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A STUDY ON THE APPROACH OF IMAGE PROCESSING AND COMPUTER VISION THROUGH NEW TECHNIQUES

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Abstract

Image processing and computer vision is a field that has become increasingly significant and indispensable in the modern world. Using computer vision techniques, one can find solutions to a number of difficulties. Because there are so many problems to be solved and chances to be taken advantage of, experts in the field of computer vision are required to have the necessary abilities. Applications of computer vision extend to every band of the electromagnetic spectrum, and each band contains a diverse set of usable programmes for computer vision. This article is geared toward graduate students, academics, and researchers who are interested in finding solutions to challenges pertaining to the fields of image processing and computer vision. It discusses the aforementioned topics in addition to the opportunities and trends that are now present in computer vision applications across all new domains. An available literature survey is used to determine what the research needs are, and these needs are then categorised according to the appropriate domains. This document contains a collection of possible exemplary photographs that were taken from a variety of research archives and made available online. The purpose of this article is to draw attention to some of the current opportunities available in the field of image processing and computer vision, along with the repositories that are most relevant to those chances. This article provides interested researchers who are already active in the field with the opportunity to select an issue to work on and provide them with a means to collect experimental photographs from the references that are cited.

1. Introduction

The idea that humans are capable of visualising practically everything in this world is widespread, yet this is only the case when our visualising is done through technological means. Through the use of our eyes, we are only able to view a small portion of the electromagnetic spectrum, which belongs to the band known as the visible spectrum. The various properties of an object, such as size (we are unable to see objects at the nano and micro levels), distance (an object that is too far from us cannot be visualised), covered structure (human eye visibility cannot penetrate a body or real object), vision in the dark (human eyes cannot see without light),

vision in fog (human eyes cannot see beyond fog), etc., all contribute to the fact that the features observable in the visible spectrum are limited for human eyes. Imaging, on the other hand, can assist us in visualising the objects in any one of the aforementioned scenarios.

Imaging is just one of the many applications that makes use of the multiple bands that are defined by the electromagnetic spectrum . These bands include radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma bands. There is an image system developed for each band of the electromagnetic spectrum, and there are cameras and devices available that are highly specialised to acquire those imaging systems.

The wavelength and energy range of each band is unique, the characteristics and qualities of the image that result from its use are likewise subject to variation. Because of these features, we are able to gather various sorts of information and data from the same environment and object, some of which even humans are unable to see. Current research prospects for image processing and computer vision Such photos are processed by a computer system, which then extracts features, followed by information, which is highly suggested as input to a system in order to address a particular problem.

2. Difference between Image Processing and Computer Vision

Both image processing and computer vision are extremely intriguing subfields within the subject of computer science.

Computer Vision:

In the field of computer vision, computers and other machines are designed to extract high-level understanding from the digital images or movies that are fed into them. This is done with the intention of automating functions that are normally performed by the human visual system. Image processing is simply one of the various methods that are utilised by this method.

Image Processing:

Image processing is a field that focuses on improving images by adjusting a wide variety of the images' parameters and characteristics. Therefore, Image Processing can be thought of as a subfield of Computer Vision. In this step, transformations are done to an image that was provided as input, and the image that was produced as a result of those transformations is then returned. Some examples of these adjustments include sharpening, smoothing, and stretching, amongst others.

There appears to be a lot of confusion regarding the difference between these two branches of computer science due to the fact that both fields deal with working in visuals, which includes working with images and movies. Within the scope of this post, we will compare and contrast the two of them.

The distinction between Image Processing and Computer Vision is as follows:

The primary goal of image processing is to improve the quality of the raw input photos or to get them ready for usage in some other application by processing such images. The primary objective of computer vision is to derive information from the pictures or videos that are used as input in order to have an accurate grasp of the data and to anticipate the visual data in the same way that the human brain does.

Methods such as anisotropic diffusion, hidden Markov models, independent component analysis, different filtering, and many more are utilised throughout the image processing process.

