AN INTERPRETATION ON RECENT IMAGE PROCESSING APPLICATIONS IN CLOUD ENVIRONMENT

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***Abstract*-**With the advancements in both image processing and cloud computing, there is considerable research taking place combining both. This paper attempts to expose the recent image processing applications that uses cloud environment for their execution. A generic system description is explained to give a picture of how the application performs in a cloud. The recent research works interconnecting the two research areas are summarized covering many domains namely medical, geographical and image analysis applications. The paper also identifies the future research directions.

***Keywords*-**image processing; cloud computing; image analysis; Iaas, Paas; image retrieval.

I. INTRODUCTION

Every image has a context associated with it along with many objects and textual content which gives a semantic understanding of the image. Image analysis is defined as the meaningful extraction of cues from the images using digital image processing techniques. Image content can be classified into perceptual content and semantic content (Jung et al. 2004). Visual perceptual attributes such as color, intensity, shape, texture and their temporal changes come under perceptual content whereas objects, events and their relations which are in human action or text form are part of semantic content. This information can aid the technological advancements in the field of artificial intelligence (AI) which is on an upward trend. It has been used in many research domains like text detection and recognition, face recognition, medicine, human activity recognition, content-based image retrieval, computer vision and so on.

"A model that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources, e.g., networks, servers, storage, applications, and services" says U.S. National Institute of Standards and Technology (NIST) (Mell & Grace, 2009) which takes credit for the definition of cloud computing with most citations. In simple terms, it provides resources on a shared basis mostly over the internet. With many applications already being delivered via the internet due to its vast usage, the advent of cloud environment has made utilization of resources effective. Also, there comes scope for research to take advantage of both AI applications and the cloud which is put forth here. This paper is organized as follows: Section 1 introduces the domain. Section 2 describes the image processing in cloud as a system. Section 3 features the recent literature and Section 4 concludes with research scope. The following section explains some of the happening research works in the image analysis domain implemented in the cloud.

II. SYSTEM DESCRIPTION OF IMAGE PROCESSING IN CLOUD

Image processing applications rely on the cloud environment for work load. It must also be considered that image data in the cloud can be prone to information loss and breech especially when using a third party cloud environment. The authors Qin et al. (2018) have addressed about preserving the privacy of images in the cloud environment. Many images carry sensitive information of high privacy and so it is important to preserve the data sent to the cloud. The introduction of image encryption algorithms as part of the preprocessing phase will ensure security. Figure 1 gives the system description of image processing in cloud.

In most applications, the input is captured by the user which is taken as the initial input. Then, the image undergoes preprocessing before it is sent to the image processing application on the cloud. The whole workload is given to the resources of the cloud to execute the application. After processing, the output is given back to the user or to another application as its input. The recent research works in the context of this paper are described in the following section.

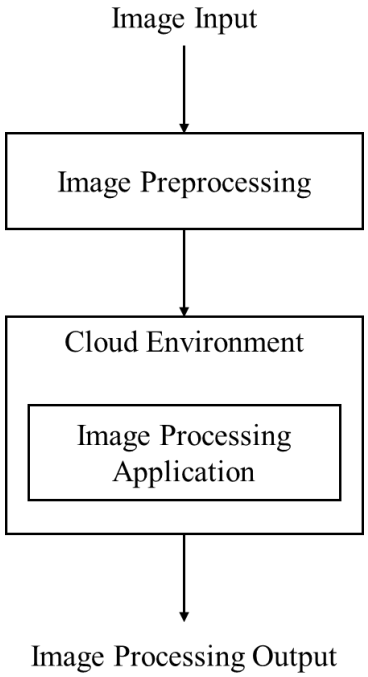

Fig.1:System Description of Image Processing in Cloud Environment

III. RESEARCH TRENDS

Milletari et al. (2018) conceptualized and designed a framework for medical image analysis in a cloud environment. Their framework, TOMAAT was open-source and it implemented deep learning on a server which gets requests from a client via an announcement service. After deep learning, the 3D medical image is pre-processed, inferred and post-processed to the final output. The modules are bundled in the server and they can be customized to leverage the deep learning framework.

Fahmi et al. (2017) implemented a smart cloud based system along with image processing server to diagnose brain diseases for hospitals with less infrastructure as such ailments require demanding resources, this service using cloud. The system was tested to recognize the size of a brain tumor wherein the user accessed the cloud service through a web application by uploading a picture. The cloud server learnt the expertise of neurologists to automatically diagnose the tumor in real time through image processing techniques. The system sent back the size of the tumor back to the user.

Lee et al. (2018) used cloud computing for geo-spatial image processing. The authors used Platform-as-a-Service (PaaS) over Infrastructure-as-a-Service (Iaas) as an open source technology to manage the application in the cloud. Iaas was implemented using OpenStack and Paas was done via Cloud Foundry. The performance of the image processing application deployed in the two cloud computing services was identified in this work.

Elias et al. (2017) came up with Where's The Bear (WTB) system that used image processing and machine learning to automatically classify animals from the motion triggered captured images in a wildlife sanctuary. With disadvantages of using public cloud services to transmit the large bulk of captured wildlife images, the authors used edge cloud along with IoT based cameras to reduce image captures and image processing overhead. The system used Google TensorFlow library for machine learning, and OpenCV Optical Character Recognition (OCR) with JPEG processing to text detect the air temperature placed in the image capture. Also on the cloud end, a module in the system accessed Google images of animals to be used for classification of the animals along with the images captured in the sanctuary.

Hong et al. (2017) developed a large-scale image retrieval system set using a newly proposed coherent semantic-visual indexing set up in the cloud. The semantic and visual descriptor space is realized using an optimization method after feature extraction followed by integration of the sematic-visual joint space system to scale the search to billion datasets. The whole service is put in a cloud and experimental results show that the cloud system has increased the performance considerably well. Xia et al (2017) came up with an Efficient and Privacy Preserving Content-based Image Retrieval

(EPCBIR) system on the cloud which preserved image contents by encrypting them.

Saleous et al. (2016) designed a cloud-based aid for the visually impaired to read text from images. The image is first captured by the application through a goggles with camera in it that a visually impaired person would wear and capture the pictures listening to voice commands. The image was then sent to the cloud where it used OCR software to recognize the text in them. A Text-To-Speech (TTS) synthesizer converted the text to audio and it was read out loud by the application. Amazon EC2 was used as the cloud component in this system.

Li et al. (2016) developed a face recognition system using Scale-Invariant Feature Transform (SIFT). The image was first encrypted and out-sourced to a cloud which extracts the features and does the computations to recognize the face. On the similar lines, Qin et al. (2016) proposed SecSIFT, a highly performing secure image SIFT feature extraction. The next section concludes the paper and suggests future scope.

IV. CONCLUSION AND FUTURE SCOPE

This paper addresses the current research trends in image processing and cloud computing along with their generic system description. It can be noted that literary works covering the two domains together are on the rise. The applications discussed covers medical, geographical and image analysis areas such as image retrieval, face recognition and image to text to speech recognition. Apart from these, image processing is advancing towards computer vision and image understanding which has wide research scope. With cloud computing, there comes a question of security for which newer security mechanisms need to be incorporated though images are encrypted before processing. Also, image processing applications that require heavy workload must also be tried on the environment to check the validity of using cloud. Cloud computing has emerging research in the areas of changing infrastructure namely multi-cloud, ad-hoc cloud and so on along with new architectures namely volunteer computing, serverless computing and so on (Varghese & Buyya, 2018) which will also pave way for executing new image processing applications on them. So the paper makes it clear that the research area is open with newer opportunities in both domains.

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