

Recognition of objets in an image for triage

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Abstract—In this paper we present the methods and techniques of computer vision and existing ones that are the subject of current research. In this work, we try to build a system for recognizing objects in an image to a triage application. The focus of our work is to recognize and sort objects in an image in computer vision. The images come from a fixed camera with a field of view with a regular and permanent result on a conveyor angle, enabling objects to be observed.

Object recognition requires knowledge of the characteristics of our camera. This in order to calibrate a camera, we proposed a simple camera Webcam oriented so as to obtain a picture through the center of the conveyor. The goal is finding objects in images; it will be unit image and not image sequences. In this case the introduction of automatic methods is necessary to ensure the rapid screening but requires complicated treatments to make it effective. The analysis determined simultaneously identifying and counting and arithmetic fault detection based mainly on comparing the shape of an object with a predefined shape and will sort this operation. An adjunct and complementary load through sensors and a PLC to send a signal to the pusher arms which are operative to eject each object in the corresponding tank.

Keywords— Computer vision, object recognition, image processing, image analysis, PLC (Logical controller).

I. INTRODUCTION

Being visually impaired is a serious handicap and ongoing support in everyday life and at any time because of the five meanings attributed to living beings and particularly to humans, the view is probably that which is considered the most important.

But nowadays the natural view, human, may not be enough, or be unable to sustain some long cadences. The man now lost between the infinitely small and the infinitely large can not do without vision tools. It is therefore quite natural that vision, that is to say, the design, manufacture, use machines imitating this option, be the subject of many scientific and technological efforts and is at the center economic issues as significant. Beyond the rapid progress of electronics in general and computers in particular, it is the development of a technology called CCD (Charge-Coupled Device) which opened the door for the development of vision [1]. A machine vision system is therefore a machine combining an image sensor and a processing system which transforms and interprets the image to provide relevant information about the

observed scene [1]. At least, that is the optimum system currently available technology.

It is a way to replace human vision by another, artificial, which must have the same performance and more speed, endurance and total lack of distraction or disruption. The focus of our work is to identify and sort objects (geometrical shapes) in an image by computer vision. An image from a camera having a fixed field of view with a permanent regular angle so on a conveyor carrying the objects to be observed. In the remainder of this article we proceeded as follows: Part 2 is the experimental study conducted in laboratory with objects manufactured by us especially for this purpose, deposited on a supporting said conveyor. Part 3 is mainly devoted to the treatment techniques in the image. So to say, the use of tools or algorithms thresholding, filtering and morphological mathematical operations to retrieve an image close to the original image to make it easier to use. Part 4 is devoted to an interesting problem in numerical analysis of images. This is a hot topic and a problem which remains open where there are numerous segmentation approaches that will deal with. The use of segmentation algorithms to extract image features essential to localization and recognition of objects in the image, represents an important step in the overall process. Come, last, part 5, the experimental phase or the application by MATLAB to validate the theoretical concept of the recognition process of objects. After this embodiment, a second embodiment is to send signals through the serial port RS 232 to a controller which actuates the pusher arms according to the characteristics of the object. When the object is not identified, it progresses and is ejected into the palettisseur unknown objects.

II. OBJECT RECOGNITION PROCESS

The experimental study is performed in the laboratory with objects manufactured by us especially for this purpose, deposited on a supporting said conveyor. The experiment was performed using a camera with a webcam. The implementation of objects is done manually by us, in order to follow their movement on the conveyor. When the position of the object is the acquisition position, the conveyor stops right time to allow the process of vision of the camera to make all image processing operations and then move to the phase analysis which corresponds to the recognition of objects for tracking and identifying objects, using tools (Figure 1). The corresponding functions are performed by a computer program that we implemented (language: MATLAB). Our work is built on a still image and not a sequence of images.

