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Computer Vision in the Field of Electrical Engineering: A Review

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Abstract: There is no doubt that electricity is an extraordinarily strong form of energy that is utilized to power machinery, lighting, tools, electronics, and other objects that we use in our daily lives. But what actually makes all this possible is a reliable power system network, and the equipment present in the network are what make up a power system. They can be a part of Generation, Transmission, or Distribution system. Any damages in any equipment of the power system network adversely affects the balance of the whole power system. These damages can often be detected by simple observatory inspections, where a technician or an engineer checks the outer surface of equipment to find any damage. Sometimes though, due to human error or negligence on the worker's part can leave a damaged equipment undetected till it's too late. This can lead to an even greater damage which in terms increases the losses. To avoid this from happening we could apply computer vision as well as image processing to do the same work that a technician does. It can also be applied for maintaining same work that a technician does. It can also be applied for maintaining optimum parameters of various different equipment that is usually a technician or an engineer's job. The parameters such as temperature, voltage, current and oil level of an equipment are monitored, processed and recorded. For this purpose, we use camera sensors as well as image processing algorithms.

Keywords: Cryptocurrency, Bitcoin, Encrypted, Currency, Bitpay, Exchange Rates

Introduction

One of the most effective and appealing forms of AI is computer vision, which you've almost certainly encountered in a variety of ways without you realizing it. Computer vision is a branch of computer science that focuses on duplicating aspects of the complexity of the human visual system and enabling computers to detect and analyze things in photos and videos in the same manner that people do. Artificial intelligence has made enormous strides in recent years, and is now capable of outperforming humans in various tasks involving detection and labelling. This is due to developments in deep learning, neural networks, and artificial intelligence. If AI gives computers the ability to think, computer vision gives them the ability to see, observe, and comprehend. At a high level, any technology is embraced because it improves something. Something slower becomes significantly faster, expensive becomes cheaper, manual becomes automated, difficult becomes easy, and something unsalable becomes scalable. And well, computer vision is a technology which helps in doing just that!

The quantity of data that we produce today, which is subsequently utilized to train and improve computer vision, is one of the key elements influencing the development of this technology. The processing capacity needed to analyze the data is now available, together with an enormous volume of visual data (each day, more than 3 billion photographs are posted online). The accuracy rates for object recognition have increased along with the development of new hardware and algorithms in the computer vision sector. Today's systems are now 99 percent accurate, up from 50%, making them faster than humans at responding

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to visual inputs.

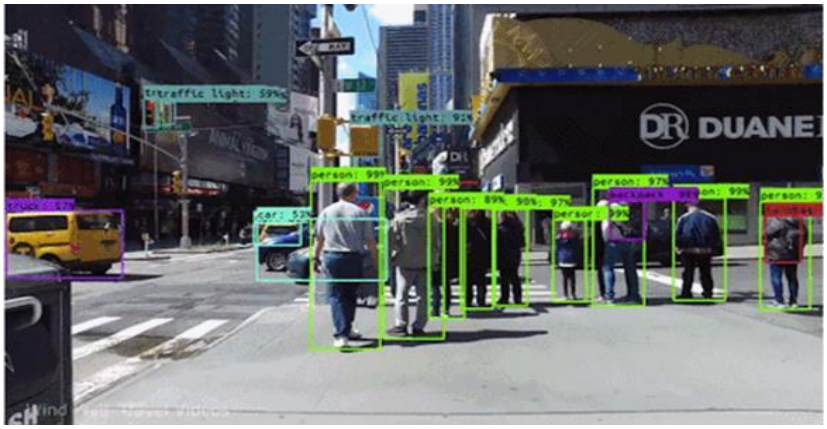

Fig. 1. Computer Vision in Action

Computer vision methods are also used in image processing applications, such medical imaging, where they help with sophisticated data analysis, visualization, and diagnosis. Figure1. Shows computer vision in action. Overall, the incorporation of computer vision into electrical engineering has resulted in a paradigm change, enabling engineers to use visual data for a variety of novel solutions and breakthroughs.

