DESIGN AND REALIZATION OF AN EXPERIMENTAL MODEL OF AUTOMATION SYSTEM FOR DOUGH DOSING

STAN Bianca Alexandra, GHIONEA Gabriel Ionuț
Faculty of Industrial Engineering and Robotics, Fields:Applied Computer Science in Industrial Engineering, Year of study: IV, e-mail: bstan170@yahoo.com

SUMMARY: The purpose of this scientific paper is to pose the question and, at the same time, justify the automation of equipment that can be part of an entire production line in the bakery industry. The idea starts with a simple question, namely: "How can this dough dosing process be automated?". Starting from this question, in the following, the methods by which the desired result was reached will be presented. The presentation will show how the problem was thought out from a functional, mechanical and electrical point of view..

KEY WORDS: dosing, automation, bakery.

1. Introduction

The topic addressed refers to and poses the problem of automating a piece of equipment so that the dosing process is carried out without the need for a person's intervention. Such devices have a very high demand in the market because they respond to many of the customer's needs. A few factors that make these devices indispensable for a bakery business would be: reduction of working time, accuracy regarding weighting, increase in production and last but not least, the need and safety of customers.

The field of automation in the bakery industry is vast and at the same time it is desired to pursue a certain problem, namely that of automatic dough dosing. In this case, the decision was made that the dough that will be used in the study will be that of muffins, with a soft and dense texture. Thus, a device that automatically doses the muffin dough into special silicone molds will be thought of and made.

Another issue that needs to be thought about and resolved is how the muffins are transported after the dosing process is done. For this, was thought, the conception of a conveyor belt that will be integrated into the system.

The starting point is quite simple and consists of two main elements. Firstly, it is necessary to design a device through which the dough will flow, taking into account certain parameters, and secondly, it is necessary to have a conveyor belt built into the system to allow the movement of the muffin forms.

Next, we will present the principle scheme from which the design of the device started and the way in which it was thought out so as to achieve the dosing in the most efficient way.

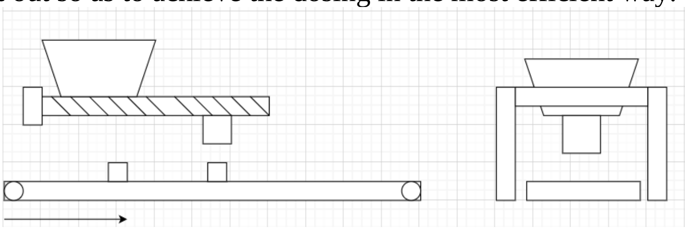

Fig. 1 Principal scheme

The scheme is quite simplified, but it started from this idea, and more precisely, an element is needed which will allow the dough to move. For this, the solution was found to use a rotating auger, which will be incorporated into a device that allows the dough to be stored. Regarding the introduction of the dough into the device, a tub will be used that will be incorporated in the upper part of the assembly, and in the lower part there is the place where the dough will flow and the belt that will transport the muffins.

2. Current status

At this moment, the work has advanced a lot in terms of the choice of electrical components and the way in which they will be connected to each other, the design of the assembly both in software and physically but also in the way the device works.

First of all, it will start with the presentation of the design part so that the working mechanism can be clearer and easier to understand. This is the final version of the assembly and, as can be seen, it consists of two subsystems. In the upper part there is the subsystem that performs the dosing, and in the lower part there is the conveyor.

