DESIGN AND REALIZATION OF AN EXPERIMENTAL MODEL OF A MODULAR PRODUCT SORTING SYSTEM

GEANTĂ Florin-Adrian, GHEORGHIȚĂ Vlad
Faculty: Industrial Engineering and Robotics, Specialization: Applied Informatics in Industrial Engineering, Year of studies: 4, e-mail: geanta300@gmail.com

ABSTRACT: In modern industrial applications, checking the integrity and quality of the product is one of the most important procedures, being also the result of the optimization and efficiency of the production process. The automatic product verification and sorting system is the fastest and most efficient system that achieves compliance with the quality standards of one or more products. These systems are classified as critical in some applications because replacing them with human personnel requires a large number of employees and related costs.

KEYWORDS: image processing, quality, sorting, verification, NI Vision Assistant

1. Introduction

Optical control systems (OCS) for quality control are becoming more and more used due to the efficiency and speed of product sorting. These systems can be observed in various industries such as: metallurgical, automotive and an increase of these systems can be observed in the additive manufacturing industry, etc. OCS are of several types, these can be with: video camera, X-rays, ultrasound, etc. The purpose of this paperwork is based on the efficiency of the OCS with video camera by performing image processing of the product, being easy to be built and having the property of modularity (the ability to easily add other outputs from the conveyor belt system).

In a simplified operating mode of the system, the operating steps can be described as follows:

1. Place the product on the conveyor belt.
2. A picture of the product is automatically taken on the belt.
3. The image is processed using NI Vision Assistant and LabVIEW.
4. The product is redirected from the conveyor belt to an exit in the system, depending on the signal given by the two programs.

2. Current status

At present, the work is divided into 3 separate sub-chapters that will be combined to result in the physical part (3D model), image processing software program, and motor control program.

