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CFA DETECTION BY BAYER FILTER ARRAY IN RGB AND CMYA PATTERNS

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ABSTRACT

A CCD (charge-coupled device) is a light-sensitive integrated circuit that stores and displays an image in such a way that each pixel in the image is converted into an electrical charge, whereas CMOS (complementary metal-oxide semiconductor device) in the semiconductor technology used in the transistors that are manufactured in a computer microchips. This paper includes a complete overview of CMOS and CCD imaging array technologies. These devices provide the complete evaluation of video quality from the user's perspective, in mass content distribution networks. CCD has been existence for nearly 30 years and suffered from many drawbacks which include cost, complex power supplies and support electronics. CMOS sensors on the other hand, are still in their infancy and offer a number of potential benefits over CCDs. This paper provides a complete explanation of how an image is being captured by the technologies trends which includes the Color filter array i.e. a mosaic of tiny color filters placed over the pixel sensors of an image sensor to capture color information.

Keywords- *CCD (charge-coupled device), CMOS (complementary metal-oxide semiconductor device), CFA (color filter array), RGB (Red, Green, and Blue), CMYG (Cyan, Magenta, Yellow, and Green).*

I. INTRODUCTION

As we all are, aware about the term image, it is information of an object produced when the amount of light reaches to the observer's eyes, and an image sensor defined as a semiconductor device that converts an optical image into electronics signals formed by an imaging lens, which required sensor consists of a pictures element called pixels.

When an image is being captured by a network camera, light passes through the lens and falls on the image sensor which consists the picture element, that register the amount of light that falls on them. They convert the received amount of light into a number of electrons. The stronger the light, the more electrons are generated, first off all the electrons are converted into voltage and then transformed into numbers by means of an analog to digital converter. Silicon, the most widely used material for very used material in very large scale integrated circuits (VLSI) is suitable for visible-image sensors because the band gap energy of silicon matches the energy of visible wavelength photons.

II. LITERATURE REVIEW

A solids state image sensor also called an image is a semiconductor device that converts an optical image into electronics signals. An image sensor can detect light within a wide spectral range, from x-rays to infrared wavelength regions, by tuning its detector structures and by employing material that is sensitive to the wavelength region. For this purpose, silicon semiconductor is most widely used because the band gap energy of silicon matches the energy of visible wavelength photons as we explained above. So for reproducing an image with acceptable resolution, a sufficient no of picture element called pixel should be arranged in the form of rows and columns and then these pixels converts the incoming light into a signal charge carrier such as electrons or holes. Here the below fig. shows the phenomena of image sensor.

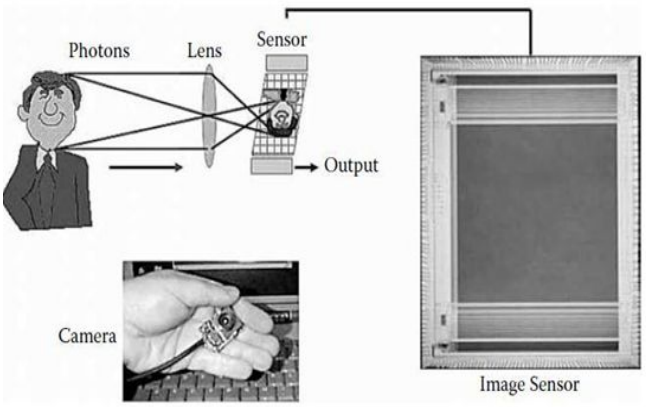

Fig 1: Image sensing phenomena

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Presently, there are two main technologies that can be used for the image sensor in camera i.e. CCD which stands for charge coupled Device and CMOS which stands for Complementary metal-oxide semiconductor.

A. CCD TECHNOLOGY

In a CCD sensor, the light that falls on the pixels of the sensor is transferred from the clip through one or only few output nodes. The charges are converted to voltage levels, buffered and sent out as an analog signal. This signal is then amplified and converted to numbers using an analog to digital converter.

