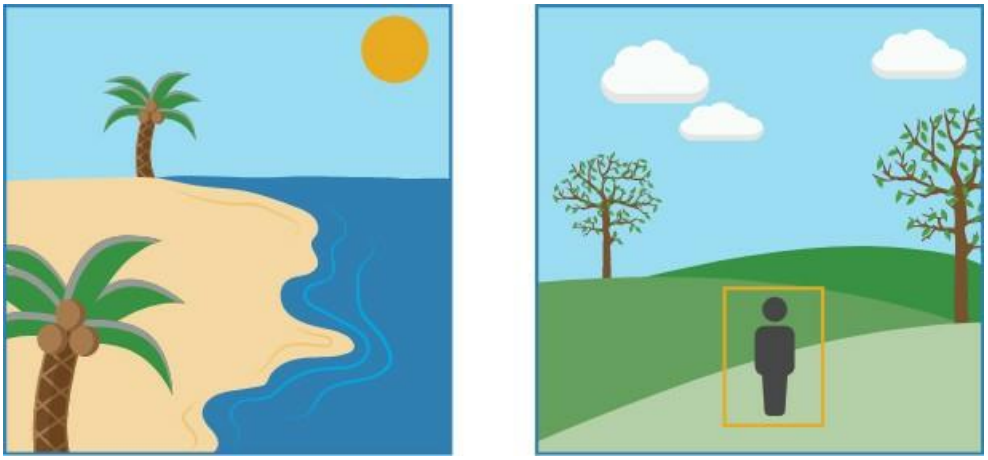

Figure 5.4: Object recognition (left) and object detection (right).

5.3. Speech Recognition

Speech recognition, or speech-to-text, is the ability for a machine or program to identify words spoken aloud and convert them into readable text. Rudimentary speech recognition software has a limited vocabulary of words and phrases, and it may only identify these if they are spoken very clearly. More sophisticated software has the ability to accept natural speech, different accents and languages.

Speech recognition incorporates different fields of research in computer science, linguistics and computer engineering. Many modern devices or text-focused programs may have speech recognition functions in them to allow for easier or hands-free use of a device.

It is important to note the terms *speech recognition* and *voice recognition* are sometimes used interchangeably. However, the two terms mean different things. Speech recognition is used to identify words in spoken language. Voice recognition is a biometric technology used to identify a particular individual's voice or for speaker identification.

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How it works

Speech recognition works using algorithms through acoustic and language modeling. Acoustic modeling represents the relationship between linguistic units of speech and audio signals; language modeling matches sounds with word sequences to help distinguish between words that sound similar.

Often, hidden Markov models are used as well to recognize temporal patterns in speech to improve accuracy within the system. This method will randomly change systems where it is assumed that future states do not depend on past states. Other methods used in speech recognition may include natural language processing (NLP) or N-grams. NLP makes the speech recognition process easier and take less time. N-Grams, on the other hand, are a relatively simple approach to language models. They help create a probability distribution for a sequence.

More advanced speech recognition software will use AI and machine learning. These systems will use grammar, structure, syntax as well as composition of audio and voice signals in order to process speech. Software using machine learning will learn more the more it is used, so it may be easier to learn concepts like accents.

Applications

The most frequent applications of speech recognition within the enterprise include the use of speech recognition in mobile devices. For example, individuals can use this functionality in smartphones for call routing, speech-to-text processing, voice dialing and voice search. A smartphone user could use the speech recognition function to respond to a text without having to look down at their phone. Speech recognition on iPhones, for example, is tied to other functions, like the keyboard and Siri. If a user adds a secondary language to their keyboard, they can then use the speech recognition functionality in the secondary language (as long as the secondary language is selected on the keyboard when activating voice recognition. To use other functions like Siri, the user would have to change the language

settings.)

Speech recognition can also be found in word processing applications like Microsoft Word, where users can dictate what they want to show up as text.

Pros and cons

While convenient, speech recognition technology still has a few issues to work through, as it is continuously developed. The pros of speech recognition software are it is easy to use and readily

available. Speech recognition software is now frequently installed in computers and mobile devices, allowing for easy access.