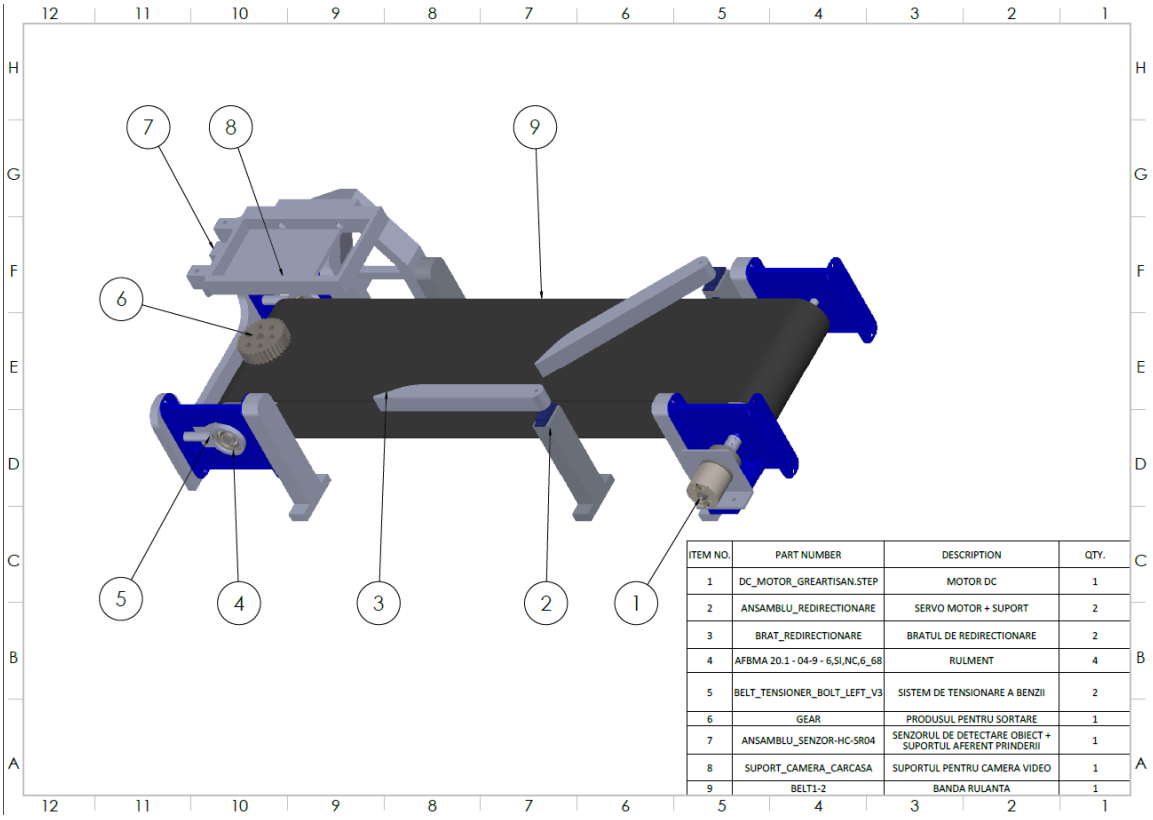
2.1 CAD Model

This sub-chapter will present the functioning mode of the sorting system using a gear as a product.

Figure 1 shows the 3D model with the following main components:

1 - DC motor - provides movement to the conveyor belt.
2 - Support and servo motor - actuate the redirection arm.
3 - Redirection arm - changes the direction of the product from the belt.
4 - Bearing - allows the shaft to move freely.
5 - Bearing support piece and threaded shaft - provides tension to the belt.
6 - Gear wheel - the product to be checked and sorted.

7 - Ultrasonic sensor - detects objects on the belt.
8 - Camera support
9 - Conveyor belt



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	DC_MOTOR_GREARTISAN.STEP	MOTOR DC	1
2	ANSAMBLU_REDIRECTIONARE	SERVO MOTOR + SUPORT	2
3	BRAT_REDIRECTIONARE	BRATUL DE REDIRECTIONARE	2
4	AFBMA 20.1 - 04-9 - 6,SI,NC,6_68	RULMENT	4
5	BELT_TENSIONER_BOLT_LEFT_V3	SISTEM DE TENSIONARE A BENZII	2
6	GEAR	PRODUSUL PENTRU SORTARE	1
7	ANSAMBLU_SENZOR-HC-SR04	SENZORUL DE DETECTARE OBIECT + SUPORTUL AFERENT PRINDERII	1
8	SUPORT_CAMERA_CARCASA	SUPORTUL PENTRU CAMERA VIDEO	1
9	BELT1-2	BANDA RULANTA	1

Fig. 1. CAD model

The system will add an Arduino board, a laptop support, which will perform the image processing and all the necessary structural elements to fix the system. The functioning mode is as follows:

The product, in this case the gear, is placed on the belt (Figure 2).

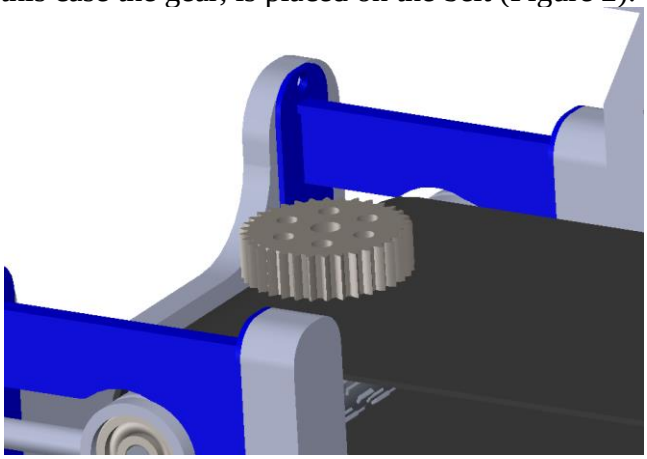


Fig. 2. The product on the belt

The ultrasonic sensor detects the presence of the object on the conveyor belt and sends information (the distance from the sensor to the belt, represented in Figure 3 as Delta Z) to the Arduino board, which is then interpreted and processed by the LabVIEW program.