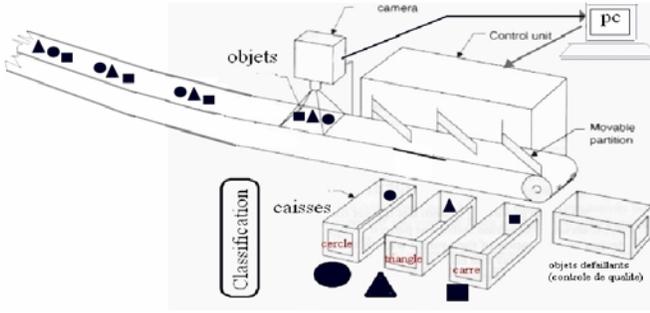


Figure 1. process for recognizing objects and sorting

The system is equipped with the following:

- A conveyor (Figure 2).
- A camera (webcam) fixed above the conveyor (vertical position in order).
- A computer (PC).

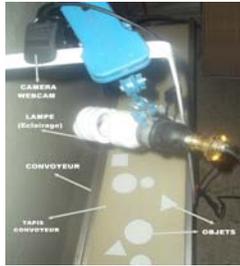


Figure 2. Conveyor

Symbolically, a machine vision system can always be represented by the diagram in Figure 3, where we find the stages of object recognition.

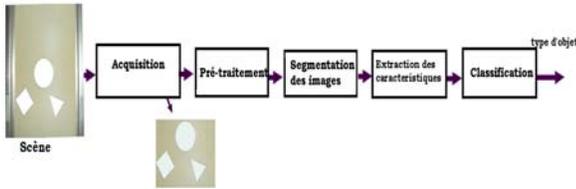


Figure 3. process for recognizing objects

III. PROCESSING

Before starting the techniques of image processing, we will present a brief acquisition phase which justifies the use of the camera is one of the main elements of the chain of image acquisition. For this, the choice was made to use the camera "USB Webcam" for laboratory testing. The decision to use a Webcam, is to reduce costs and to validate the feasibility of the basic material and not dedicated to the vision For the determination of lighting conditions, an element essential to good control of vision, good lighting can sometimes greatly simplify the processing step. It is therefore important to start

the design of an image processing chain with the question of lighting. In our work we used a neon lamp lighting a way to be able to give the image acquired a thorough processing.

The vision is not an easy area as identify a single object in an image requires a lot of operations. Treatment, often called preprocessing includes all techniques to improve the quality of an image. Therefore, the starting data is the original image and the result is an image. We started with a reduction in the sense of image cropping since the field of view was set near the center of the image acquired with a resolution of 320x240 pixels. It is a space control that ensures the identification and location of objects and erase the edges of the conveyor in the image in order to facilitate the processing of an image for a successful operation classification (Figure 4).

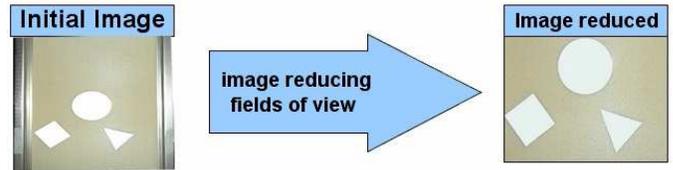


Figure 4. Image reduced

Then processing the image through the steps of:

- Converting the color image into a gray-level image (Figure 5).

Threshold: The binary image takes up less memory space for

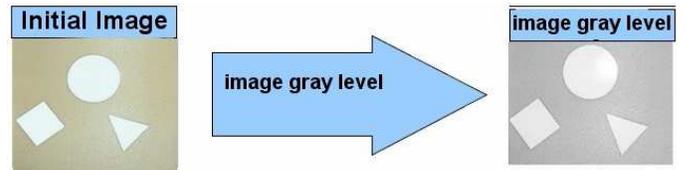


Figure 5. image processing grayscale

storage and it is faster to process a color image or gray scale. The extraction of the information in the image passes through the reduction in the number of gray used to its coding, the lower limit to this number is 2, which leads to produce a binary image in which the pixels are black or white.

