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Computational Photography

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Abstract

Computational imaging process integrates computer-aided graphics, images and vision. This approach presents a means for overcoming the weaknesses realized in the normal imaging equipment for developing high quality graphic elements for better representation of the real 3-dimensional world. The use of computation photography in the field of imaging develops on the possibilities of typical imaging. The objective of computational photography processes is to aid in image processing and other areas of research such as archaeology by directly manipulating and interacting with the original photographed content.

I. INTRODUCTION

Photography has been for long the cornerstone of imaging. Cameras became a consumer's products over a century ago, this has led to great technological advancement in optics and recording mediums, we have witnessed cameras changing from using photographic films to digital sensors. Recent developments in the field of computational photography have made even the armature photographers to take and manipulate 3D photographs and the results are satisfactory [1]. The basic idea behind 3D photography can be traced to early 20^{th} century, but recently through the advancement in digital processing, imaging technology has grown substantially to become practical in human's day to day activities.

II. RECENT STUDIES

The latest revolution in imaging is computational photography, which aims at making image reconstruction an integral part of the formation of an image. With this revolution, new capabilities are going to be identified and the overall imaging experience will improve. One of the leading Artificial intelligence applications in this revolution is invention of plenoptic camera; this device aims at capturing the light field of an object. Relevant algorithms are then used to adjust the focus of the image after it has been captured [2]. The big question about the current advancement of technology in imaging is, with computation how can we experience photography in a different way?

The world has become very rich with information. The goal of many images is to record something and display it in a manner that will make sense. A few decades ago, humans were only able to represent pictures in 2D format but after the invention of the digital sensors, digital cameras were able to capture images in 3D format [1]. The popularization of digital sensors such as CCD, CMOs and increased processing power in computers has caused a paradigm shift in the field of imaging. It is possible to consider digital sensors as a replacement of analog detectors or the film.

III. METHODS

Today computational photography is the most common form of optical imaging. From the pinhole image, formation that was fist described in writing during the spring and autumn period in China. The design was aimed to the first permanent photograph that was captured by French inventor Joseph Nicephore; photography has indeed come a very long way as field in technology and art. Light field photography has become one of the most important parts of computational photography. Conventionally, photography involves capturing of light regardless of whether digital sensors or films have been used. Light field photography tries to change the imaging system that is currently in use to a new system called plenoptic technology. This system can discriminate and capture light from a few directions [2]. Together with use of appropriate algorithms these systems bring three advantages which includes, construction of images with small viewpoints changes, it helps to compute the depth map using depth from the focus, and also helps in reconstruction of images as if they have been focused at different planes, this makes it possible to refocus and image after data capture.

NASA's Langley research center has been in the forefront of constructing the plenoptic camera that can image two-dimensional and, in some cases, three-dimensional color and spatial information [1]. Plenoptic technology measures the brightness of the image as wells as the directions of the light rays. These technologies come with numerous advantages such as, it is inexpensive to produce, it is very easy to modify the filters arrangements and the technology is versatile, this means that the camera can have different applications. The camera has found many applications such as image pyrometer, emission spectrograph imaging, smokestack pollution detection, tomographic particle imaging velocimetry and astronomy.

3.1. Equations

In the initial methods of computation, digital images are segmented into 120 by 120 blocks. A series of correlation measures is arranged in a windy order as in the compression of images. The parameter D_k is restrained through the Gaussian measure S_k having a mean of zero and a standard deviation 1. This computation involves addition of the signal D_k and S_{k+1}.

$$D'_k = D_k + \alpha S_k, \quad k = 1 \ldots N_m$$
(1)

In this equation, D'_k *is the* modulated coefficient of the computational photography model and α is the digital color intensity, and N_m is the number of improved coefficients. For each symbol, a new alignment of random numbers is generated. The information made of *M* symbols is thus represented by the summation in equation 2 below.

