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Image Stitching to form a Telecentric Image using a Non-Telecentric Lens

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ABSTRACT

This paper describes a unique technique to capture a huge amount of images of an object in without any memory constraint or without much memory requirement, with the help of a simple, easily available and low cost pinhole camera that is available with Raspberry Pi, called as picamera, eliminating the image sequencing problem. Along with this, stitching these images simultaneously is the chief part of this work. The unique hardware setup proposed in this work makes it more suitable to stitch the images effectively and make it a telecentric image. At times, affording an expensive telecentric lens becomes impossible in small industries or in college level projects for example. Developing a way of using simple cost-effective pinhole camera instead of expensive telecentric lenses, to form a telecentric image is the main motivation of this work. With some future modifications in this work, it can prove to be very helpful technology in Vision Based Measurement.

***Keywords** :- capturing images, feature points, Image stitching, image processing, telecentricity, Raspberry Pi B, vision based measurement.*

1. INTRODUCTION

The method of joining images to make a panorama is known as image stitching [15].Image stitching stitches multiple overlapping images into a seamless image according to the corresponding geometric relationship between the reference and source images. It is an enthusiastic research area in image processing and computer vision but still a challenging problem for panoramic images [15]. A good number of researches had been carried out to develop different algorithms for image stitching in the last few years. Although there are many fast Image Stitching Algorithms available nowadays, but, stitching images in a way, so that they are suitable for Vision Based Measurement (VBM) is important. In this project, we have proposed a way to effectively stitch images using easily available algorithms to form a telecentric image and as far as the future scope of this work is concerned, the proposed method can be very helpful for VBM after making few modifications to it. Here, we have used RaspberryPi and a hardware setup which has a very high significance to provide a perfect field of view of the object for which the images are to be stitched.

Image Stitching

Image mosaicing or stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama of high-resolution image[13]. It is commonly performed through the use of computer software; most approaches to image stitching require nearly exact overlaps between images and identical exposures to produce seamless results. An Image mosaic is a synthetic composition generated from a sequence of images and it can be obtained by understanding geometric relationships between images. The geometric relations are coordinate transformations that relate the different image coordinate systems. By applying the appropriate transformations via a warping operation and merging the overlapping regions of warped images, it is possible to construct a single image indistinguishable from a single large image of the same object, covering the entire visible area of the scene. This merged single image is the motivation for the term mosaic. There are two methods of image moasaicing: 1) Direct method 2) Feature based methods. In this work, feature based method is used as in this case, the overlapping region required is very less.

Telecentricity of an Image

The ability to quickly perform repeatable, high accuracy measurements is critical to maximize the performance of many machine vision systems [16]. For such systems, a telecentric lens allows the highest possible accuracy to be obtained. This section discusses the unique performance characteristics of Telecentric Lenses and how telecentricity can impact system performance.

Fig- 1 Telecentric lenses

Zero Angular Field of view: Parallax Error Elimination

Conventional lenses have angular fields of view such that as the distance between the lens and object increases, the magnification decreases. This is how the human vision behaves, and contributes to our depth perception. This angular field of view results in parallax, also known as perspective error, which decreases accuracy, as the observed measurement of the vision system will change if the object is moved (even when remaining within the depth of field) due to the magnification change. Telecentric Lenses eliminate the parallax error characteristic of standard lenses by having a constant, non-angular field of view; at any distance from the lens, a Telecentric Lens will always have the same field of view. See Figure for the difference between a non-telecentric and a telecentric field of view. A Telecentric Lens's constant field of view has both benefits and constraints for gauging applications. The primary advantage of a Telecentric Lens is that its magnification does not change in respect to depth.

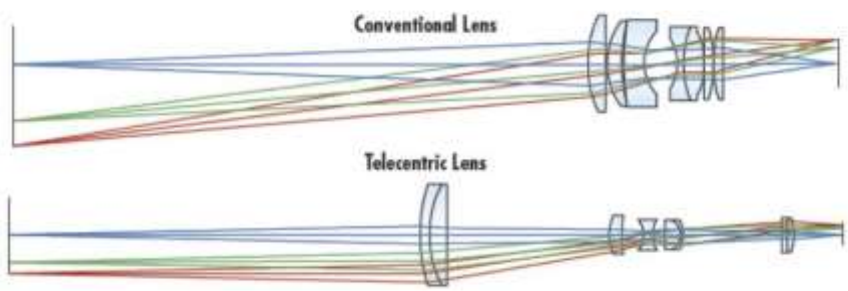

Fig- 2 Field of View comparison of a Conventional and Telecentric Lens. Note the conventional lens's angular field of view and the Telecentric Lens's zero angle field of view