- Choosing a threshold value (T)
 - If $f(x,y) \geq T$ then $f(x,y) \in \text{object}$
 - If not $f(x,y) \in \text{background}$
- Formation of a binary image g

image matrix $g(x,y) = \begin{cases} 1 & \text{if } f(x,y) \geq T \\ 0 & \text{if } f(x,y) < T \end{cases}$ Thresholding is possible to produce an array containing only values equal to 0 or 255 if we think the set [0 .. 255], 0 or 1 or if one works in the set [0 .. 1]. The resulting algorithm is very simple, simply assign all pixels

with a gray level higher than the threshold value white color (1 or 255). Otherwise they are assigned the color black (0). The image formatting and X in the square matrix of the values of the gray levels for each pixel or Figure 6.

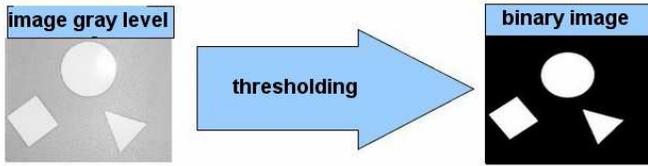


Figure 6. Transformation image grayscale picture binary

The algorithm allows an initial image binarize grayscale, this technique allows segmentation of specific objects in the image.

Image filtering has the same purpose as that of 1D signals. It is basically clean image when scanning by filtering concepts. Including noise (eg in a poor reception of data), blur (due to poor focus), or loss of quality (due to poor lighting). Different filtering methods have been developed according to the type of noise intensity. These filters have spectral characteristics; talking and linear filters and nonlinear filters.

Linear filtering corresponds to the first operation using the near vicinity that comes to mind. It is in fact to replace the value of a pixel by a linear combination of the values of surrounding pixels. For noise attenuation resulting in local variations random luminance filter said averaging or low-pass is often used. This attenuation can be performed using two methods of filtering or filtering in the frequency domain or in the spatial domain filtering (convolution) [2]. In frequency representation is used including Fourier transform.

Filtering in the frequency domain Is a continuous signal, $f(x)$ checking the condition of existence of a finite energy following :

$$\int_{-\infty}^{+\infty} |f(x)|^2 dx$$

We obtain the following discrete transform pair:

$$F(u, v) = \frac{1}{N} \sum_{j=0}^{N-1} \sum_{k=0}^{N-1} f(j, k) e^{-\frac{i2\pi}{N}(uj+vk)}$$

Calculating the transfer function is of as follows:
Calculating the Fourier transform is defined then the vectors normalized frequencies and displaying the FFT module The modulus of the spectrum before and after filtering is shown in Figure 7.

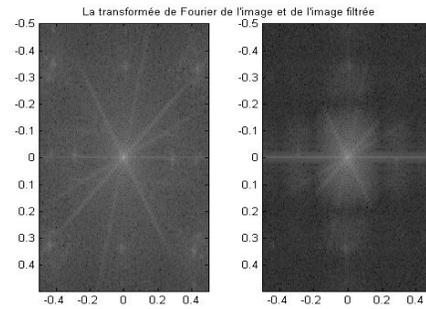


Figure 7. The Fourier transform of the image and the filtered image.

The image at left shows the modulus of the spectrum before filtering. One sees a bright area in the center of the spectrum, which corresponds to the DC component of the image. The scatter around the DC component corresponds to some medium and high frequency components of the image (contours, details, transition zones, ...). The right image shows the spectrum after low-pass filtering. The DC component is low frequency is well preserved. The cloud of points representing the medium and high frequencies was generally removed. However, according to the axes of the horizontal and vertical spatial frequency pure appear significant gains for medium and high frequencies.

Spatial domain filtering (convolution)

Linear filtering space is essentially a convolution operation (2D). If f is the image filter and g the spatial filter was:

$$f(x, y) * k(x, y) = F^{-1} \left\{ F(f(x, y)) \cdot \underbrace{F(g(x, y))}_{k(u, v)} \right\}$$

Filtering can be performed in the image space (spatial domain) using the convolution operator, well known in the signal processing.