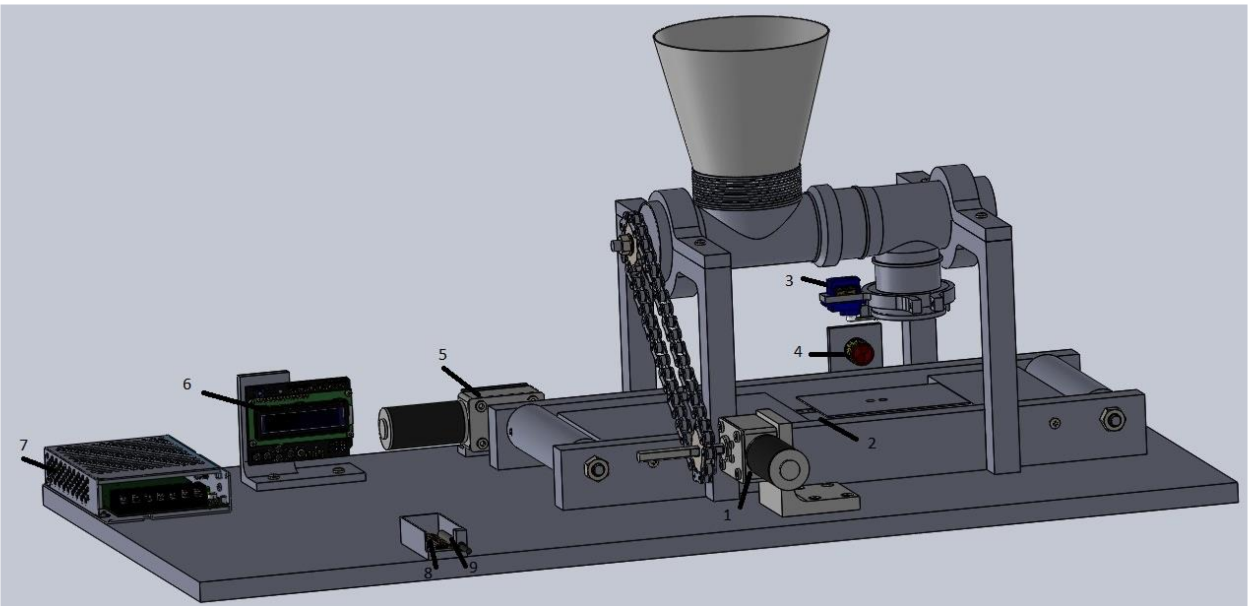

Fig. 2 Dough Dosing Device Overview (Isometric View)

In the figure above (Fig.2) the overall picture is presented and the components are numbered so that they can be easily identified in the following table:

Table 1. Identification of the electric components

1	Direct current motor [1]
2	Weight sensor
3	Servomotor [2]
4	Object detection sensor [3]
5	Direct current motor [1]
6	LCD display [4]
7	Power source [5]
8	Soil moisture sensor [14]
9	Temperature sensor [15]

After choosing all the components that will be part of the system, the electrical diagram could be made. A 12 V source [6] was chosen as the power supply for the system, from where several elements will get their current, such as the 12 V DC motors [7], the voltage lowering modules [8], but also the relay [9]. The rest of the elements need an operating voltage of 5V, the voltage they will receive from the voltage lowering modules. Among these elements are the sensors (weight, object detection, humidity [10], temperature [11]), the LCD screen[12], the SG 90 servomotor[12]. The commands will be read through the Arduino Uno board [13], where all the sensors and other elements will be connected, either using digital or analog pins. In this diagram, the junctions are represented by circles to show that several wires receive current either from the same source or from the voltage drop modules, and they are used to load the image as little as possible.

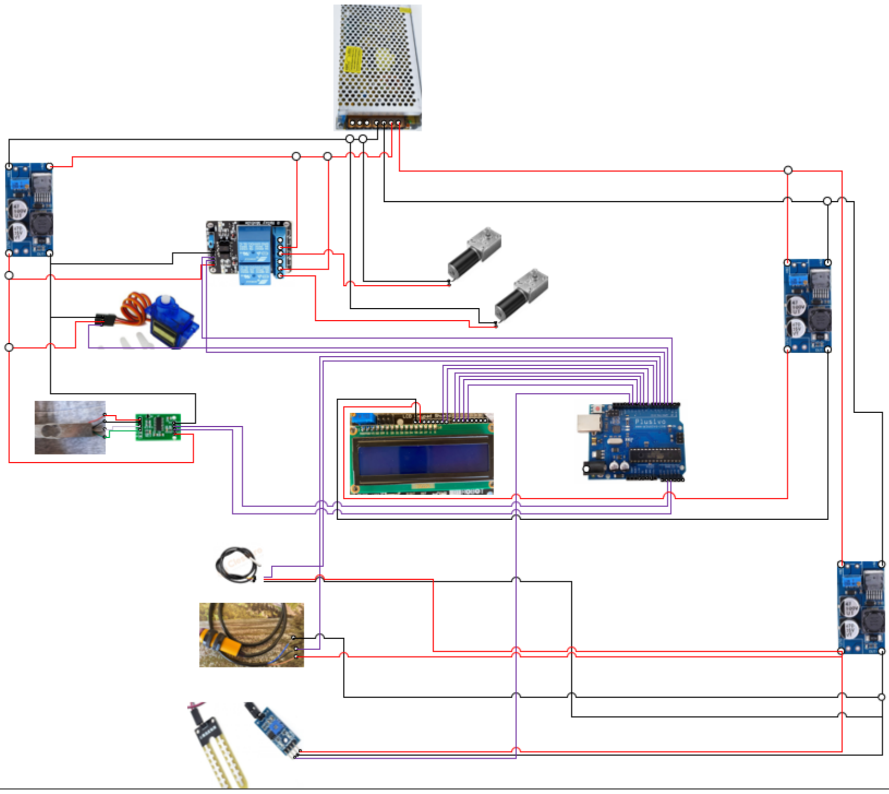

Fig. 3 Electrical scheme

Now that things are clearer about the experimental design and the elements that make up the system, it also needs to be very well understood how this system will work.