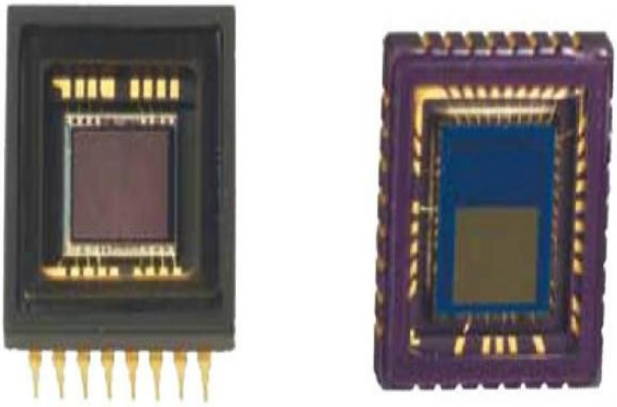

Fig 2: (a) CCD sensors (b) CMOS sensors

The CCD sensors have been used for more than 30 years. It is specially developed to be used in cameras. It has the advantages of better light sensitivity and less noise. But it has also the disadvantages; they are analog computers that require more electronic circuitry outside the sensor, which can consume 100 times more power consumption, that leads to head issue in the camera, which not only impact the image quality negatively but also impact the product.

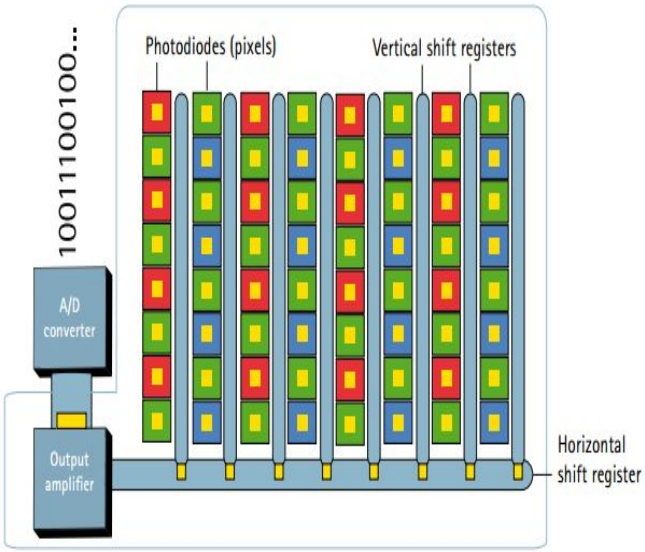

Fig 3: CCD Technology

B. CMOS TECHNOLGY

In earlier days, the ordinary CMOS chips were used for imaging purposes, but the image quality was not so good due to their inferior light sensitivity. But the modern CMOS sensors use a more specialized technology and the quality and light sensitivity of the sensors have increased in a very rapid manner. CMOS chips have several advantages unlike the CCD sensors, the CMOS chips incorporate amplifiers and analog to digital converter, so their cost decreases. CMOS sensors have better integration possibilities and more functions, it also have faster readout, lower powers consumption, higher noise immunity and a smaller system size.

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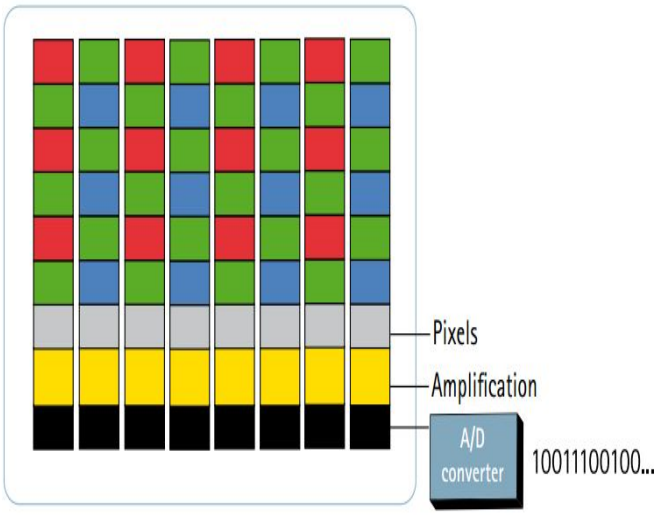