The convolution of a 2D signal (an image) with a filter is given by:

$$f'(i, j) = (j * h)(i, j) = \sum_{n=i-1}^{i+1} \sum_{m=j-1}^{j+1} f(i, j) h(n-i, m-j)$$

Example: if $h(n, m)$ is a square mask of size $d = 3$ odd:

$$f'(i, j) = h(1,1)f(i-1, j-1) + h(1,0)f(i-1, j) + h(1,-1)f(i-1, j+1) + h(0,1)f(i, j-1) + h(0,0)f(i, j) + h(0,-1)f(i, j+1) + h(-1,1)f(i+1, j-1) + h(-1,0)f(i+1, j) + h(-1,-1)f(i+1, j+1)$$

Principle of calculating the convolution filter. Is a FIR filter impulse response $h(n, m)$ pixel

$$p = f(i, j) :$$

- Rotate P_i of the core relative to the center:
 $h(n, m) \Rightarrow h(-n, -m) = g(n, m)$
- Center the filter p superimposing the image
- Perform a weighted sum between the pixels of the image and the filter coefficients $g(n, m)$
- The pixel p in the image view (filtered) value will be the weighted sum.

Case with a filter size of $d = 3$

$$h = \begin{pmatrix} w_9 & w_8 & w_7 \\ w_6 & w_5 & w_4 \\ w_3 & w_2 & w_1 \end{pmatrix} \quad g = \begin{pmatrix} w_1 & w_2 & w_3 \\ w_4 & w_5 & w_6 \\ w_7 & w_8 & w_9 \end{pmatrix}$$

The convolution pixel (i, j) of f by h nuclei is given by:

$$f'(i, j) = w_1f(i-1, j+1) + w_2f(i-1, j) + w_3f(i-1, j-1) + w_4f(i, j-1) + w_5f(i, j) + w_6f(i, j+1) + w_7f(i+1, j-1) + w_8f(i+1, j) + w_9f(i+1, j+1)$$

To retain the original average f in f' , we normalize the coefficients of the filter, so we

$$\sum_{i=1}^d w_i = 1 \quad \text{où } t = d^2 \text{ is the number of coefficients of filter.}$$

Multiplication in the frequency domain corresponds to a convolution in the spatial domain. A large number of filters can be obtained from the convolution kernels symmetric and normalized (sum = 1). Few methods most used filters:

The averaging filters are a type low-pass principle is to calculate the average values of neighboring pixels. The result of this filter is a fuzzy picture.

The averaging filter replaces the pixel value by the average value and the value of the 8 surrounding pixels. The matrix is therefore a 3×3 which each member is $1/9$. Impulsionnelle response:

Le filtre de taille $d = 3$:

$$h = 1/9 \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

- Generally speaking, if you have a filter size, all filter coefficients have value as $w_i = 1/d^2$
 - More, the greater the smoothing is important, and the filtered image loses detail of the original image.
- The averaging filter in effect generates the average for each pixel of a neighborhood (3×3) . See figure 8

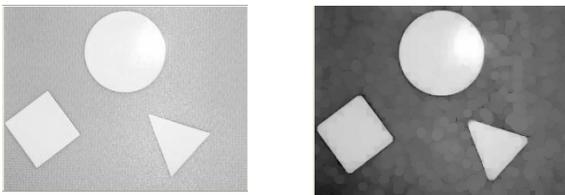


Figure 8. The averaging filter

There is another type of filtering can reduce the noise in an image, the Gaussian filter that will not be addressed in this article.

Nonlinear filtering Unlike the convolution filtering (linear filtering), the non-linear filtering involves the neighboring pixels in a non-linear law. Only non-linear filters can help preserve contours while adapting the content of images. The best known: the median filter (special case of filtering order).

