Body Mass Index based Health drink vending machine using Programmable Logic Controllers

M Kalaiyarasi 1, C Ganesh Babu2, K Ramya Deekshitha3 and B V Sakthi4

1, Assistant Professor, Bannari Amman Institute of Technology, Department of Electronics and Instrumentation Engineering, Sathyamangalam, Tamilnadu, India.
2, Professor, Bannari Amman Institute of Technology, Department of Electronics and Instrumentation Engineering, Sathyamangalam, Tamilnadu, India.
3,4 UG Student, Bannari Amman Institute of Technology, Department of Electronics and Instrumentation Engineering, Sathyamangalam, Tamilnadu, India.

Abstract. As the consumer enters his/her height and weight the BMI of the person is calculated. If the BMI indicates that the person is fit, then the machine makes an ideal health drink with all nutrient content. If the BMI of the person indicates he/she is skinny or obese the combinations of the drink mixes vary accordingly. Once the BMI is calculated, a pump connected to a water sump is activated and it allows some amount of water to the mixing container. The mixes are allowed to fall through a screw conveyor to maintain constant discharge irrespective of the amount of the mix in the container. The amount of mix to be discharged is controlled by a PLC which is already programmed using Ladder Logics. Timers are used in the program for exact measurement. Then the motors attached to the screw conveyors start working for a certain period of time as programmed and allow the mixes to fall into the mixing container. When the motors complete its rotation, a motor attached to the mixer starts rotating for some time to blend all the ingredients. A solenoid valve that connects the mixing container and the dispensing cup is opened when the mixer completes its mixing. Then the user can collect the drink. The whole process takes a maximum time of 3 minutes approximately.

Keywords: Body Mass Index (BMI), Programmable Logic Controllers (PLC), Human Machine Interface (HMI), Mixing units, Solenoid valves.

1 Introduction

In these modern times, people are running towards anything and everything forgetting that their health is much more important than anything else. Worldwide obesity kills a lot more people than underweight. In Europe, one in three 11-year-old children is obese or overweight. Obesity is linked to more than 60 chronic diseases. Obesity is costly. People who are obese pay more out of pocket than people who are not. In fact, the medical costs for people with obesity are $1,500 higher each year than those with a normal BMI. Overweight and obesity can be fatal. In this case, nearly 9.5% of the world’s population is suffering from underweight and malnutrition issues.
Though there are a lot more reasons for this case, one of the most important reasons is ignorance about food and food habits. Having a large amount of carbohydrate-rich food leads to obesity and vice versa. In addition to this, modern people rely on health drinks as it acts as a better supplement for food. Most of the health drinks available at the market are full of chemicals, carbonated water, and other additives that cause serious afflictions. In order to reduce the consequences of unhealthy food habits, many alternatives are found in the food market. One of the healthiest ways to gain energy is health drinks that contain ingredients whose quantities are chosen on the basis of their own height and weight i.e. Body Mass Index.

2 Literature review
A vending machine is an electronic device that provides items that are filled to it. Basically, vending machines are used to supply food items like snacks, beverages etc. The machine works when the consumer inserts a coin or cash or a token that is designed for the particular machine[1]. Vending machines were first developed in England in early 1880s while now it is an important part in malls, sports stadiums etc. as it is completely automated and doesn’t need a person to provide whatever the consumer want. Normally vending machines use microcontrollers or microprocessors. But in some cases, vending machines are operated using programmable logic controllers[2][3]. Programmable logic controllers that are considered as industrial digital computers.

A lot of applications use PLCs as their controllers[4][5]. A PLC consists of a CPU, a power supply unit that converts the alternating voltage to direct voltage, memory unit, I/O interfaces, and a communication interface. In this project, PLCs of Allen Bradley are used and the software used is RX logix. The role of programmable logic controllers in this project is to control the flow timings of the drink mixes and also the opening and closing of the solenoid valve. PLCs also maintain the flow of water or milk from the storage sump to the mixing container. In this machine, the role of PLC is to calculate the Body Mass Index (BMI) of an individual and to control the timings of rotation of the screw conveyors. BMI is usually calculated by dividing a person’s weight in kilograms by the square of height in meters. It is an inexpensive way to categorize a person’s weight whether he/she is obese or skinny or normal. It can be used as a simple screening tool rather than a diagnosing tool. BMI ranges from 18.5 – 30. BMI is used as a tool that prevents risk as it gives data that may prevent several health issues. BMI plays an important role in everyone’s life as well as in this machine, as it acts as a deciding factor with a person’s weight range and to determine the ratio of components to be mixed in this machine. A lot of surveys and research papers are written on the BMI range across many urban and rural areas across the globe[6][7].

This unit is just a set of containers that contains various drink mixes such as protein powder, vitamin supplements, whole grain mixes and some flavoring substances such as badam drink mix, powdered saffron etc.

3 Proposed working
3.1 Block Diagram
As the consumer enters his/her weight and height, a drink is supplied to him/her within minutes. This is done through the collective working of various components like Human Machine interface, Programmable Logic controllers, mixers, valves etc. The role of every individual component is explained in figure 1.
3.1.1 **Human machine interface:** The Human Machine interface unit is basically a computer dashboard that allows the consumer to enter his/her height and weight. The values are sent to the next unit.