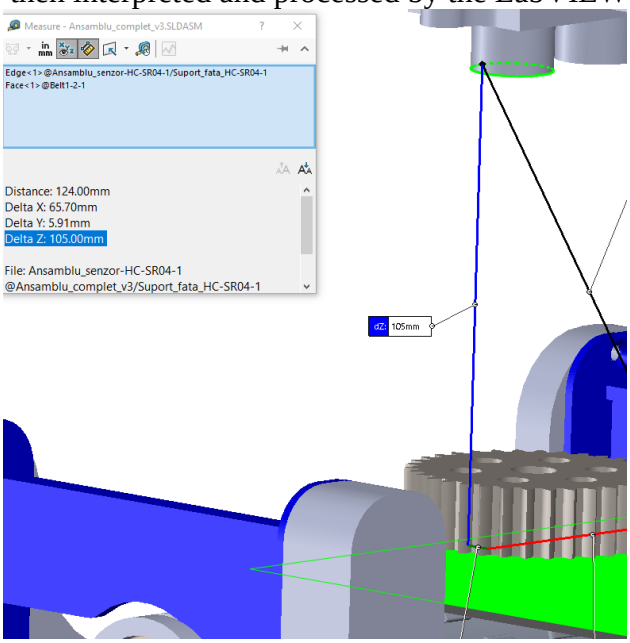


Fig. 3. The distance from the sensor to the belt

If the distance is less than this value (from Figure 3), then the program knows that there is a product on the conveyor belt and moves on to the next steps in the software application.

The program sends a signal to the video camera only after detecting the object, which will take a photo. This picture is retrieved by the LabVIEW application and processed to perform product verification (Chapter 2.3).

After verifying and identifying the product category (e.g. good, recoverable, unrecoverable), the software program transmits servo motor control information through the connection to the Arduino board (Chapter 2.2).

2.2 Motor Control Application

The motor control application was created in LabVIEW (Figure 4) and represents the connection between it and the Arduino microcontroller. This application also controls the motors (both for the conveyor belt and for redirection).

The application operates with the help of the Linx module, which establishes the connection and transmits data between LabVIEW and the microcontroller. Analyzing Figure 4 from left to right: the application opens a communication port and iterates a "While" structure, then configures the DC motor direction pins and its speed for both directions.

Next, the distance in centimeters is read from the ultrasonic sensor, and at the bottom, there is a "Select" structure that is activated only when the piece is detected on the belt (if the Delta Z distance is less than 10 cm). In this structure, the angles at which the servo motors should move are set, and finally, both the "Select" and "While" structures are closed, and the communication port is closed with the help of the Linx library.