Section 2 and 3 will be discussing about Literature survey of the computer vision and its applications and some of the various works done in the field as well as the problem identification for the widespread application of Computer Vision in the field of Electrical Engineering. Section 4 and 5 will decide and describe the expected outcomes of the implementation of computer vision. Furthermore, it also describes about the basic methodology used for computer vision.

Review of Literature

In the field of artificial intelligence known as computer vision, objects in images and videos may be seen, recognized, and analyzed by computers in the same ways that people do. For automated AI vision inspection, remote monitoring, and automation,computational vision is quickly growing in popularity.

- Robotics and automation: Computer vision is a key component of electrical engineering applications in robotics and automation. Computer vision enables robots to detect and comprehend their environment, enabling them to carry out difficult tasks independently. For instance, computer vision algorithms in assembly lines may direct robotic arms to precisely arrange electrical components for exact and effective assembly.

- Surveillance and Security: Security and surveillance systems use computer vision to monitor and protect the safety of electrical infrastructure. Computer vision algorithms can be used to analyze visual data from cameras in order to spot unauthorized entry, recognize possible threats, or keep an eye on sensitive locations for security breaches. This improves the safety and security of electrical infrastructure as a whole.

- Image and Signal Processing: Electrical engineering applications for image and signal processing

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can make use of computer vision technology. For instance, computer vision algorithms can help with the analysis and interpretation of diagnostic pictures in the field of medical imaging, assisting in the identification of anomalies or illnesses. Computer vision may be used in audio processing to analyze spectrograms or waveform data for tasks like voice identification or noise suppression.

- Human-Machine Interaction: Computer vision can improve human-machine interaction in systems designed for electrical engineering.

- For instance, computer vision-based gesture recognition enables users to operate machinery or electrical devices using simple hand motions. In secure electrical environments, facial recognition algorithms may also be used for access control or biometric identification.

Table 1. Summary of Literature Survey

Authors	Paper Title	Ref.	Findings
R. A. Jarvis et. Al	A Perspective on Range Finding Techniques for Computer Vision.	[1]	The paper surveyed various approaches to generalized range finding, their applicability, and their shortcomings.
Fitri Utaminingrum, et al.	Development of Computer Vision Based Obstacle Detection and Human Tracking on Smart Wheelchair for Disabled Patient.	[5]	The paper gives explanation about a smart wheelchair system equipped with obstacle detection and human tracking algorithm based on computer vision.
Debalina Barik, et al.	Object Identification For Computer Vision using Image Segmentation.	[4]	The Authors proposed a method for the detection of objects from chaotic backgrounds using Image Segmentation and Graph Partitioning.
Victor Wiley, et al.	Computer Vision and Image Processing: A Paper Review.	[6]	The paper provides a survey of the recent technologies and theoretical concepts revolving around the development of computer vision related to image processing using different domains (field applications);
Sami Gazzah, et al.	A Survey on how computer vision can response to urgent need to contribute in COVID-19 pandemics.	[7]	The paper contains a survey and discussion regarding the detection of COVID-19 using computer vision and machine learning.

These are only a few instances of the many issues that computer vision can solve in the area of electrical engineering. Computer vision offers increased effectiveness, safety, and decision-making in a variety of electrical engineering applications by using visual data and sophisticated algorithms.

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Application of Computer Vision in Different Fields

Computer vision is employed in a variety of industries, from energy and utilities to manufacturing and automotive, and the industry is expanding. By 2020, it was estimated to reach USD 48.6 billion. Various applications of computer vision are present and they're increasing at a rapid rate;

3.1 Applications of Computer Vision:

- Healthcare
- Banking
- Agriculture
- Insurance
- Manufacturing
- Surveillance
- Automobiles

3.2 Disadvantage of Existing System

The majority of failures in electrical power networks are caused by equipment. Field inspection and aviation inspection are two conventional ways for testing the electrical network. These two approaches are the most commonly used since they may cover a wide range of frequent defects, including line components and the power line itself.