2. OBJECTIVES

There are multiple advantages of using a telecentric lens over a simple fixed focal length lens or pinhole camera lens. In this work, we have used the simple picamera which is a pinhole camera for capturing images. Developing a way of making a picamera instead of a telecentric lens to work as a telecentric lens is the main moto. As said earlier, the unique hardware setup proposed here, contributes the most. The primary aim is to write a python application, with the help of OpenCV libraries, which can be used on an embedded UNIX-based system, specifically a Raspberry Pi to:

a) Capturing multiple images in a way such that an effective field of view is obtained to acquire a telecentric view.
b) Detecting feature points from the captured images.
c) Matching the correspondences between the images.
d) Eliminating the problem of storing and arranging images as the entire process of capturing images and stitching them are simultaneous.
e) Stitching images

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3. METHODOLOGY

System Model

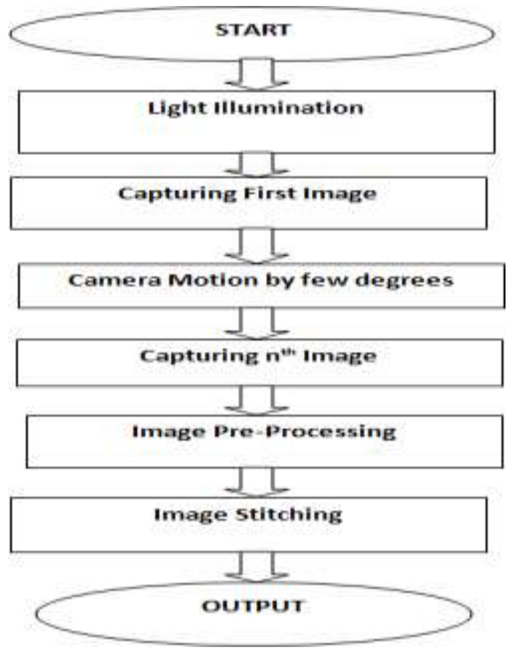

Fig- 3 System model

As shown in fig 3,There are six works applied which are carried out one by one such as light illumination, capturing the first image, camera motion, capturing the second image, image pre-processing and image stitching.

Light Illumination

Light illumination is done with a simple electronic circuit consisting of few LEDs, BC547 transistors and few resistors. The purpose of this circuit is to illuminate led light of a suitable intensity on the interested object so as to enhance the image quality.

Capturing Images

In this process, the picamera capture the images as soon as the light illumination starts which are stored in RaspberryPi itself.

Camera Motion

After capturing the first image of an object, some part of it is captured. For next part of the object, camera motion is necessary. The significance of camera motion is to move the picamera, a few steps ahead so that the further part of the object is captured which is obviously different from the previous one with some common overlapping area.

Image Pre-Processing

Image pre-processing consists of few image processing conversions or transforms.

Image Stitching

This is the final step in which the images captured, are stitched.