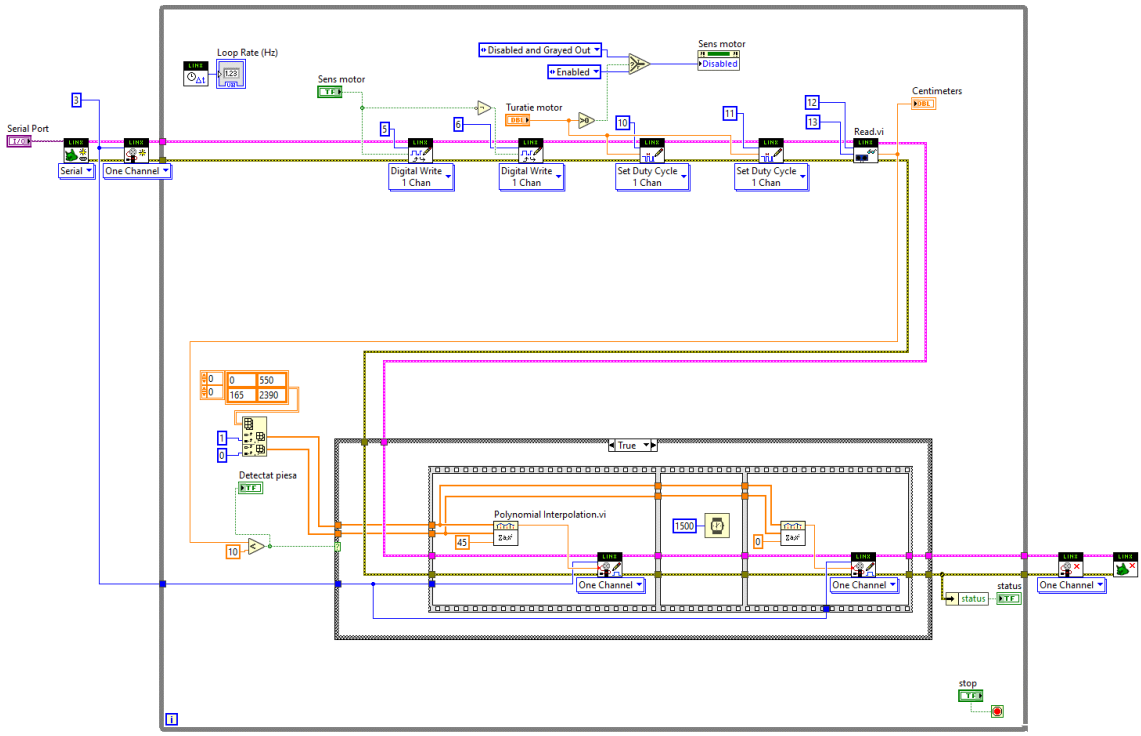


Fig. 4. Motor control application

2.3 Product Verification Application

This application was also programmed in LabVIEW (figure 5) and performs verification of the photo taken by the video camera using the Vision Assistant module (Chapter 2.4) and Vision Acquisition.

Following the program from left to right, it can be observed that it runs in a "While" structure, which contains the image acquisition module with a preview element. The ultrasonic sensor and transmitted signal have been replaced in this program with a button element („Take photo") for the simplicity of the testing program. When the button is pressed to capture the image, the "Select" structure is activated, which includes the algorithm for saving the image and its processing module.

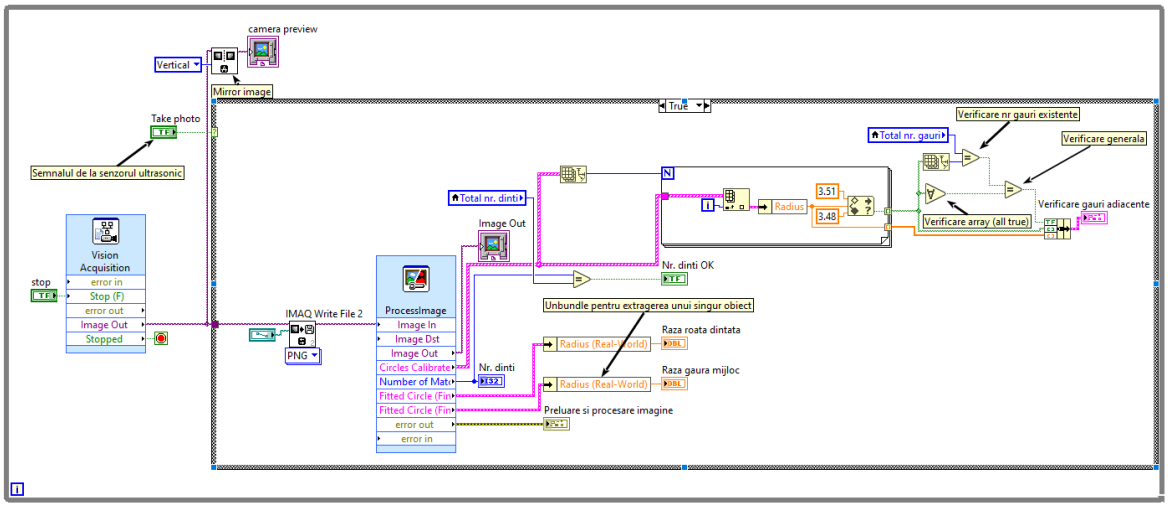


Fig. 5. Product verification application

After this processing, data validation is performed (e.g. verification of the number of teeth, verification of hole diameters, etc.), and the final result can be seen in figure 6.