However, the following are some of the downsides of conventional / most widely utilized power system practices:

- Slow walking inspections
- Labour intensive
- Defect detection influenced by personnel experience;
- Helicopter inspection can be challenging to implement in practice;

Working Method

One of the key unanswered topics in Neuroscience and Machine Learning is nothing but working of human brains. The reality is that there are very few functioning and complete theories of brain computation; hence, despite the fact that Neural Nets are meant to "mimic the way the brain works," no one knows for sure

The same contradiction applies to computer vision: because we haven't decided how the brain and eyes perceive pictures, we can't evaluate how closely the algorithms employed in production mimic our own internal mental processes. Pattern recognition is at the heart of computer vision on some level. So one method of teaching a computer to understand visual data is to feed it images, thousands, if not millions, of labelled images, and then subject those to various software techniques, or algorithms, that allow the computer to search for patterns in all the elements that relate to those labels. A large amount of data is required for computer vision. It repeatedly executes data analyses until it detects distinctions and, eventually, recognizes pictures. To teach a computer to recognize automotive tires, for example, massive amounts of tire photos and tire-related materials must be given into it in order for it to understand the distinctions and recognize a tire, especially one with no faults.

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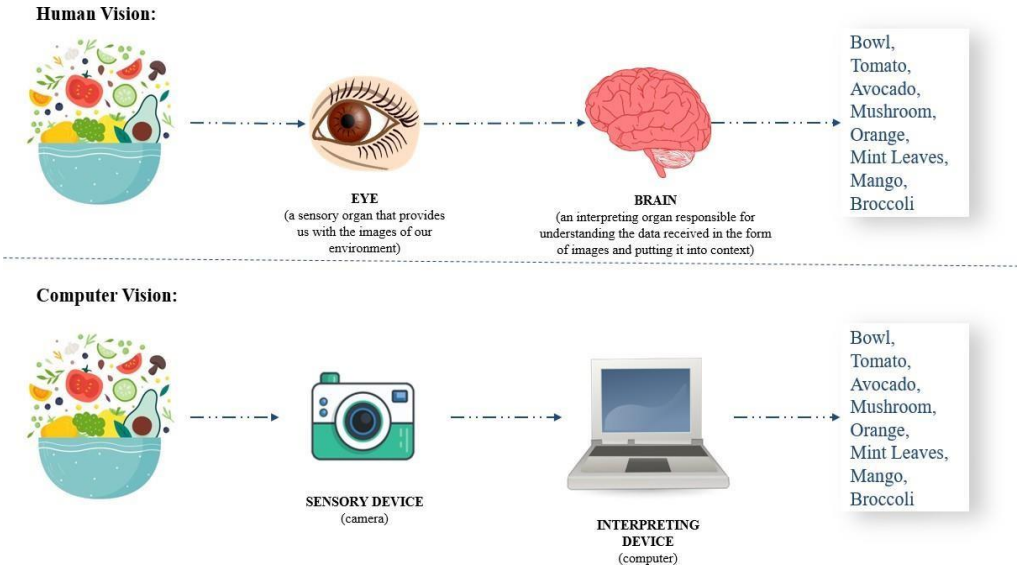

Fig. 2. Human Vision V/S Computer Vision

4.1 Components of Computer Vision

- **Lighting:** When it comes to high image quality, illumination is crucial. We desire well-lit surroundings for all machine vision applications so that objects may be scanned repeatedly with well-defined features and edges and a high enough contrast ratio to discern what we want to detect. The primary message here is that even if you have the greatest cameras, lenses, PC, software, and picture pre-processing algorithms, none of this will be able to compensate without well-planned and adequate lighting to highlight crucial elements. Good lighting makes almost everything else in the process much simpler.

- **Camera:** This is also known as a vision sensor (or, imaging sensor), and it is in charge of assessing pictures taken by the camera to determine assembly correctness or the presence of flaws. The most prevalent types of vision sensors on the market are orthographic projection and perspective projection. The field of vision in an orthographic projection is rectangular, making it suited for infrared sensors. The perspective type, on the other hand, projects a trapezoidal field of vision, making it more ideal for camera-type sensors.

