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APPLICATION OF MACHINE VISION SYSTEM IN ROBOTIC WORK CELL

(IEEE FORMAT APPLIED)

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APPLICATION OF MACHINE VISION SYSTEM IN ROBOTIC WORK CELL, A COMPLETE STUDY

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***Summary*- Machine Vision utilizes computer vision in industry. While Computer Vision focuses on image processing at hardware level, Machine Vision usually need the use of additional hardware I/O and computer networks to transfer information and data generated by other components, such as robot arm. Machine Vision is used mostly to inspect industries by allowing for complete automation and thereby increasing the accuracy and efficiency. This paper provides information on principle, components and possible application of machine vision and image processing at present.**

Keywords* ——— *image processing; inspection; Machine Vision.

I. INTRODUCTION

The introduction of the automation brought a new revolution in manufacturing by breaking down a complex operation into step by step instructions to be repeated by the machine. Tasks are usually performed by humans but the rectification of errors have made a Machine Vision system more useful. The expectations from a Visual System is as follows: to perform acquisition and analysis of an image, recognizing certain features or objects within the image, and exploitation and imposition of environmental constraints.

Different techniques, including structured lighting, can be used to implement such techniques. The process of Machine Vision system begins with acquiring of image and then accomplishment of representing of image data, image sensing and digitalization is done. The next step is Image Sensing to obtain a clear image of the illuminated scene. Then digitalization comes into play, where image capturing and displaying is done. The final step is that the image processed in which a more suitable image is prepared.

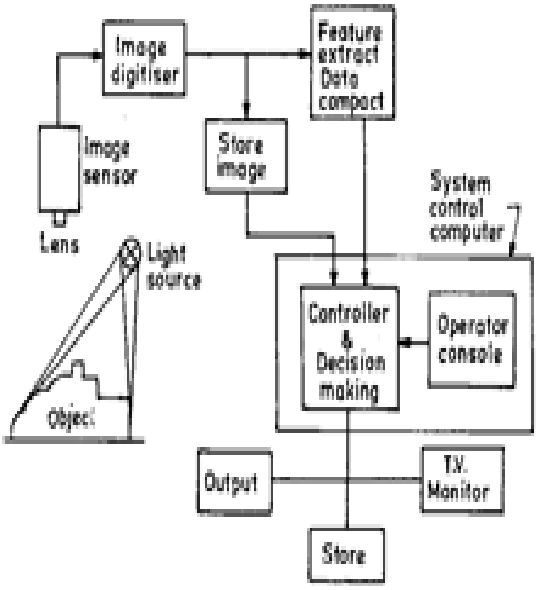
II. MACHINE VISION SYSTEM OPERATION

A Machine Vision system can perform the following functions: image acquisition, analyzing and recognizing of objects within another group. As the light source illuminates the scene and the image sensor helps to generate an optical image. Image acquisition is defined as a process where a photo detector is used for generating an optical image to be converted to a digital image. Image processing involves modifying and preparing the pixel values of a digital image to obtain a more suitable value for other operations. Segmentation means to make partition of an image into regions that correspond to entire part or similar objects within that scene. Feature extraction, in general, means identification of inherent characteristics of the objects found within another object. Pattern classification means the process in which an unidentified object within an image is identified as being part of one particular group among a number of possible object groups.

III. MACHINE VISION SYSTEM COMPONENTS

A typical Machine Vision system comprises of components like:-

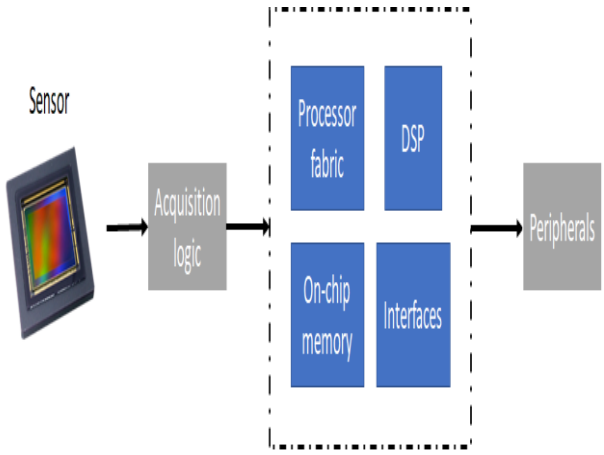
- One or more cameras (digital or analog) with optical lenses.
- The camera interface to digitize the image (so called frame-grabber).
- Processor; usually PC or embedded processor such as DSP
- Sometimes all the above elements are included in one device called Smart Camera.
- Device I/O or communication links (eg: - RS-232) used to provide the result of system.
- Lens to take close shots
- Fluorescent light source adapted to the system (such as LEDs, halogen lamps, etc.)
- Software to detect the features in common image (image processing algorithm)
- Sync-sensor to detect objects and provides signal for sampling and processing of image.
- Regulation to reject defective products.