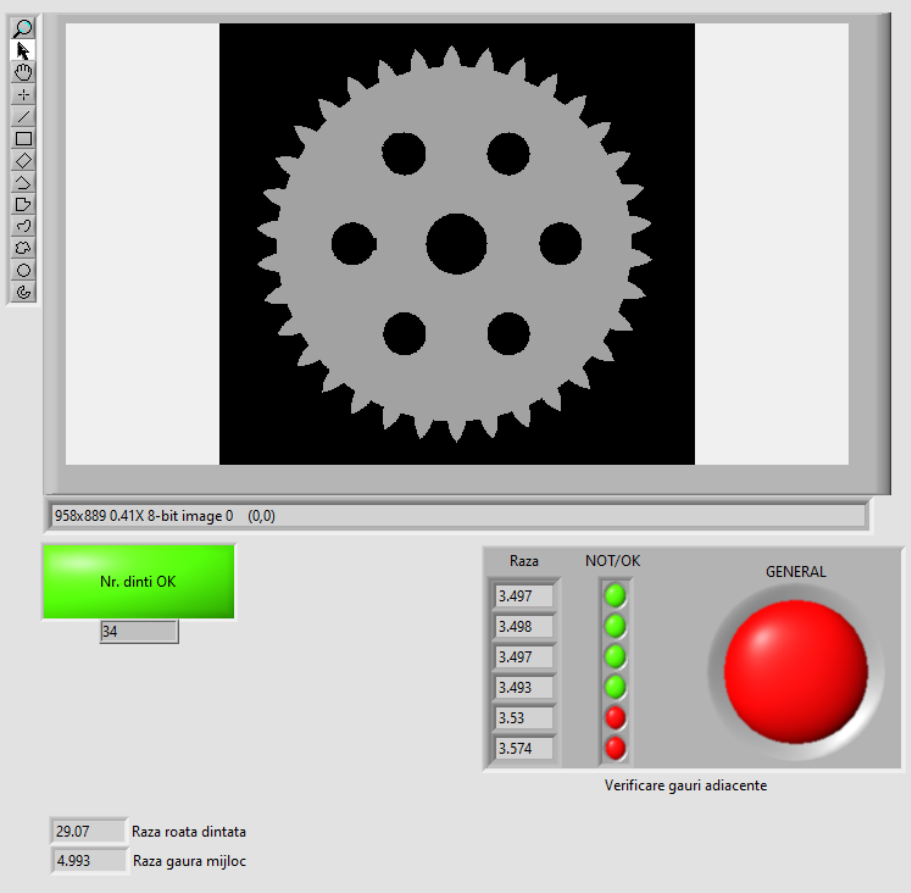


Fig.6. The output of the image processing process

2.4 Image Processing

This application was created in the Vision Assistant module (Figure 7) and the main processes were:

- "Image Calibration" - performs calibration after a standard photo, in order to measure in units of measurement (mm / cm) and not in pixels, as the program does without this calibration.
- "Find Circular Edge" - used to determine the diameter of the hole in the center, but also to configure the center coordinates in the next step.
- "Shape Detection" - performs detection of small bores in the cogwheel and provides us with information about their dimensions.
- "Pattern Matching" - with the help of a template, the program can search for it in the image taken by the camera in the sorting system. Thus, the number of teeth for the gear wheel can be detected.