In the figure below (Fig. 4) is presented the logical scheme of operation of the experimental model. The process consists of:

- Stage I – testing phase;
- Stage II – dosing phase;

When it comes to the dough, whether it's like the dough for bread or cake, i.e. harder, or like the dough for brioche, denser and softer, two very important factors in the process are temperature and humidity conditions. So, to be sure that the dough which will be used in production is one that meets the conditions required to rise and bake properly, in phase I some tests will be done on a dough sample. Thus, the temperature and humidity sensors were chosen because they are important and have great decision-making power regarding the dough. The standard values for each individual sensor will be retrieved and an important condition will be created without which one cannot proceed to the next stage. When both conditions are met, a "Conformable" message will be displayed and thus the dough can be used in production, otherwise, a "Not Conforming T/H" message will be displayed on the screen and a decision will be made regarding the dough.

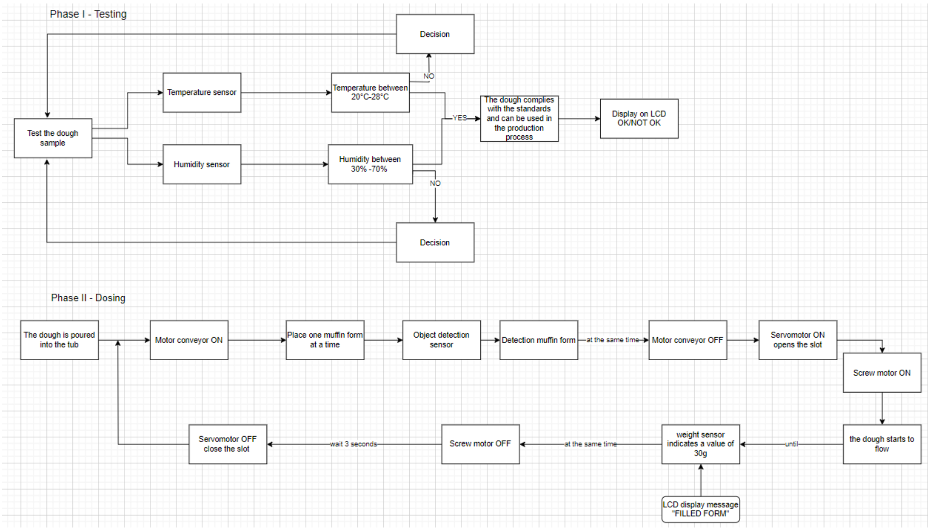

Fig. 4 The logical scheme of the operation of the experimental model

After stage I has been successfully accomplished, the dough can be poured into the tub and the dosing process can start. It starts the belt which is driven by a DC motor and starts placing a muffin shape on the belt, which moves until it is detected by the object sensor. At this moment the motor that feeds the conveyor has stopped, and immediately after, the servomotor that is built into the place where the dosing is done, opens its slot to allow the dough to flow. Only at this moment turns on the motor that feeds the auger. It starts and the dough flows until the weight sensor integrated in the band indicates a preset value of 30g . Then a message will be displayed on the LCD display "Form filled" and at the same moment the motor of the auger will stop. After a 3 second delay the servo will close its slot and then the motor that powers the conveyor will start again so the loop repeats as many times as it needs to.

At this moment the programming part is being developed, and so far the movement of the two motors using Arduino has been achieved. In the first phase, the conveyor motor starts, then it stops for a few seconds, the motor that drives the auger starts, it stops for a few seconds and the loop resumes. An example of the code can be seen in the image below (Fig.5). In the adjacent image (Fig.6) you can see the experimental model in physical format.

Control2DCmotors.ino

```
int In1motor1 =2;
int In2motor2 =4;

void setup() {
  Serial.begin(9600);
  pinMode(In1motor1, OUTPUT);
  pinMode(In2motor2, OUTPUT);

}

void loop() {
  digitalWrite(In1motor1,HIGH);

  digitalWrite(In2motor2,LOW);

  delay(5000);
  digitalWrite(In1motor1,LOW);

  digitalWrite(In2motor2,HIGH);



delay(5000);


}
```

Fig. 5 Control of the DC motors

Fig. 6 Physical project overview

3. Conclusions and future directions for research and development

The presented work managed to answer the question I started from, namely "How can this dosing process be automated", but along the way a lot of other questions arose that still haven't found a clear answer because they weren't really just priority.

It is desired that the material from which it is designed be changed in the future, the most favorable being stainless steel due to its resistance over time, it can be cleaned very easily, it has an affordable price, etc. Stainless steel is widely used in food production for good reason. It is characterized by the addition of chromium - at least 10.5 percent of the total composition. Chromium is highly reactive in oxygen environments and quickly forms a strong barrier on its outer surface. This barrier is very resistant and protects the internal structures from further corrosion [13].

Another idea that may become a topic of thought is the design of the experimental model in such a way as to allow cleaning of the equipment from the inside.

It is desired that in the future a sensor can be integrated that can measure the amount of dough so that the operator can be alerted when he needs to refill something.

My own contribution consists in the thinking and conception of this experimental model, starting from a simple sketch of the operating mechanism and developing the idea in such a way as to meet all the requirements related to the design, mechanical part, electricity, programming and last but not least the construction of the physical model.

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