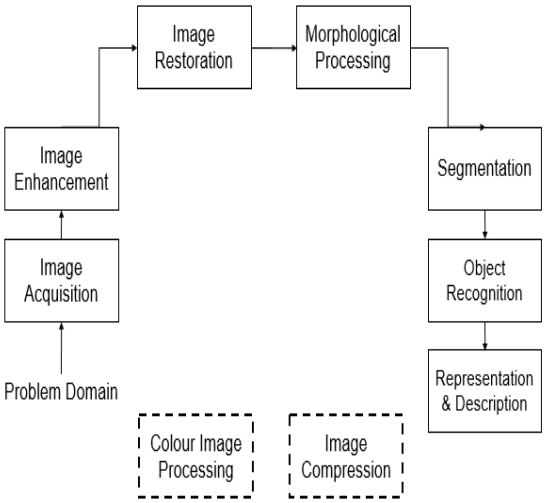
BLOCK DIAGRAM OF MACHINE VISION SYSTEM

Sync-sensor is used to determine the time when an object has reached the position of being inspected. The sensor signal enables the camera and starts downloading the image of the object and then depending on the system, provides a signal to synchronize the lighting in order to obtain good image sharpness. Machine Vision system uses light sources for lighting objects in order to remove the dark positions and minimize the adverse effect of the emergence of the conditions for the observation. Most of the panels are to be used with LEDs.

The image captured by frame grabber is converted from digital camera to digital format. The digital form is saved in computer memory for further processing by the Machine Vision Software.



MACHINE VISION SYSTEM DESIGN



BLOCK DIAGRAM OF IMAGE PROCESSING SYSTEM

IV. INTERFACE AND CAMERAS

There are many cameras available for Machine Vision. They vary in interface, sensors and sizes. The camera and the lens together provides information on field of view, resolution and other properties of image. Certain cameras are specially designed for machine vision application.

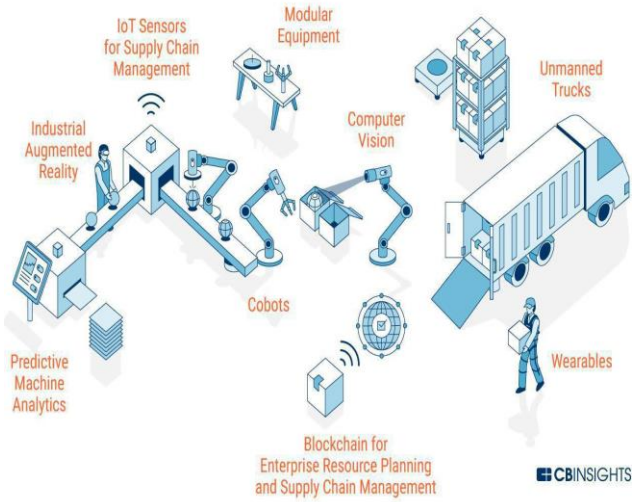
Most of the cameras use Charge Coupled Device (CCD) sensors. The video signal is obtained by transferring the charge from each pixel line down the line, line by line and pixel by pixel, to an amplifier. CCD cameras are widely available for variety of formats, resolutions and sensitivities and thereby providing best performance for most applications.

CMOS (Complementary Metal Oxide Semiconductor) sensors also have many applications. Since they are made in the same way as computer chip fabrication is done, so they can produced very inexpressibly. Low cost CMOS are already used in toys and webcams but unlike CCD sensors, which should be read out one complete line at a time, CMOS sensors must be read pixel by pixel, in any order. This is applicable for time based applications where only a particular part of image is our concern. Again, the noise performance of CMOS sensors are less efficient than CCDs.