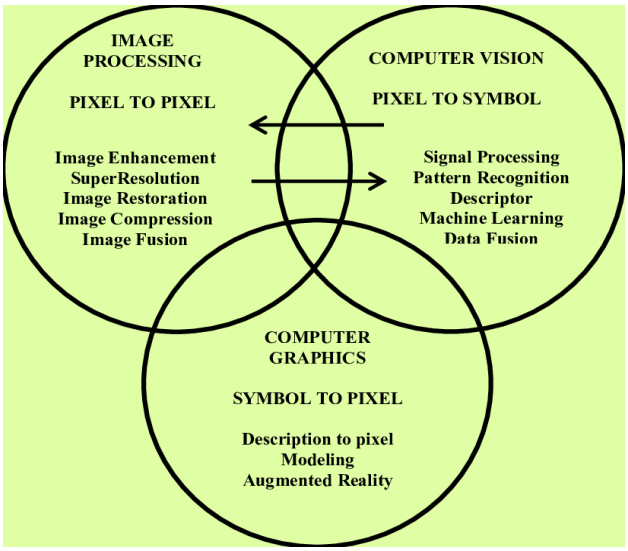
Image processing is just one of the many techniques that are employed in computer vision; other approaches, such as machine learning, CNN, and so on are also utilised.

The field of Computer Vision includes Image Processing as one of its subfields. Image processing is the subfield that Computer Vision falls under.

Some applications of image processing include rescaling the image (also known as digital zoom), correcting the illumination, and changing the tones, among other things.

Object detection, face detection, handwriting recognition, and other similar tasks are all examples of applications that computer vision can perform.

Figure 1 Shows the differences



Essential Steps in Digital Image Processing

1. Image Acquisition

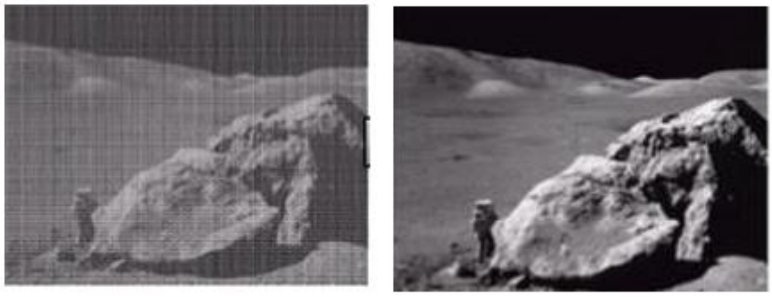
Image acquisition typically involves a sensor like a camera taking a picture of an object to be used as an image. A device known as an analogue to digital converter is utilised whenever there is a need to transform non-digital forms of output into digital formats. Pre-processing steps, such as scaling the images, are also a part of this process.

2. Image Enhancement

Image enhancement refers to a procedure that is associated with the editing of images in order to generate results that are useful for specific tasks that need to be carried out. In an ideal situation, this procedure is related to image filtering and entails the execution of activities such as noise removal, contrast adjustment, brightness modification, and sharpening of the photos for the purpose of increasing the quality of the images that were initially recorded.

3. The Restoring of images

The process of enhancing the appearance of a picture that may have been degraded due to the interaction of mathematical and probabilistic models is known as image restoration. One perfect illustration of this would be the elimination of blurring in an image.



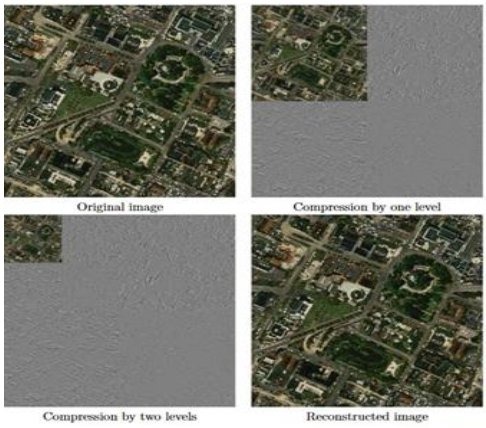
Degraded Image Quality Image Restoration

4. The Processing of Color Images

The process of extracting features from an image using a method based on colour.

5. Processing in Wavelets and at Multiple Resolutions

It entails representing images in terms of the possible resolutions of varying degrees, which is typically done for the purpose of image compression. This is also helpful for compressing the data associated with images.

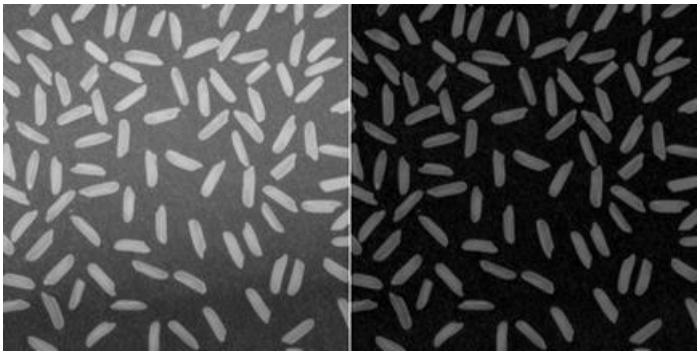


6. Compression

Compression can either reduce the amount of storage space needed to save an image or the amount of bandwidth needed to display an image. Both of these reductions can be accomplished with the help of compression. The approach known as image compression includes all of the methods that involve reducing the size of an image while simultaneously adjusting it in such a way that the quality suffers the least possible loss.