$$S = \sqrt{\frac{3}{M}} \sum_{i=1}^{M} \eta^{(i)}$$

(2)

The distributed spectrum of signal *S* is a Gaussian function of mean zero and standard deviation zero even for the middle values of *M* (like $M \approx 10$). The likelihood of false photography recognition is estimated as shown. The likelihood *P* (*k*, *M*) that a minimum of *k* *r*-bit symbols from the recovered message of length *M* are correct is

$$P(k, N) = \frac{\binom{M}{k}}{2^{rk}}.$$
(3)

Therefore, the recognition proceeds by computation of the correlation C between the obtained *L* coefficients D^*_k and the random sequence S_k, and the limit in the result Th, a function derived from the computational photography model.

$$C = \frac{1}{L}\sum_{k=M+1}^{M+L} D^*{}_k S_k > 3.3\sqrt{\frac{2\sigma^2}{L}} = Th, \quad (4)$$

3.2. Discussion

Inside the plenoptic camera there is an array of 470 by 360 micro-lenses, each micro-lens produces an image onto a 14 by 14-pixel array [3] The specific colors or the spectra can be continuous or arbitrary determined, this makes it easily and inexpensive to modify. The modifications of colors or the spectra are very useful for different applications where there is need to analyze emitted light so that information obtained can be qualitatively or quantitatively be analyzed. The sensor is so advanced such that it can measure fluid, thermodynamic, mechanical, or structural properties of gases, liquids and solids. Figure 1 below shows the mapping of final image to the original image after the Computational image processing.

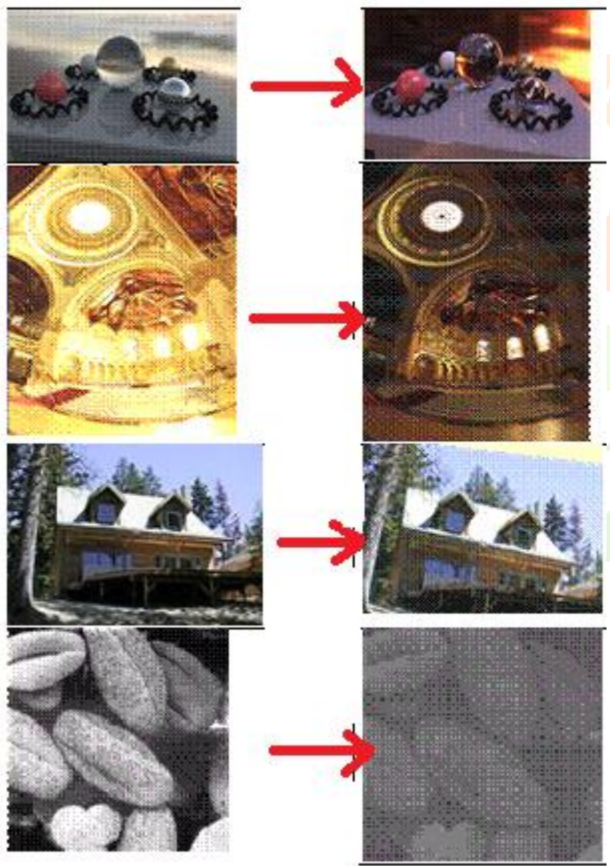

Figure 1: Image Mapping

CONCLUSION

In conclusion, the imaging field has come a long way and has been part of the human history as they have been using it to try to express their ideas in form of images. The technological advancement in this field is still young and there is much that can be done to make it more useful to humans, latest inventions in this field such as invention of plenoptic camera proves that humans can do much with use of imaging systems. Plenoptic camera has not been fully adopted into the field of photography but when it will be released to the market there is going to be a real change in how we see and use images. Astronomy will be one of the greatest beneficiaries of this technology as it involves high usage of images. In addition, this technology will lower the cost of producing and maintaining the imaging devices.

IV. BIBLIOGRAPHY

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