Camera interfaces used are basically analog and digital. In an analog camera, the signal from the sensor is converted into analog voltage and then sent to the frame grabber board in the operated computer. EIA, RS-170, NTSC, CCIR and PAL are all common analog interface standards. Even though analog cameras are inexpensive, but causes problem due to noise and timing. The signal thus obtained is digitized by camera and the obtained data is sent in digital form directly to computer. CameraLink, Firewire and GigaEthernet are three popular digital interface standard. The digital signal thus obtained is not provided with noise and there is a perfect sync between each pixel on the sensor and the obtained image. Digital cameras support a huge number of images resolutions and frame rates. Since the signal is already digitized, a simple interface board replaces the frame grabber.

V. METHOD FOR IMAGE PROCESSING

Machine Vision System software for both commercial and open source consists of numerous techniques of image processing, such as:-
Counting pixels (light and dark),
Binarization (converting colours from shade of gray to two colours like white and black),
Segmentation (to locate and count objects),
Reading the barcode (decoding the barcodes),
Recognition of text,
Measurement of size of object,
Detection of edge of object,
Matching of template (i.e., to find, match, count specific number of patterns).
In most cases, in order to perform complete inspection, the machine vision system uses these combinations. For example, besides reading barcodes, a system can check surface of object to detect any damage and also can measure dimensions of the object.



MACHINE VISION IN MANUFACTURING TECHNOLOGY

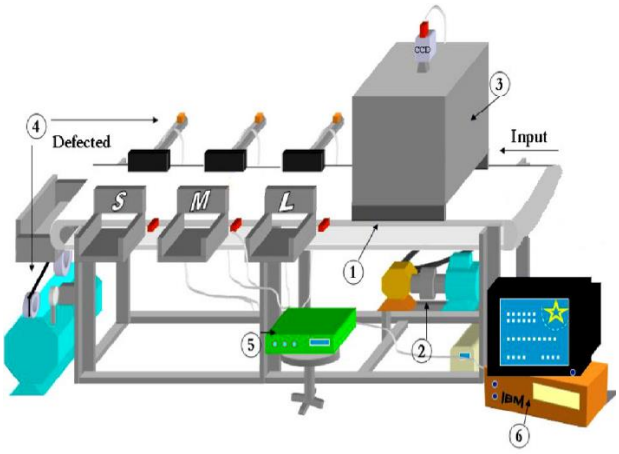
VI. APPLICATION OF MACHINE VISION SYSTEM

Machine vision system is widely used in industry, like in manufacture of semiconductors. These systems performs inspection of silicon wafers, microchips and components such as resistors and capacitors.

In the automobile industry, machine vision system are used widely in control systems, industrial robots, inspecting painted surfaces, controlling welding quality, rapid prototype check of the engine block as well as detecting defects of various parts.
Product checking and controlling quality procedures include the following: presence of various parts (screws, cables, etc.), regularity in assembling of proper execution and locating shapes (curves, circular area, perpendicular surfaces, etc.), correctly selecting equipment for implementing quality of surface marking, geometrical dimensions and quality of printing.

Besides the above list, there are other areas to implement machine vision. The inspection of defect online is based on machine vision for fabrication of float glass. This mentioned method helps to detect the defect appropriately and the miss-detection under circumstance of curviness's fabricating.
Many line scan monochrome digital cameras are placed above float glass to capture glass image. The red LED light source placed under the glass provides illumination to grab the image. In order to complete the inspection task based on image processing, high performance computers are to be used.

Another important application is to use machine vision system for validating vehicle instrumental cluster. The machine vision system comprises of the camera, light, optics and image processing software. In order to acquisition of image and further processing, cognex In-sight CCD is to be used. It offers a resolution of 1600 × 1200 pixels and 64MB flash memory. The rate of acquisition of the vision sensor is 15 full frames per second and it is done through scanning progressively. The camera can also work in a partial image acquisition mode thereby providing flexibility for selecting image resolution and rate of acquisition. A wide library of vision tools are available to identify, verify, measure and test the application. The PatMax^{TM} technology is used to fix and we use advance OCR/OCV to read available text in the software. The main source of illumination is from LED lights which brightens with directional front lighting and thereby provides high contrast between object and background. The optical lens is selected based on the field of view and distance of working.



MACHINE VISION TO DETECT FAULT OR DEFECTED MATERIALS

VII. CONCLUSION

- The application of Machine Vision is enormous:-
- Biometrics,
- Position,
- Large scale industrial products,
- Unique object production at small lot,
- Inspection,
- Autonomous mobile robot control,
- Exploiting bridges,
- Retail automation,
- Agriculture,
- Exploiting railways,
- Vision mechanism for blind people.

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