5.4. Robots

Robotics is a branch of AI, which is composed of Electrical Engineering, Mechanical Engineering, and Computer Science for designing, construction, and application of robots.

Aspects of Robotics

- The robots have **mechanical construction**, form, or shape designed to accomplish a particular task.
- They have **electrical components** which power and control the machinery.
- They contain some level of **computer program** that determines what, when and how a robot does something.

Difference in Robot System and Other AI Program

Here is the difference between the two −

AI Programs	Robots

They usually operate in computer-stimulated worlds.	They operate in real physical world
The input to an AI program is in symbols and rules.	Inputs to robots is analog signal in the form of speech waveform or images
They need general purpose computers to operate on.	They need special hardware with sensors and effectors.

Robot Locomotion

Locomotion is the mechanism that makes a robot capable of moving in its environment. There are various types of locomotions −

- Legged
- Wheeled
- Combination of Legged and Wheeled Locomotion
- Tracked slip/skid

Legged Locomotion

- This type of locomotion consumes more power while demonstrating walk, jump, trot, hop, climb up or down, etc.
- It requires more number of motors to accomplish a movement. It is suited for rough as well as smooth terrain where irregular or too smooth surface makes it consume more power for a wheeled locomotion. It is little difficult to implement because of stability issues.
- It comes with the variety of one, two, four, and six legs. If a robot has multiple legs then leg coordination is necessary for locomotion.

The total number of possible **gaits** (a periodic sequence of lift and release events for each of the total legs) a robot can travel depends upon the number of its legs.

If a robot has k legs, then the number of possible events N = (2k-1)!.

In case of a two-legged robot (k=2), the number of possible events is N = (2k-1)! = (2*2-1)! = 3! = 6.

Hence there are six possible different events −

- Lifting the Left leg
- Releasing the Left leg
- Lifting the Right leg
- Releasing the Right leg
- Lifting both the legs together
- Releasing both the legs together

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In case of k=6 legs, there are 39916800 possible events. Hence the complexity of robots is directly proportional to the number of legs.

Wheeled Locomotion

It requires fewer number of motors to accomplish a movement. It is little easy to implement as there are less stability issues in case of more number of wheels. It is power efficient as compared to legged locomotion.

- **Standard wheel** − Rotates around the wheel axle and around the contact
- **Castor wheel** − Rotates around the wheel axle and the offset steering joint.
- **Swedish 45º and Swedish 90º wheels** − Omni-wheel, rotates around the contact point, around the wheel axle, and around the rollers.
- **Ball or spherical wheel** − Omnidirectional wheel, technically difficult to implement.

Slip/Skid Locomotion

In this type, the vehicles use tracks as in a tank. The robot is steered by moving the tracks with different speeds in the same or opposite direction. It offers stability because of large contact area of track and ground.

Components of a Robot

Robots are constructed with the following −

- **Power Supply** − The robots are powered by batteries, solar power, hydraulic, or pneumatic power sources.
- **Actuators** − They convert energy into movement.
- **Electric motors (AC/DC)** − They are required for rotational movement.
- **Pneumatic Air Muscles** − They contract almost 40% when air is sucked in them.

- **Muscle Wires** − They contract by 5% when electric current is passed through them.

- **Piezo Motors and Ultrasonic Motors** − Best for industrial robots.