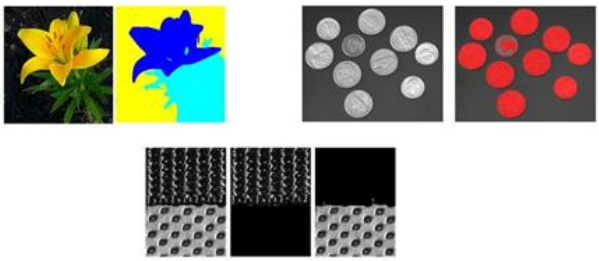
7. The processing of morphological information

The shape of a given object in an image can be described by isolating its basic components and working backwards from there. Erosion and dilation are two examples of common morphological procedures that are used in the production of picture characteristics.



8. Segmentation

Image segmentation is one of the necessary procedures that must be performed during image processing. This procedure involves dividing the image into a number of different segments. This method enables the items inside a picture to be located as well as the boundaries of those objects to be identified. It is essential to keep in mind that the accuracy of the segmentation will lead to improved recognition and classification accuracy. This is a vital connection to make.



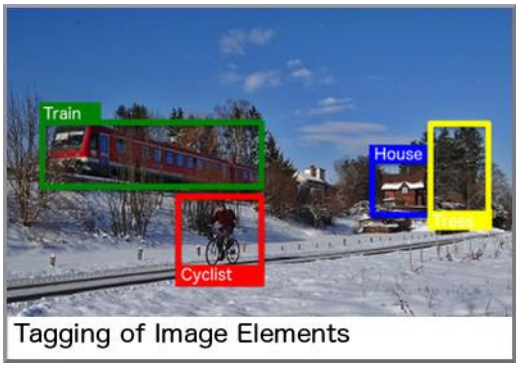
9. Representation and Specific Detailed Description

Displaying the visual output in the shape of a region or border is related with the representation. It could entail the qualities of the shapes in the corners, or it might incorporate regional representations like the texture or the skeletal structures.

On the other side, the description, also known as feature selection, is in charge of gleaning relevant information from an image. This task falls under the umbrella of feature extraction. The information that was retrieved has the potential to assist in the accurate differentiation of distinct kinds of objects from one another.

10. Object Recognition / Image Labeling

The act of labelling something based on its description in order to organise it into a category for the purposes of classification. This is a very significant step in the development of computer vision. In order to train models, it is necessary to process and label a sufficient number of photos from a big corpus. This enables the Computer Vision model to recognise similar objects in images that have not been labelled.



Tagging of Image Elements

3. Vision Using Computers

As was just mentioned, "Image Processing" generally refers to the process of applying algorithms to various types of images. These kinds of algorithms typically have the goal of improving the image's overall quality or modifying it in order to get a different kind of visual effect. However, Image Processing is also highly crucial when it comes to preparing images for Computer Vision models. This may involve applying segmentation or identifying recognised objects. Image Processing can do both of these things.

The term "computer vision" refers to the various techniques that are used to give computers the ability to interpret the meaning of images. Visual recognition, a method that permits the recognising of objects and image attributes, is the most prevalent application of this technology. Image recognition is a process. Image recognition is utilised in a wide variety of applications in the modern world, including but not limited to medical imaging, security monitoring, facial recognition, identification of brands and buildings, and many others. However, in order for these models to function, the images will first need to be segmented, tagged, or subjected to any of the other processing procedures that were discussed earlier.

In the modern era, applications that make use of computer vision have seen a great deal of success; some of the most noteworthy use cases are described in the following paragraphs:

Inspection for Defects

The manufacturing units have benefited from image recognition's contributions in a beneficial way. During the production process, the major purpose of picture recognition has been to pinpoint any flawed products that may have been produced. The total process is sped up, which leads to increased levels of efficiency in the mode of operations, and the capacity to quickly evaluate thousands of defective products along the assembly line is essential to this.