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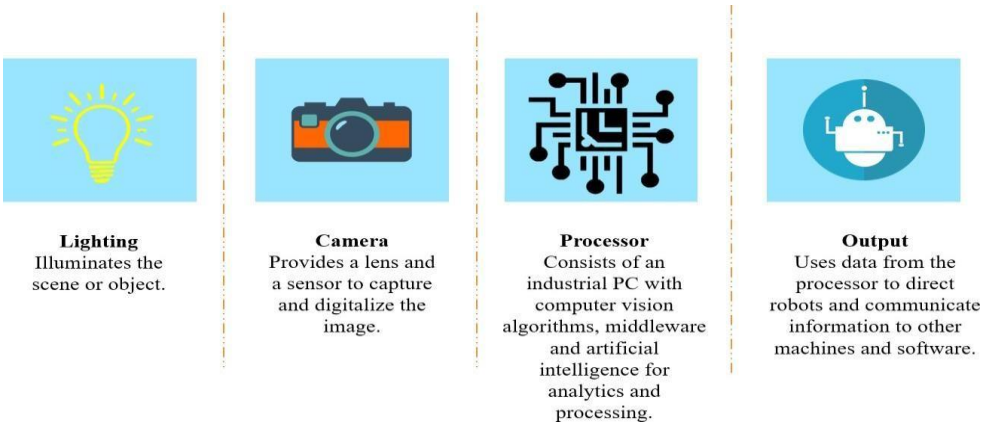

Fig. 3. Components of Computer Vision

- **Processor:** It is obvious from the name alone that the processor is in charge of carrying out machine vision algorithms. It could have a direct link with the ability to get pertinent information from a camera device. In essence, it is crucial to guarantee that the picture processing is finished flawlessly

- **Output:** A description or an interpretation of the structures in a 3D environment is what computer vision produces. In order to identify a certain class of picture and then recognize and tabulate its existence in an image or video, object detection might employ image classification. Instead than focusing on the metadata tags that are attached to the photos, content-based image retrieval employs computer vision to browse, search, and retrieve images from massive data repositories. After an item is found, it is followed or tracked. This operation is frequently carried out using real-time video streams or a series of sequentially taken pictures. Autonomous automobiles, as an illustration. A puppy, an apple, or a person's face are examples of images that may be classified using image classification.

4.2 Limitations

Despite all the benefits of computer vision made possible by machine learning, there are still drawbacks to be aware of:

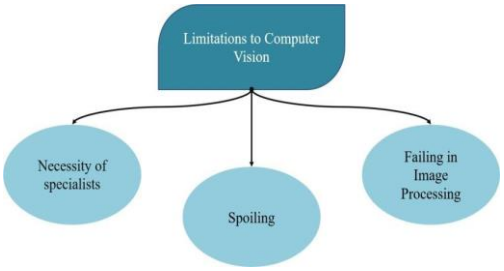

Fig. 4. Limitations of Computer Vision

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4.3 Need for expertise: The fields of machine learning and artificial intelligence have a great need for specialists. A qualified individual who is familiar with such gadgets' operations and can effectively utilize computer vision. Additionally, if required, the person can fix them. After earning a master's degree in artificial intelligence, there are several employment prospects. Companies are still waiting for such professionals, though.

4.4 Spoiling: In some situations, removing the human element may be beneficial. However, when a machine or equipment breaks down, it doesn't signal or foresee the issue. A human, however, can predict when a person won't arrive.

4.5 Failing in image processing: It is very likely that Computer Vision and image processing will fail when the device malfunctions due to a virus or other software problems. But if we don't fix the issue, the device's features can stop working. In the case of warehouses, it may even freeze the entire output.

Expected Outcomes

Computer Vision, although a new and emerging technology has many benefits along with its long list of applications invarious different fields.