Fig 4: CMOS Technology

C. MAIN DIFFERENCES

In a CCD sensor there is a need of amplifiers, analog to digital converter and circuitry for additional processing and their many signal processing functions are preformed outside the sensor. Whereas in case of CMOS sensors it has lower power consumption it means that the temperature inside the camera can be kept lower. A CMOS sensor also allows 'windowing' and multi-view streaming, which cannot be performed with a CCD sensor. In case of CCD sensor, it has one charge-to voltage converter per sensor whereas a CMOS sensor has one per pixel.

III. PROPOSED WORK

Above we are study about the technologies of CCD and CMOS sensors, and also their working phenomena, now we are going to describe the mechanism process of these sensors. As we already know that, there are two basic types of image sensors, CCD and CMOS as described above and these both uses large a arrays of thousands of photo sites known as pixels. Here there is a mechanism of CCD and CMOS image sensors which involves as;

There steps involves:-

- Light to charge conversion, here the light directed from the camera lens is first converted into electrons and then it is collected in a semiconductor bucket.
- Charge accumulation, if larger number of light enters then more number of electrons comes into the bucket.
- Charge transfer, here the transfer of charge takes place from vertical to horizontal direction in the photosensitive area of the chip.
- Charge to voltage conversion, is the accumulated charge must be the output as a voltage sign.
- An amplifier, the processes of charge to voltage conversion is a very week that should be made strong by this process, before it can be handed off to the camera circuitry.

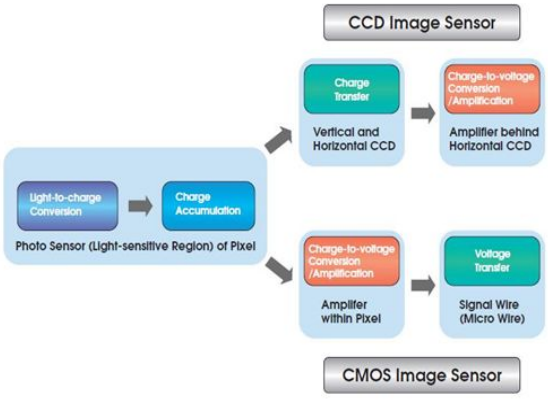

Fig 5: Mechanism involves in CCD and CMOS sensors

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In case of CCD sensor, it move the bucket of charge into the photo sensitive areas, these buckets of charge are then passed through vertical and horizontal shift registers, these registers act as bucket brigades and it handles the required charge from one semiconductor bucket to the next as shown in the above fig. but in case of CMOS image sensors, it immediately convert the bucket of charge into voltage before it leaves each pixel. The recent developed CMOS sensors include an amplifier for each pixel, so after amplification, the voltage output of the pixel is transferred via micro-wire to the output of the chip.

1. TECHNOLOGY AND DESIGN TRENDS: - It includes:

1.1 COLOUR FILTER ARRAY (CFA)

In photography a color filter array is a array of tiny color filter placed over the pixels sensors of an image sensor to capture color information. The color filters are needed because the typical photo sensors detect light intensity with a very small wavelength and thus cannot separate color information.