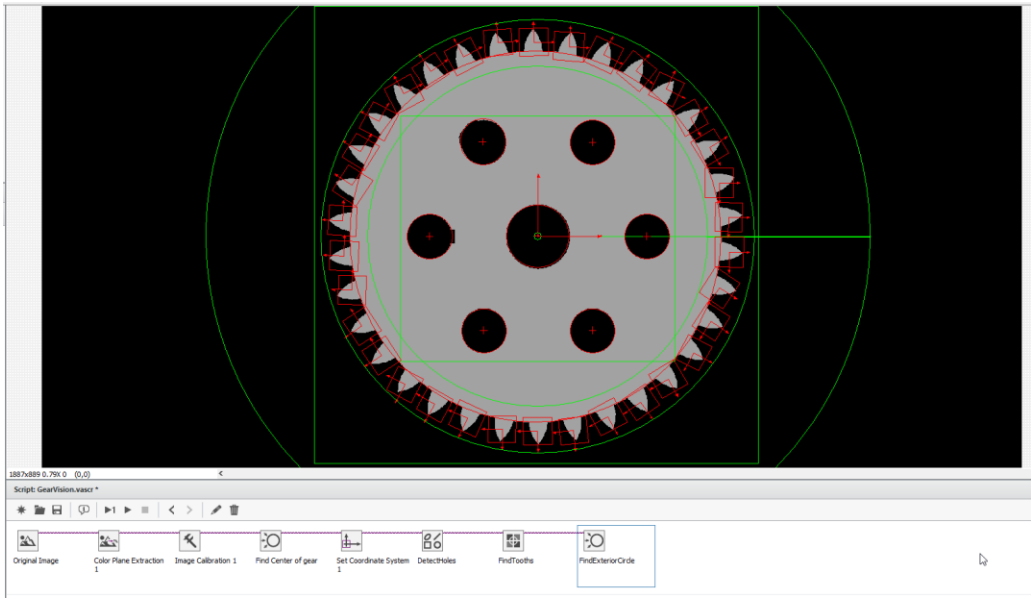


Fig. 7. The product with the active processes

Once this program has been created, the user can select the variables that they want to use or display in the LabVIEW program for image processing in the next window (Figure 8). These are properties of the processes used in the program presented earlier.

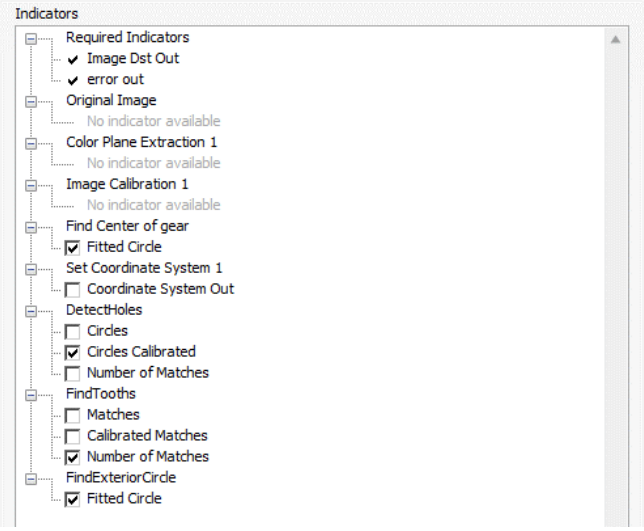


Fig. 8. The exported variables to LabVIEW

3. Conclusions

Verification and sorting systems are completely necessary not only in series production, but also when the product requires a lot of time to be manually checked for quality. These systems can be relatively easily built, mostly with 3D printed components, a laptop, and a few prototyping components (Arduino board, servomotors, etc.).

Depending on the product, this system can be partially or totally modified, with the changes being easily made once the basic design is established. Also, the product can be easily changed, and in case critical properties of the product are changed (weight, height, etc.), the components that need to be changed can be re-designed in a short time.