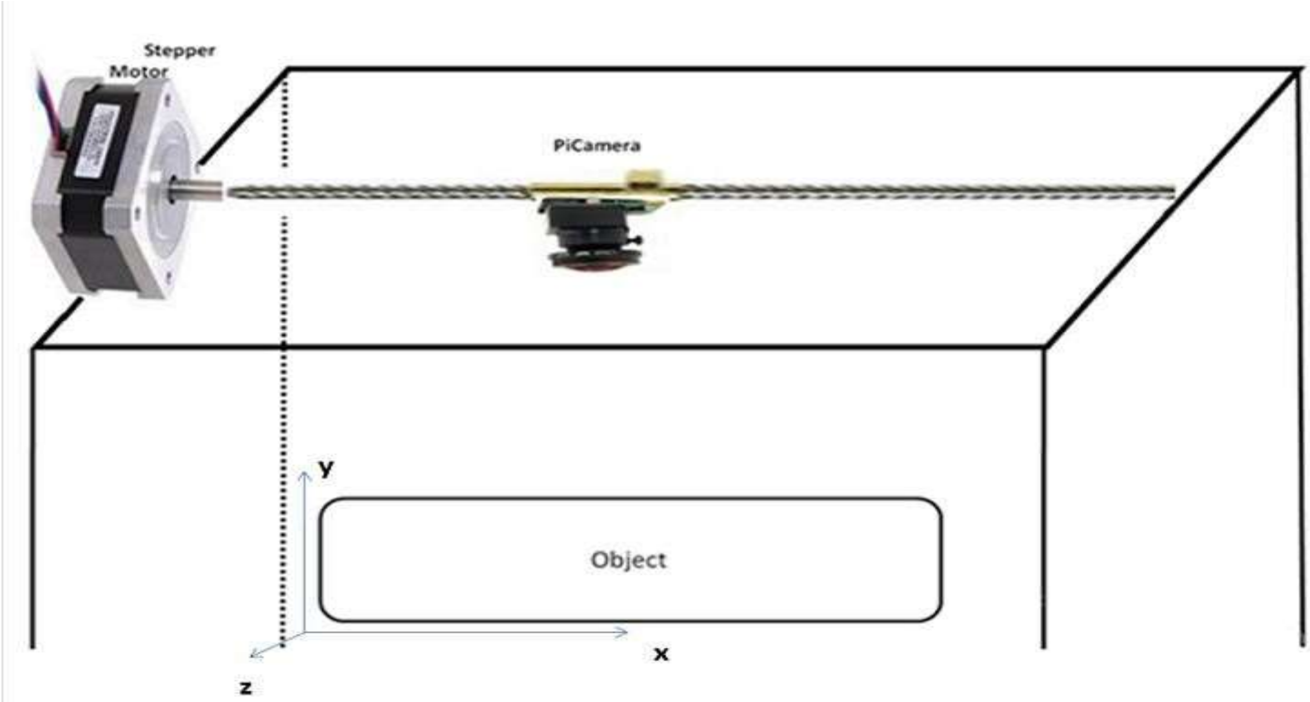

Fig- 4 Diagramatic illustration of the proposed hardware setup

This setup is used to provide linear movement to the camera to capture images at different intervals. With the help of this setup a perfect field of view is achieved. Images are captured per single step of the stepper motor and along with capturing images, stitching is done simultaneously. Due to this, the problem of storing images, arranging them in order which is generally faced, is completely eliminated.

4. RESULTS

According to the approach that has been used in this project, given below is a complete telecentric image formed.

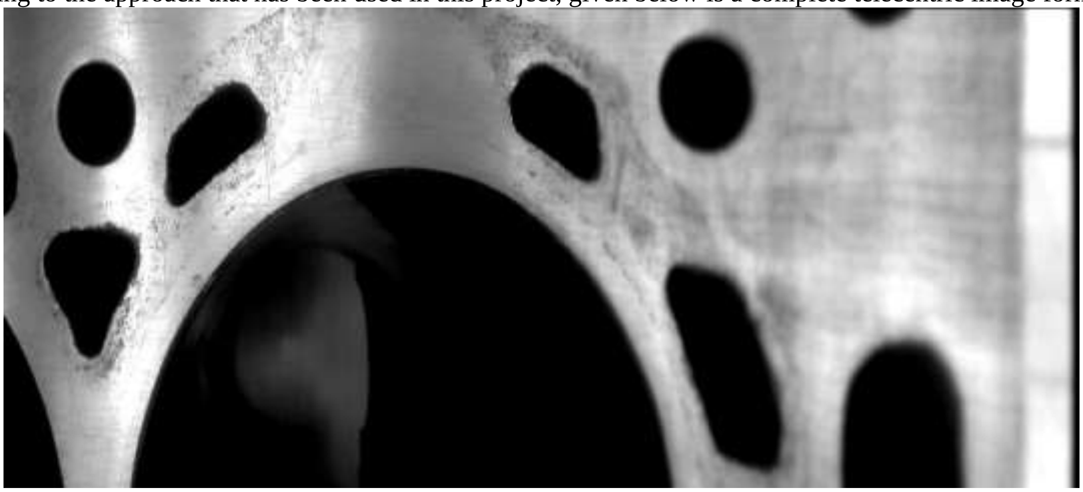

Fig- 5 Stitched image The reference images for the telecentric image are as follows:

Fig- 6 Reference Image 'a'

Fig- 7 Reference Image 'b'

Fig- 8 Reference Image 'c'

Fig- 9 Reference Image 'd'

5. CONCLUSION

Image Stitching is an enthusiastic and emerging area in research field. Here, we have added a slightly different way as a contribution to it which proves to be cost effective and efficient. Also we have discussed about the significance of the hardware setup we have developed here and its contribution to the telecentricity of the image. If we make few modifications in this project, we look forward to include Vision Based Measurement System (VBM) as a future scope in which will not only be able to form a telecentric image but also measure the contours present on the image.

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