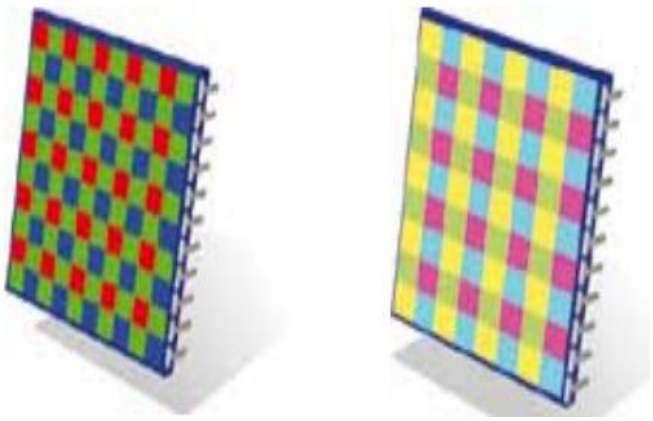

Fig 6: (a) Color Filter Array (b) Bayer filter array

Image sensors register the amount of light from bright to dark with no color information. Since CMOS and CCD image sensors are 'color blind', a filter in front of the sensor allows the sensor to assign color tones to each pixel. Two common color registration methods are RGB (Red, Green, and Blue) and CMYG (Cyan, Magenta, Yellow, and Green). Red, green, and blue are the primary colors that, mixed in different combinations which produce most of the colors visible to the human eye. The Bayer array, which has alternating rows of red-green and green-blue filters, is the most common RGB color filter; see Fig. 2 (b). Since the human eye is more sensitive to green than to the other two colors i.e. red and blue, the Bayer array has twice as many green color filters. This also means that with the Bayer array, the human eye can detect more detail than if the three colors were used in equal measures in the filter. Another way to filter or register color is to use the complementary colors like cyan, magenta, and yellow. Complementary color filters on sensors are often combined with green filters to form a CMYG color array, see Figure 2 (b). The CMYG system generally offers higher pixel signals due to its broader spectral band pass. However, the signals must then be converted to RGB since this is used in the final image, and the conversion implies more processing and added noise. The result is that the initial gain in signal-to-noise is reduced, and the CMYG system is often not as good at presenting colors accurately. The CMYG color array is often used in interlaced CCD image sensors, whereas the RGB system primarily is used in progressive scan image sensors.

1.2 BAYER FILTER ARRAY

A Bayer Filter mosaic is a color filter array (CFA) for arranging the RGB i.e. red, green and blue color filter on a square grid of photo sensors. Its particular arrangement of color filters is used in most single-chips digital image sensors used in digital camera, camcorders and scanners to create a color image. The Filter pattern which is produced is of 50% of green, 25% of red and 25% blue hence is also called RGBG, GRGB and RGGB.. The Bayer Filter gives information about the intensity of light in red, green and blue wavelength region. The raw image data captured to a full color image by a demosaicing algorithm which is tailored for each type of color filter. The Bayer arrangement of color filter on the pixel array of an image sensor is shown below.

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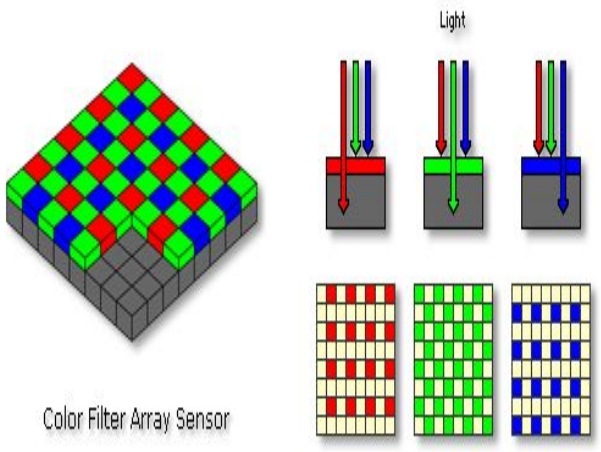

Fig 7: Filter pattern produced by RGB i.e. red 25%, blue 25% and green 50%

IV. CONCLUSION AND FUTURE ASPECTS

CCD and CMOS sensors have different advantages but the technology is evolving rapidly and the situation changes constantly. CCD is still the technology of choice in high-end camcorders and digital still cameras, as well as science and astronomy. The latter are expected to penetrate into existing CCD markets for example in terms of speed and security due to the higher integration. CMOS image sensors will be the technology of portable devices, biomedical and as well as application that rely on custom sensors and smart pixels to locally relevant information such as the presence, distance, position and temp of an object. But for the future aspects both technologies will remain to a large extend complementary.

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