3.1.2 **BMI calculation:** The BMI of the consumer is calculated and the height and weight of the consumer from the user. BMI of the user is calculated using the following formula

\[
BMI = \frac{\text{weight (kg)}}{[\text{height (m)}]^2}
\]

(1)

3.1.3 **Programmable logic controllers:** This unit allows the motors connected to the containers rotate for a particular period of time calculated using ladder logic, rotate the motor which is connected to the whisk and opens the solenoid valve when the mixing is done.

3.1.4 **Drink mixes and milk solids:** This unit is just a set of containers that contains various drink mixes such as protein powder, vitamin supplements, whole grain mixes and some flavoring substances such as badam drink mix, powdered saffron etc.

3.1.5 **Mixing unit:** This unit consists of a whisk which is connected to a motor that is powered by the PLC. When the motor is activated the whisk starts mixing the water and all the ingredients together at a high speed in order to blend them into a drink.

3.1.6 **Solenoid valve:** One end of the valve is connected to the mixing unit and the other end is placed just above the dispensing cup. When the mixing is done, the solenoid valve is activated and allows the drink to drain into the dispensing cup.
3.1.7 Dispensing unit: The user can collect the drink which has the right proportion of nutrients according to their BMI.

3.2 Working
When the user enters his/her height and weight, BMI of the user is calculated using the formula mentioned above. Their weight status is found by the following data.

| BMI         | Weight Status |
|-------------|---------------|
| Below 18.5  | Underweight   |
| 18.5 – 24.9 | Normal        |
| 25.0 – 29.9 | Overweight    |
| 30.0 and above | Obese       |

For example: Weight = 73 kg and height = 1.73 M, then BMI =73/(1.73)^2 = 24.08 and it is considered as Normal.

The amount of the supplements is calculated and it sends the time needed for that particular amount of mix to fall into the mixing jar to PLC. The PLC then rotates each motor in different time intervals to allow all mixes to fall in the mixing jar. Simultaneously a particular amount of water is allowed to the mixing bowl by PLC. Once everything is done, PLC activates the motor connected to the mixer and rotates it. The mixer blends all the mixes and water together into a drink. Once it’s done, the solenoid valve is activated and all the drink is drained into the dispensing cup.

3.3 Results & Calculations

| Weight in kgs | Height in m | BMI kg/m² | Weight Range | Carbs in g | Protein in g |
|---------------|-------------|-----------|--------------|------------|--------------|
| 43            | 1.61        | 16.8      | Underweight  | 192        | 36           |
| 47            | 1.57        | 19.1      | Normal       | 208        | 39           |
| 68            | 1.61        | 26.2      | Overweight   | 245        | 56           |
| 82            | 1.62        | 31.2      | Obese        | 268        | 68           |

The above mentioned table (Table 2) is an example of how Body Mass Index works in this machine. For example if a person enters his/her weight and height as 43, 1.61 respectively then BMI of that person is calculated using the formula stated below table 1 and a health drink that contains 192 grams of carbohydrates and 36 grams of protein will be vended.

4 Conclusion
We can elevate the machine by adding some behavior like the machine gets the data only if a coin or cash is inserted or we can use a load cell and IR sensor to detect the height and weight of the user automatically instead of collecting the data from the user. In future, the machine can be retained in malls, sports stadiums, gymnasiums etc. as people in these areas will be more conscious about their fitness. As this machine is able to provide drinks according to a person’s own height and weight, it can be a gamechanger in the athletics fields as well. To increase the efficiency of this machine, the programming can be altered a bit so that it can supply a healthy drink to kids, infants, and the elderly.
References

[1] Mallikarjun G Hudedmani, R M Umayal, Shiva Kumar Kabberalli, Raghavendra Hittalamani 2017, Programmable Logic Controller (PLC) in Automation. Advanced Journal of Graduate Research ISSN:

[2] 2456 – 7108 Vol. 2, Issue 1, pp. 37-45

[3] Anubhav Kumar, Puja Rani, Anjali 2016 Automation of beverage vending machines using PLC and Scada.in An International Journal of Engineering & Technology Vol 3 No 5 pp 78-84.

[4] Ephrem Ryan, Alphonsus, Mohammad Omar Abdullah 2016 A review on the applications of programmable logic controllers (PLCs). Renewable and Sustainable Energy Reviews Vol. 60 pp. 1185-1205

[5] Yadong Niu, Jian Chu 2015 Design of beverage vending machine based on PLC Proceedings of the 4th International Conference on Information Technology and Management Innovation pp 414 – 419.

[6] Jun C. (2011) Survey of BMI Distribution among University Students Aged 17 - 24 in Wenzhou. In: Tan H. (eds) Informatics in Control, Automation and Robotics. Lecture Notes in Electrical Engineering, vol 132. Springer, Berlin, Heidelberg.

[7] Kohei Ushukibo 1986, Automatic Vending machines in United States Patent and Trademark Office (USPTO)