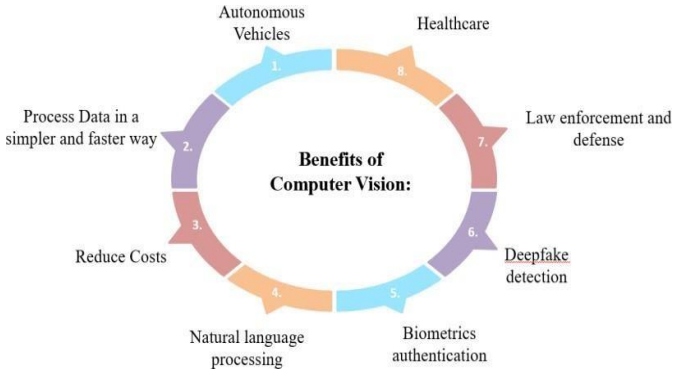

Fig. 5. Benefits of Computer Vision

Some of the benefits include: The work that took days if not weeks can now be completed in mere minutes and seconds thanks to the superfast processors as well as the new processing algorithms and techniques. Applications of Computer Vision in power system networks would help simplify various labour intensive tasks. Tasks requiring highly experienced technicians can also be done by computer vision applications instead. Gaining experience in the field is long and tedious task and once, the technician or engineer retires the experience goes with them. Hence, CV can help in both training new employees as well as retain the previously earned experiences. Computer Vision is comparatively cost-effective for running on a large scale.

Conclusion

We have made some significant recent advances, but computer vision is still a problem that we are far from addressing. However, a number of organizations and businesses have already discovered methods to adapt

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CNN-powered CV systems to actual issues.

- Within the next decade, computer vision has the potential to transform almost every industry vertical.
- With the benefits and drawbacks of computer vision in mind, you may create a solution that meets your specific business requirements.
- Making computers see and understand what they see is a significant step forward for the AI domain and all companies that rely on the timely development of AI in general.
- In case the said technology on a large scale is implemented in the power system network, it would revolutionize a wide variety of applications such as, increasing the efficiency and accuracy of meter reading and parameter reading of equipment;
- Activities such as power equipment monitoring and conditioning as well as maintenance can be completed with ease with the help of computer vision and image processing techniques. The reason for this is the complex nature of identification and segmentation of bigger, chaotic environments. Computer Vision, unlike our brain and eyes needs techniques such as CNN and deep learning for recognizing new objects which increases the training that a model requires. But it has been proven to be excellent at performing repetitive tasks including fault or defect detection in industries.

Future Scope

With many developments and applications in the works, computer vision's potential in the field of electrical engineering is quite encouraging. The following are some crucial areas where computer vision is anticipated to make a big impact:

- The development of autonomous systems, such as self-driving automobiles, drones, and robots, will depend increasingly on computer vision. These systems will be able to observe and comprehend their surroundings in real-time thanks to sophisticated computer vision algorithms, resulting in safer and more effective functioning.
- By allowing smart factories and automated quality monitoring, computer vision will further revolutionize the production process. In order to monitor manufacturing lines, identify flaws, and streamline the assembly process, vision-based solutions will be used, improving product quality and productivity.
- By facilitating effective monitoring, issue identification, and proactive maintenance, computer vision can benefit energy and power systems. Vision-based algorithms may be used to optimize energy use, find and track power distribution network issues, and keep an eye on the health of vital infrastructure.
- By providing organic and intuitive interfaces, computer vision will continue to improve human-computer interaction. The seamlessness and immersion of interactions with computers and other devices will be improved through gesture detection, facial expression analysis, and eye-tracking techniques.
- Environmental monitoring and conservation activities can benefit from the application of computer

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vision. Computer vision algorithms can help in tracking animals, environmental study, and habitat preservation by looking at visual data.

- These are only a few illustrations of computer vision's potential applications in electrical engineering. Computer vision will likely keep pushing limits and creating new opportunities as technology develops in a variety of fields and applications.

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