The median filter was introduced by [3]. These are non-linear filters and therefore are not convolution filters. These filters are useful to counter the effect Salt and Pepper "(P & S) that is false" 0 "and" 255 "" in the image [4]. Noise "pepper-and-salt" as used herein is to set, randomly, several pixels values 255 or 0 (extreme values of the range of gray levels). This type of impulse noise may appear by scanning an image or over a transmission (Figure 9).

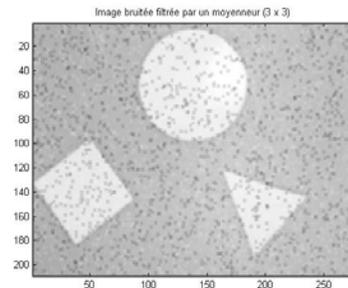


Figure 9. The median filter

Noise "salt-and-pepper" is slightly reduced. You can still see clearly the grain in the image. Indeed a convolution filter affects the processed pixel values of a barycenter of the gray levels of the pixels in a neighborhood. A pixel whose gray level is very different from the others is going to affect the result of the convolution. It is preferred in this case replace the pixel value by the median value and not the average value (for example).

Another filter to soften the image without making it blurry edges Nagao filter.

The idea of Nagao [6] is to make a partitioning of the analysis window of size 5×5 in various filtering windows (9 areas). After calculating the empirical variance of each filter output field is the average over the area with the lowest variance.

Mathematical morphology is a particular type of filter order theory therefore nonlinear processing is now widely used in the analysis of binary images, but has since been extended to grayscale images. Mathematical morphology does not rely on signal processing, but based on set theory, which is a discipline relatively "self contained" and forming a coherent whole.

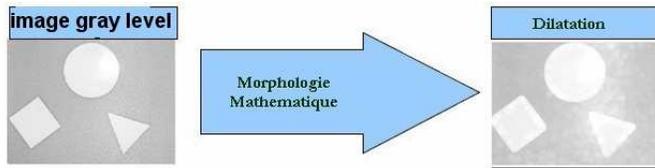


Figure 10. Mathematical morphology dilation.



Figure 11. Mathematical morphology erosion.

Mathematical morphology brought us new concepts of geometric transformation of an image of our vision system. Including the expansion operation (figure10) and the erosion operation (figure11) and their combinations called opening (erosion and dilation) and closing (dilation and erosion) followed the same aperture closure. The choice of four or eight neighbors depends on the type of connection that is desired.

We noticed that using a dilation with a mask connectedness four (4 neighbors) we get an outline dilated connectivity eight, whereas with a mask connectedness eight showed a contour connectivity four. This last operation we also pose problems for the contour tracking. We opted for expansion with an operator with connectivity four.

IV. SEGMENTATION

The segmentation is an essential step in image processing and is a complex problem. Segmentation is a process of computer vision; it is usually the first step in image analysis that comes after the pretreatment. Segmentation is the extraction of characteristics of the object, which allows a distinction between the object and the background.

It helps to locate and define the entities present in the image. Exists a variety of segmentation methods whose effectiveness is difficult to assess.

Image segmentation is carried out which leads to a segmentation of the image into a finite number of regions (or segments) which correspond to well-defined objects, parts of objects or groups of objects that appear in an image. This is a very useful transformation vision.

An error in the segmentation of the form to acknowledge necessarily increases the risk of poor recognition.

A-The principles of segmentation

Many studies have been done on this subject, in areas as varied as the medical field, military, industrial, geophysical,

etc. ... It is always a hot topic and a problem which remains open where there are very many approaches:

- Segmentation by thresholding
- Segmentation by regions
- The segmentation contours
- The Hough Transform
- The approach to classification

All these approaches aim to feature extraction. There is no universal algorithm of segmentation, each image type corresponds to a specific approach. A good method of segmentation will be one that will arrive at a correct interpretation.

