RESEARCH ON DESIGNING AND DEVELOPING AN EXPERIMENTAL MODEL OF DEVICE FOR SLICING PRODUCTS IN THE FOOD INDUSTRY

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ABSTRACT: This scientific paper focuses on developing a device/machine for cutting wheels of cheese. It contains information about some of the existing types of cheese cutting machines, the working principle and the solutions that will be implemented. The machine has to cut cheese wheels in slices with required weight and can be placed in stores, supermarkets and restaurants. Two cameras send the acquired images to a program in which data is collected and the calculations are made. In order to do this the cameras will read the actual diameter and height of the cheese wheel that is placed on the table. Next, the program will determine the volume of the wheel and, knowing the weight that is required, the table will rotate with the angle needed to cut the desired slice.

Keywords: image processing, food industry, slicing

1. Introduction

The subject of this paper is represented by designing and programming of a preferential slicing device of cheese wheels. Currently, the applications used in the food industry field are machines which cut the products only at standard dimensions [1].

The pursued goals are the presentation of the working principle and the development of the algorithm used for the determining the piece which will be sliced and also of the elements that will be improved with future research, starting with the initial obtained results.

In order to develop the product, and the programme that will coordinate the components, Catia V5 R21, and the processing image module of Python were used.

Table 1. Actual stadium/stage

Fig. 1. Cheese slicer RS [2]

Fig. 2. Hard Cheese slicer Rock 13 [3]

Fig. 3. Hendi Profi Line 300 [4]

Fig. 4. Hard Cheese slicer Rock 20 [5]

Fig. 5. Cheese slicer EC14 [6]

2. Working principle

2.1. Logical scheme of the working principle

The series of steps that the product uses is shown in figure 6, as it follows:

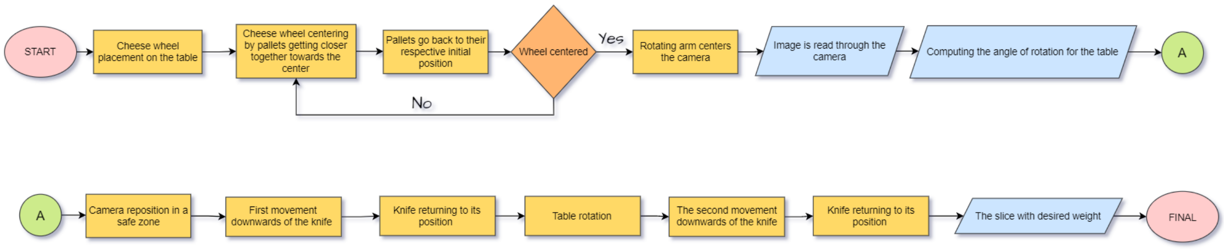

Fig 6. Logical scheme of the operating principle

2.2. The components of the designed device

The equipment has two cameras, the one mounted on the upper cover which will transmit information about the diameter; the other one is placed on the side, therefore will collect images of the wheel profile. After image acquisition, the programme will determine the volume. As the desired quantity is known, the angle of rotation of the table can be computed, such that the final slice will be at the specified weight.

The block diagram of the equipment is presented in figure 7, as follows:

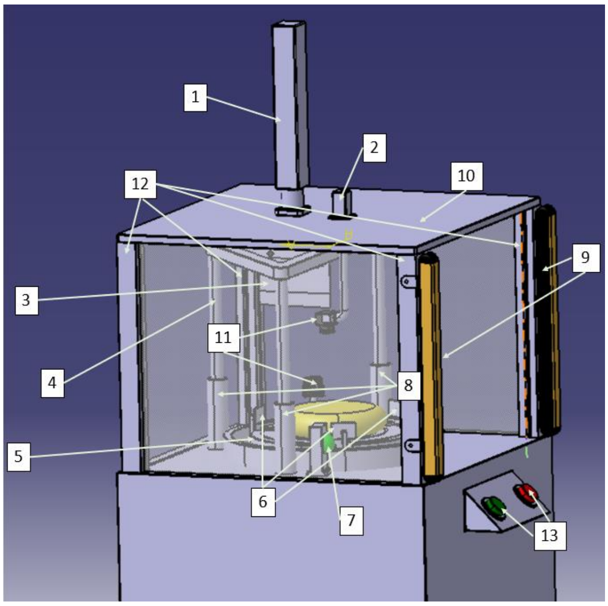

Fig. 7. Block diagram of the equipment

The device components are as follows:
1 - Actuator
2 - Motor
3 - Knife
4 - Knife subassembly
5 - Rotating table
6 - Pallets
7 - Led
8 - Guiding nuts
9 - Protection barriers
10 - Lid/Cover
11 - Cameras
12 - Support bars
13 - Start/Stop buttons

3. Identified problems

3.1. The position of the cameras

The cameras must be centred and placed perpendicular to the surface of the cheese wheel in order to determinate with precision its dimensions. To ensure this functionality I assembled the cameras on a mobile support. The upper camera is placed on a support controlled by a stepper motor, which has only rotational motion, whereas the other camera is placed on a stand that only has translation motion on the vertical axis, in order to always be positioned in the middle of the distance between the table and the maximum height of the wheel. Because it was necessary that both the camera and the knife to be in the middle, it was chosen a support that has a 90^{o} angle, which is larger than the overall dimension of the knife subassembly, in order to read the diameter of the cheese wheel, without interrupting the image acquisition.

3.2. The calculation of the geometrical parameters

After image acquisition stage, in which the programme reads the effective dimensions, the density of the individual cheese wheel is inputted, followed by the determination of the total volume by computational means. After the volume was found, the operator enters the weight of the desired slice. With these two values, the programme defines the angle where the table should rotate so that at the end of the knife movements, it results the slice with the desired weight. In figure 8, are represented the steps for the volume determination. Initially are represented the views of a cheese wheel (A1 from the side, A2 from the top).

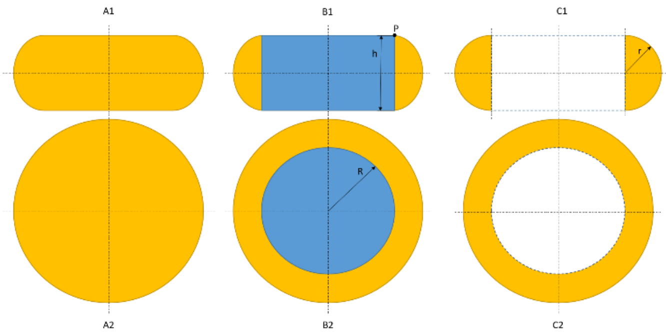

Fig. 8. Steps for the volume determination

In order to determine the volume of a cheese wheel, it can be separated in two volumes easier to calculate: the blue cylinder and half of a torus represented in views C1 and C2 with the colour yellow.

Firstly the volume of the blue cylinder can be calculated with the following formula:

$$V_C = \pi * R^2 * h \tag{1}$$

In figure 9 it is demonstarted the fact that when a torus is unfolded, it is exactly a cylinder. In this case, the height of the cylinder is identhical to the lenght of the circle of diameter R, represented in figure 8.

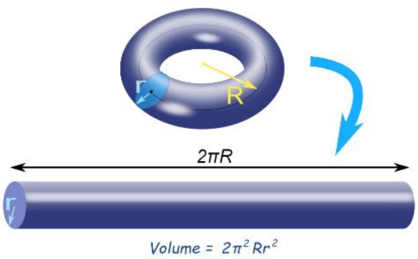

Fig. 9. Volume of a torus [6]

To determine the volume of a torus the following formula is used [7]:

$$V_T = 2 * \pi^2 * R * r^2 \tag{2}$$

For the computation of the zone represented in yellow in figure 8, C1 and C2 views, the volume of the torus will be used and divided in half. Because the volume of the figure that must be identified is half of a cylinder.

$$V_{T/2} = \pi^2 * R * r^2 \qquad (3)$$

Finally, to determine the volume of the cheese wheel we need to add the 2 formulas (1) and (3).

$$V_{Total} = \pi * R^2 * h + \pi^2 * R * r^2 \qquad (4)$$

3.3. Software development

In order to read the dimensions of the wheel of cheese it is necessary a programme written in Python and integrate them in the formulas earlier mentioned in order to determine the volume.