Image Classification

Picture classification is one of the various sorts of study that has been conducted, and it is possibly the most important component of image recognition. In recent years, a number of studies have been conducted with the goal of determining whether or not it is possible to provide medical professionals with assistance in locating an area of interest that can identify and anticipate a certain disease. Image classification has been a significant factor in the development of e-commerce businesses, helping to improve the user experience by providing more rapid search options. The ability to classify images according to the content of an image is provided by image classification. It is incorporated into the vast majority of the image retrieval engines and recommendation systems that are in use in the modern era.

Automatic Driving System

The cutting-edge technology of driverless cars has not yet reached its full potential and cannot legally be used in commercial settings until this occurs. However, by incorporating picture recognition into computer vision

algorithms, it is now conceivable to have the ability to identify pedestrians and to stop when a stop sign is being displayed.

Robotics

Image recognition has been included into a variety of robotics-based projects as a means of instructing the robots to recognise objects for the purpose of improved navigation and locating obstacles that may be in their way.

The detection of text

The detection of text is another another potentially useful contribution that can be made with the assistance of picture recognition. Text detection allows for the extraction of text and characters from an image, such as a photograph, which may contain a street sign or a traffic sign. This extraction of text and characters from an image has been a possibility for some time. Cloud Vision by Google is one of the most successful businesses operating in the text detection industry today.

Facial Recognition

The development of artificial intelligence has made facial recognition a reality in recent years. Facial recognition is in high demand on the market due to its possible applications, which range from protecting the device to conducting surveillance. However, there are a number of specialists who are concerned about the privacy implications of the technology. Nevertheless, it cannot be denied that each and every technological advancement comes with a set of inherent constraints. Therefore, the effective application of techniques for facial recognition will result in life essentials such as traffic and city monitoring if it is done correctly.

e-Commerce

Customers can now search for products that are comparable to those they already own by uploading photographs of things that they already own or products that they want to find complementary styles to. In order to accomplish this, the image must first be converted into a visual embedding. Following this step, the recommendations will consist of either products that are comparable to the one that was uploaded or products that are known to be complementary.

Getting Started with Image Recognition Models

Some of the most valuable packages to utilize for Computer Vision and Image Processing include:

Imutils

Opencv

Dlib

Scikit-learn

Scikit-image

Tensorflow

Keras

Mxnet

Fastai

Pytessarct

Pytorchcv

4. Current trends in image processing

The principles of image processing and computer vision can be used to the solution of a wide variety of problems in a variety of contexts. The rigorous research and development for each application has evolved based on certain parameters, such as the improvement in imaging technique, the improvement in principle, the extension of computation power and space, and the use and requirement of applications in the current scenario. Table 1 contains a list of applications that are currently evolving and necessary for research and development in the aforementioned fields. Keeping these characteristics in mind, we were able to compile this list. These applications are categorised according to the study areas, and the opportunities that belong to those categories are addressed in further detail.

Table 1

Various opportunities in field of image processing

S. No.	Research Area	Opportunity	Modality
1.	Medical Diagnosis and Treatment Planning	Volumetric segmentation	3D
		Region of interest segmentation	2D
		Automatic detection of landmarks	2D, 3D
		Automatic registration and fusion	2D, 3D
		3D surface reconstruction	2D, 3D
		Tumor/cancer detection	2D, 3D
		Superimposition of facial structure	3D
2.	Agricultural sector	Seed analysis and grading based on X-ray image	2D, 3D
		Automatic seed grading system based on visible spectrum	2D, 3D
		Automatic fruit, pulse, rice grading system	2D, 3D
		Categorization of plants	2D
		Disease detection in plants	2D
		Automatic monitoring of plants	2D
3.	Monitoring applications	Surveillance through infrared imaging	2D
		Fault detection in machinery using thermal imaging	2D
4.	Disaster Management application	Prediction of land sliding using image registration in sensitive areas	2D
5.	Underwater Image Processing	Automatic classification of marine species in underwater imaging	2D, 3D
6.	Others	Multiple image fusion	2D, 3D
		Exploration of hyperspectral images	2D, 3D

Current research opportunities for image processing and computer vision

Current Trends in computer vision

The discipline of computer vision is one of the most cutting-edge and constantly expanding areas of study. According to Grand View Research, the size of the global computer vision market was assessed at $11.32 billion in 2020. From 2021 to 2028, it is anticipated that the market would rise at a compound yearly growth rate of 7.3 percent. There are almost an infinite number of applications for computer vision that is enabled by artificial intelligence, but some of the most common ones include consumer drones, fully autonomous vehicles, and semi-autonomous vehicles. In addition, as a result of recent developments in computer vision, artificial intelligence (AI) is now essential in many different fields, including but not limited to education, healthcare, robotics, consumer electronics, retail, manufacturing, and more. In light of the rapid development that has taken place in the field of computer vision, it is essential to conduct research into the history of the field in order to gain a better understanding of where it came from and where it is headed, particularly when it comes to selecting the next computer vision project. In this piece, we will discuss the fundamentals of computer vision as well as some recent developments in the field.