In this paper we have implemented an algorithm for detecting the connected components of binary images. The notion of connectedness is here the notion of neighborhood by direct contact. In general, we use two rules of connectivity: 4-connectedness which are considered related side four neighbors (left, right, top, bottom); 8-connectivity are considered related when four neighbors side (right, left, above, below) and the four diagonal neighbors (Figure12).

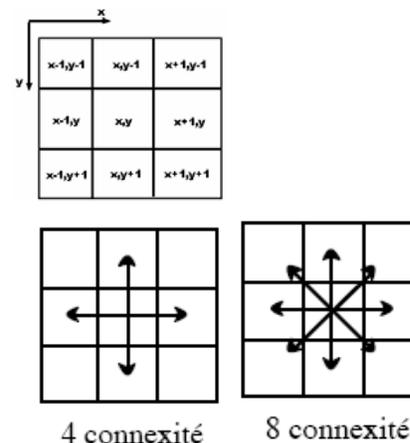


Figure 12. Connected components

B- Labeling Related Components

Example of an algorithm:

- Scanning the pixels of the image line by line and considering only those of the form.

If the pixel has no connected neighbor already labeled, create a new label and assign it to that pixel.

If the pixel has exactly one pixel related labeled assign this label.

If the pixel has more than one pixel associated (with different labels) assign one of the tags and storing all these labels are equivalent.

- Redo pass on the image grouping equivalent labels on one label

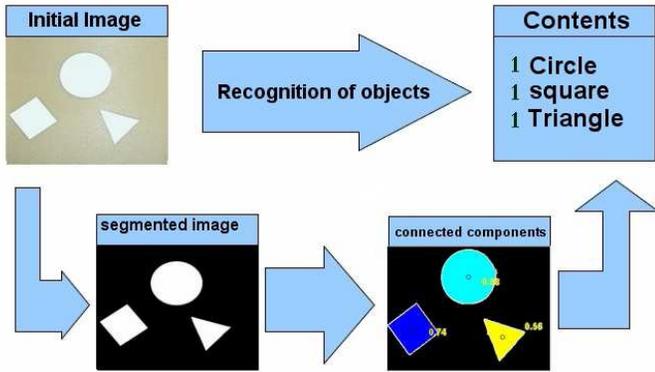


Figure 13. Labeling Related Components

V. RECOGNITION OF OBJECTS PLC

Once objects are identified and sent through a signal through the RS 232 serial port to the controller which operates the pusher arms according to the characteristics of the object. When the object is not identified, it progresses and is ejected into the palettiseur unknown objects.

In this case we define three variables:

ob1, and ob2 ob3 as follows:

If the first object is a square then square = ob1

If the first object is a circle then circle ob1 =

If the first object is then a triangle triangle ob1 =

If the first object is neither square nor triangle or circle and then ob1 = unrecognized

If the second object is a square then square = ob2

If the second object is a circle then ob2 circle =

If the second object is a triangle when ob2 triangle =

If the second object is either square or triangle or circle and then ob2 = unrecognized

If there is no second object then ob2 = nothing

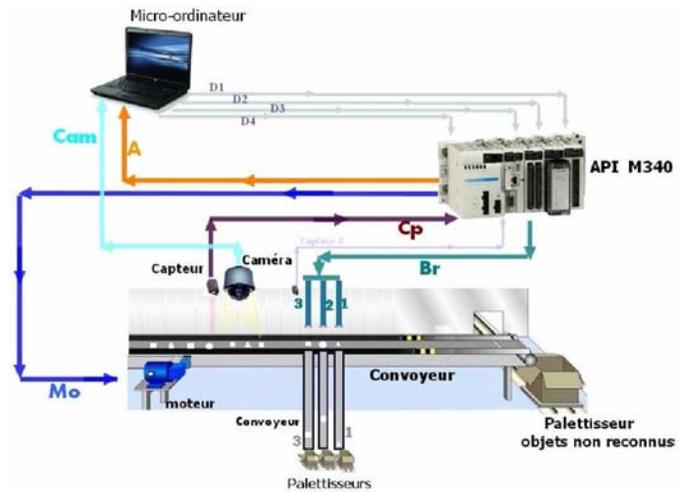
If the third object is a square then square = ob3