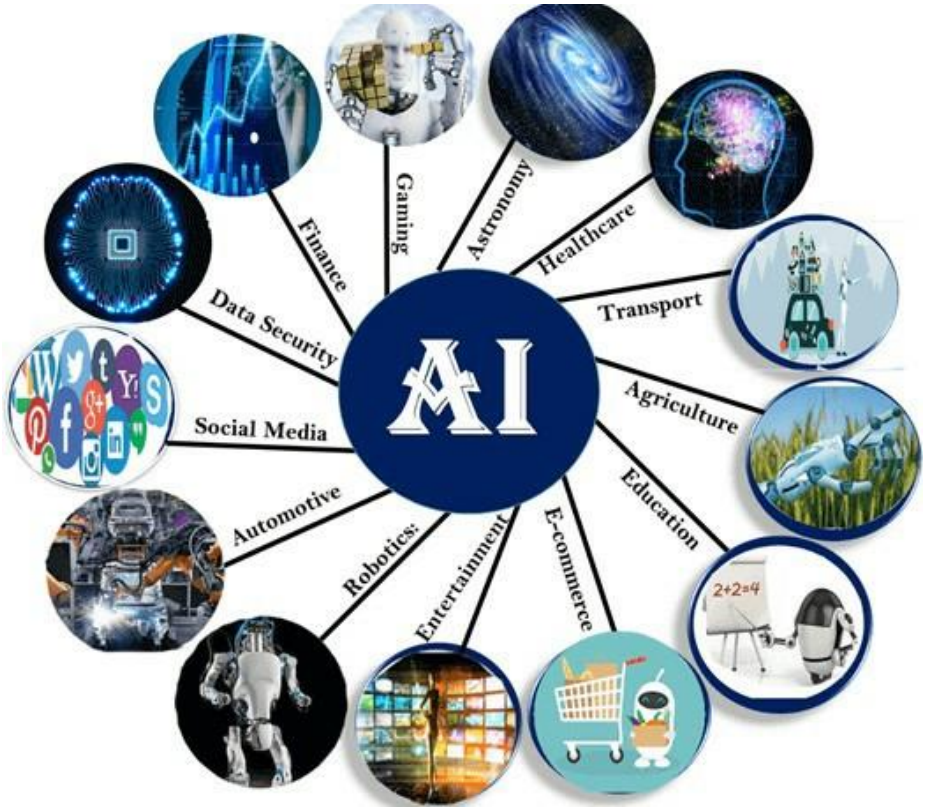
- **Sensors** − They provide knowledge of real time information on the task environment. Robots are equipped with vision sensors to be to compute the depth in the environment. A tactile sensor imitates the mechanical properties of touch receptors of human fingertips.

5.5. Application of AI

Artificial Intelligence has various applications in today's society. It is becoming essential for today's time because it can solve complex problems with an efficient way in multiple industries, such as

Healthcare, entertainment, finance, education, etc. AI is making our daily life more comfortable and fast.

Following are some sectors which have the application of Artificial Intelligence:



1. AI in Astronomy
   - Artificial Intelligence can be very useful to solve complex universe problems. AI technology can be helpful for understanding the universe such as how it works, origin, etc.

2. AI in Healthcare
   - In the last, five to ten years, AI becoming more advantageous for the healthcare industry and

going to have a significant impact on this industry.

- Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization.

3. AI in Gaming

- AI can be used for gaming purpose. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

4. AI in Finance

- AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

5. AI in Data Security

- The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure. Some examples such as AEG bot, AI2 Platform,are used to determine software bug and cyber- attacks in a better way.

6. AI in Social Media

- Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyze lots of data to identify the latest trends, hashtag, and requirement of different users.

7. AI in Travel & Transport

- AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangement to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response.

8. AI in Automotive Industry

- Some Automotive industries are using AI to provide virtual assistant to their user for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant.
- Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure.

9. AI in Robotics:
   - Artificial Intelligence has a remarkable role in Robotics. Usually, general robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.

- Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot named as Erica and Sophia has been developed which can talk and behave like humans.

10. AI in Entertainment
    - We are currently using some AI based applications in our daily life with some entertainment services such as Netflix or Amazon. With the help of ML/AI algorithms, these services show the recommendations for programs or shows.

11. AI in Agriculture
    - Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis. AI in agriculture can be very helpful for farmers.

12. AI in E-commerce
    - AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand.

13. AI in education:
    - AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant.
    - AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

Questions:

1. What is the Working of Image Recognition and How it is Used?
2. What is facial recognition - and how sinister is it?
3. What is object recognition in image processing?

4. what is speech recognition in artificial intelligence
5. What's the Difference Between Robotics and Artificial Intelligence?
6. What is robotics?
7. what are applications of artificial intelligence

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