Trend 1: Computer vision on the edge

It's all about the edge these days. Instead of being processed and analysed in the cloud or at a data centre, data can be processed and analysed closer to where it is collected, which is what is meant by the term "edge computing." Edge computing refers to a technology that is attached to the location where the data is generated, also known as "at the edge of the architecture." Edge computing architectures are being implemented into computer vision projects at an increasing rate due to the fact that they provide a solution to the issues of network accessibility, capacity, and latency. Even cloud architectures frequently need to be deployed on edge devices in order to ensure adequate levels of performance, resilience, and privacy. Computing at the edge is becoming increasingly used for applications and projects that require real-time data processing. Projects like these include self-driving cars, drones, and other similar technologies.

Identify objects

Find a specific object among others

Detect obstacles

With sign detections and navigation

Recognize people

Share information about human crowds

Trend 2: Computer vision as a service

As a result of the increasing popularity of computer vision, an increasing number of platforms are recommending various types of solutions. The use of platforms can cut down on the amount of time you spend processing images, classifying data, and curating data. In general, if you do not use a platform that supports computer vision, you will need to delve significantly deeper and carry out the following steps:

Developing the workflow around your AI processes.

Getting data from different sources.

Storing and labeling the data.

Checking and correcting mislabeled data.

Following versioning.

The term "computer vision as a service," abbreviated as "CVaaS," is currently receiving a significant amount of attention. It paves the way for businesses who are not in the AI industry to purchase pre-built algorithms that are available on computer vision platforms and so take benefit of the technical breakthroughs. Because the computer vision algorithms and application programming interfaces (APIs) may be downloaded on demand in accordance with a pay-as-you-go model, innovation in the field of computer vision becomes both affordable and scalable. One example of a prudent action would be to outsource services for data annotation.

Trend 3: Data-centric computer vision

Data is the most important aspect of computer vision, and the quality of the model is dependent on the instances that are provided to it. The first thing that has to be done to construct AI models is to collect enormous datasets for training. We are under the misguided impression that the only way to address the inaccuracy of our models is to amass enormous, borderline insanity-inducing amounts of data. For instance, if we are developing a model to identify rabbits, we will want ten thousand photos of rabbits taken from a variety of perspectives, under a wide range of climatic and illuminative conditions, and with a wide range of rabbits in terms of size and colour.

However, the trend in today's society is toward putting an emphasis on quality above quantity. It does not imply that the number of training instances does not play a role; nonetheless, it is possible that your training model may not necessarily benefit from a large number of training examples. Rather, if the training examples that are offered are correct as well as helpful, it will work out quite well. In the event that we discover that our training data is erroneous, we have the option of either cleaning up the noise or locating the photos that have been incorrectly labelled. If it does not provide sufficient insight, we may either increase the size of the data set by gathering an additional group of pictures that feature rabbits or even start over with a new collection. How can the level of information contained within an image be evaluated? This certainly qualifies to be the topic of its own article.

According to the findings of recent studies, the performance of your learning algorithm can be improved just as well by any of these two methods. The majority of the time, it is far simpler to identify samples that have been incorrectly classified and to come up with a methodical approach to accurately describe them. Data-centric computer vision is the type of computer vision that will be essential to the development of effective computer vision applications in the future.

Conclusion

This article identifies a significant number of possibilities, both already available and those that will become available in the near future, that can be found in the field of image processing and computer vision and lists them in the appropriate categories. Coverage of the electromagnetic spectrum is determined by opportunities that have recently emerged in the current environment. The majority of the issues are presented through the use of example photographs, which makes the content more engaging to readers and motivates them to continue. There are a lot of data repositories that are described, along with their applications, so that any researcher who is interested can locate data to use in order to solve a research topic that corresponds to it.

References

S. Sankaran and R. Ehsani, ”Introduction to the Electromagnetic Spectrum,” in Imaging with Electromagnetic Spectrum: Applications in Food and Agriculture, A. Manickavasagan and H. Jayasuriya, Eds., ed Berlin, Heidelberg: Springer Berlin Heidelberg, 2014, pp. 1-15.