If the third object is a circle = circle then ob3

If the third object is a triangle then triangle = ob3

If the third object or rectangle or circle or triangle and then ob3 = unrecognized

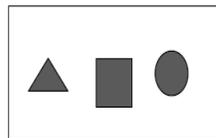
If there is no third object = nothing then ob3



A Communication between the PC and the PLC



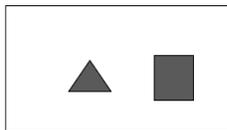
Send 0.5s for the sequence 1000. For 0.5s and then send the sequence 0010. For 0.5s and then send the sequence 0100. Then send the sequence 0000



Send 0.5s for the sequence 0100. For 0.5s and then send the sequence 1000. For 0.5s and then send the sequence 0010. Then send the sequence 0000.



Send 0.5s for the sequence 0010. For 0.5s and then send the sequence 1000. For 0.5s and then send the sequence 0001. Then send the sequence 0000.



Send 0.5s for the sequence 1000. For 0.5s and then send the sequence 0010. Then send the sequence 0000.

B Human Machine Interface (HMI)

The interface is a program created to simplify access rights to the configuration or commissioning of equipment configurable computing. Indeed, the most frequent case in the field of vision is to have a visual interface for programming and configuration. In this work, an interface is set up for the configuration of the control system. To achieve our application via Vijeo Citect interface (Figure 5.10), we describe a series of successive operations detailed and

complementary process recognition of objects for sorting application. The simulation consists of:

Detection by the first sensor concomitant to the camera, the object causes a reaction consisting of the controller to send a signal to the motor driving the main conveyor to a stop (BFI 26) allows the camera to capture the image. Wherein the image is in turn sent to the computer to analyze and recognize the object of the image (LI 31).

This is actually the next phase of the process, because it is from there that the controller receives the order to operate the push arms. This second operation, initiated by writing a word corresponding to the detected input in a FIFO register, continues with the action of the 2nd sensor placed before the arm push the controller operates according to the value of the selected word in the FIFO. The control of one of its arms, pushes the object on its conveyor specific place it in the corresponding tank (23 FBI, FBI 24, FBI 25). In the case of non-detection of one of the three selected objects, this leads to a lack of signal to the controller, saving the object, and leads to the unrecognized paletisseur objects. It should be noted that the whole process is completed in its appearance and utility implicational the counting operation, the control itself changing trays, once maximum capacity is reached (eg 90 objects).

VI. CONCLUSION

Computer Vision is the basis of any artificial vision system that takes as input one or more digital images, and performs processing on these images in order to extract information about the scene. In this paper we presented the steps necessary to ensure the speed of sorting objects (geometrical shapes) in an image by computer vision. Indeed, some phenomena such as noise (eg in a poor reception of data), blur (due to poor focus), or loss of quality (due to poor lighting) will burden the course process, it would be interesting to use professional equipment containing a CCD camera for high definition vision.

Complicated operations of image processing are needed in order to make more effective the next step in image analysis, the sample median filtering is more suitable than linear filtering to reduce impulse noise. It eliminates events smaller than half the size of the observation window (pulse type noise elimination). Segmentation is an essential step in object recognition remains a complex problem. Segmentation is a process of computer vision; it is usually the first step in image analysis that comes after the pretreatment. This is a must for computer vision. Segmentation is therefore the extraction of characteristics of the object, which enables a distinction between the object and the background.

The test results obtained are very satisfactory, we were able to recognize certain objects in the image and sort according to their forms by the method of labeling component. Object recognition involves the identification of a correct object to send the signal via the RS 232 serial port that communicates to the PLC object type identified for sorting application.

Ultimately, this study may lead to the development of an analytical tool that can be applied for example to the study of sorting and quality control in an industry related to manufacturing.

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