The logical scheme on which the programme is based is represented in figure 10.

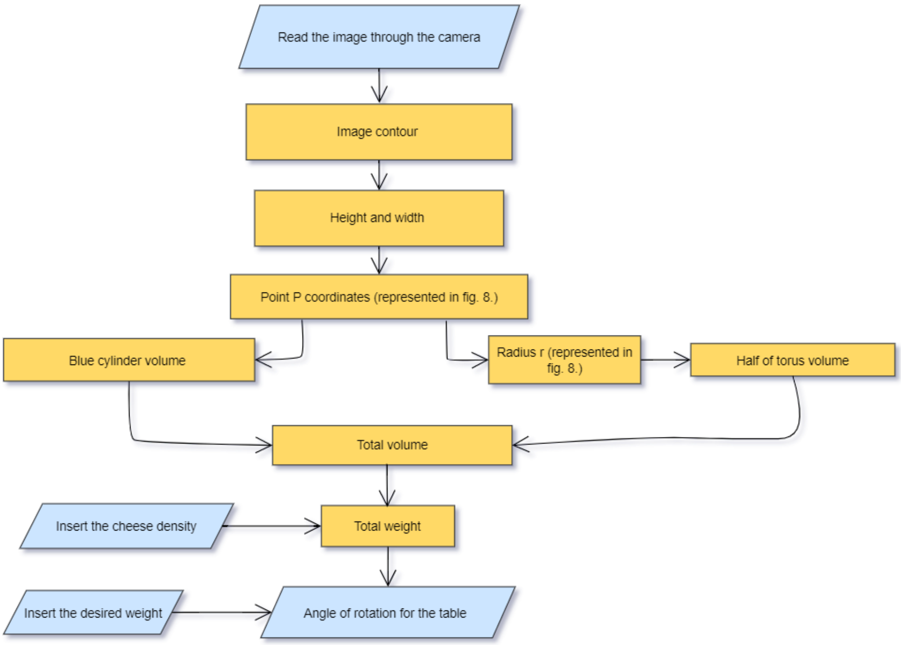

Fig. 10. The logical scheme of the written programme

3.4. The position of the cheese wheel

In order to complete this task, a number of three pallets are needed, which will be actioned by three actuators. These are located in some existing canals in the table support, so that the translation motion be possible. Also, these have the role of centring the cheese wheel, therefore they should be placed equidistantly, at 120º. They have a pressure sensor which determinates the moment when they can start retiring to their initial position.

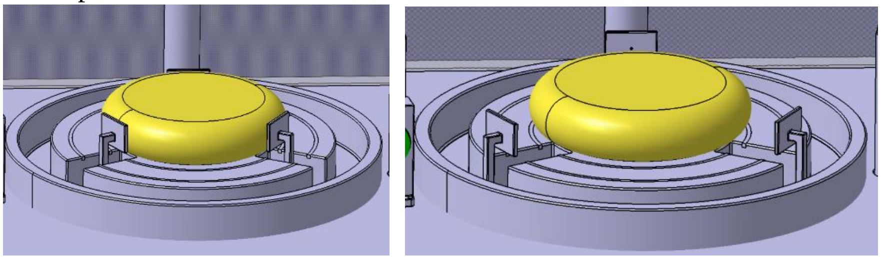

Fig. 11. Centering the cheese wheel

4. Conclusions

Original contributions are represented by the designing the product and having a few optimisation solutions such as cameras positioning or the movement of the knife.

Future research is represented by equipment optimisation so that it can slice a variety of products with different dimensions.

5. Bibliography

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6. Notations

The following symbols were used in this paper

V_C= volume of the cylinder [mm^3];

V_T = volume of the torus [mm^3]

$V_{T/2}$ = half the volume of the torus [mm^3]