F. A. Jolesz and S. M. Blumenfeld, ”Interventional use of magnetic resonance imaging,” Magn Reson Q, vol. 10, pp. 85-96, Jun 1994.

Y. Cui, C. Yuan, and Z. Ji, ”A review of microwave-induced thermoacoustic imaging: Excitation source, data acquisition system and biomedical applications,” Journal of Innovative Optical Health Sciences, vol. 10, p. 1730007, 2017.

A. W. Kraszewski and S. O. Nelson, ”Application of microwave techniques in agricultural research,” in Proceedings of 1995 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference, 1995, pp. 117-126 vol.1.

R. ZOUGHI and S. KHARKOVSKY, ”Microwave and millimetre wave sensors for crack detection,” Fatigue & Fracture of Engineering Materials & Structures, vol. 31, pp. 695-713, 2008.

I. Jorge Aldave, P. Venegas Bosom, L. Vega Gonz´alez, I. L´opez de Santiago, B. Vollheim, L. Krausz, et al., ”Review of thermal imaging systems in composite defect detection,” Infrared Physics & Technology, vol. 61, pp. 167-175, 2013/11/01/ 2013.

W. K. Wong, P. N. Tan, C. K. Loo, and W. S. Lim, ”An Effective Surveillance System Using Thermal Camera,” in 2009 International Conference on Signal Acquisition and Processing, 2009, pp. 13-17.

C. J. Simon, D. E. Dupuy, and W. W. Mayo-Smith, ”Microwave Ablation: Principles and Applications,” RadioGraphics, vol. 25, pp. S69-S83, 2005.

M. Regier, K. Knoerzer, and H. Schubert, ”1 - Introducing microwave-assisted processing of food: Fundamentals of the technology,” in The Microwave Processing of Foods (Second Edition), ed: Woodhead Publishing, 2017, pp. 1-22.

J. A. Huisman, S. S. Hubbard, J. D. Redman, and A. P. Annan, ”Measuring Soil Water Content with Ground Penetrating Radar,” Vadose Zone Journal, vol. 2, pp. 476-491, 2003.

D. Cardone and A. Merla, ”New Frontiers for Applications of Thermal Infrared Imaging Devices: Computational Psychopshysiology in the Neurosciences,” Sensors (Basel, Switzerland), vol. 17, p. 1042, 05/05/2017.

C. Lavers, K. Franks, M. Floyd, and A. Plowman, ”Application of remote thermal imaging and night vision technology to improve endangered wildlife resource management with minimal animal distress and hazard to humans,” Journal of Physics: Conference Series, vol. 15, p. 207, 2005.

A. G. Vandit Gajjar, Yash Khandhediya, ”Human Detection for Night Surveillance using Adaptive Background Subtracted Image,” presented at the In Pro-

Abhishek Gupta

ceedings of the IEEE International Conference on Computer Vision Workshops, 2017.

A. C. Jean Dumoulin, ”Infrared Thermography applied to transport infrastructures monitoring: outcomes and perspectives,” SPIE - Thermosense: Thermal Infrared Applications XXXIX, Apr 2017.

Chen, P. J. Flynn, and K. W. Bowyer, ”IR and visible light face recognition,” Computer Vision and Image Understanding, vol. 99, pp. 332-358, 2005/09/01/ 2005.

P. Kumar, A. Mittal, and P. Kumar, ”Fusion of Thermal Infrared and Visible Spectrum Video for Robust Surveillance,” in Computer Vision, Graphics and Image Processing, Berlin, Heidelberg, 2006, pp. 528-539.

N. Arica and F. T. Yarman-Vural, ”An overview of character recognition focused on off-line handwriting,” IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), vol. 31, pp. 216-233, 2001.

M. Sharma and S. Singh, ”Evaluation of texture methods for image analysis,” in The Seventh Australian and New Zealand Intelligent Information Systems Conference, 2001, 2001, pp. 117-121.

P. Sarkar and R. Choudhary, ”UV Imaging,” in Imaging with Electromagnetic Spectrum: Applications in Food and Agriculture, A. Manickavasagan and H. Jayasuriya, Eds., ed Berlin, Heidelberg: Springer Berlin Heidelberg, 2014, pp. 57-66.

Reports

https://blog.superannotate.com/computer-vision-trends/

https://medium.com/swlh/computer-vision-and-image-processing-470ceea06b91