AUTOMATIC WAX CANDLE FILLING MACHINE

S.Santhosh[1], Dr.G.Balamuruga Mohan Raj[2], R. Mounishwar[3],M.Bharanidharan[4]

[2]Head of Department, Department of Mechatronics, Sri Manakula Vinayagar Engineering College, Puducherry, India

[1,3,4]U.G.Student, Department of Mechatronics, Sri Manakula Vinayagar Engineering College, Puducherry, India

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Abstract - Our main objective is to design and fabricate an automatic wax candle-filling machine that can fill candle containers of various shapes and sizes with the highest accuracy and precision. It would greatly help many small-scale industries by reducing a lot of manual labor and time required to fill a large number of candles. It is also done in such a way that it helps to reduce the amount of wax wastage through this controlled process

Key Words: Wax, Candles

1. INTRODUCTION

The demand for wax candles in India has been steadily increasing due to various factors such as religious and cultural festivities, decorative purposes, aromatherapy, and power outages in certain regions. This has led to a lot of small-scale industries developing and making their candles and sell in the market. But one of the major problems they face as a whole is the amount of time required to fill a large quantity of candles in a single day which is held back by the tiring work done manually.

So we have developed an Automatic wax candle machine, which helps to fill a large number of candles and also reduces the amount of time and the wastage of wax in this automated process. In this machine, we have also added the feature of filling any type of shape or size.

2. WORKING

The Automatic wax candle filling machine has a simple working and it can be easily understood. First of all the molten wax is poured inside a hopper of the machine. As wax can easily cool down an induction coil is paired up with a thermostat to keep and maintain its temperature above 100 degrees Celsius. Then the amount of weight is entered through the keypad which can verified via the display. The value of weight given as the input is the value that needs to be filled inside the container and not the weight along the container itself.

After the value is entered, a conveyor belt moves up the container near the load cell which is kept in the filling part of the machine. An infrared sensor is fixed which checks whether the container has reached or not and if it has reached it would stop the conveyor. As for the next step, the amount of wax to be filled is filled inside the container. The filled quantity is checked through a load cell which is kept in the filling portion of the machine. After it has reached the desired quantity, the container is moved to the next conveyor belt, which moves it to the end of the part where it can be left to cool down. This process is repeated until there is a stop command given manually. There will also be a function to show if there are no containers left to be filled.

In this way, a lot of candles can be easily filled by the machine which also greatly benefits the industry.

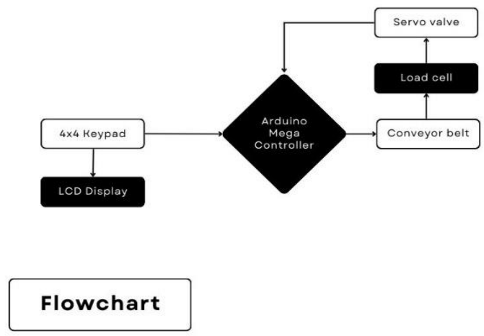

Fig -1: Working block diagram

3. METHODOLOGY

In the iterative development journey of our candle production machine, we encountered several formidable challenges necessitating innovative solutions to ensure seamless operation. The foremost challenge confronted pertained to the imperative of maintaining the wax at a steadfast temperature of 100 degrees Celsius throughout the production continuum. To mitigate this challenge, we instituted an intricate system comprising an induction coil heater in tandem with a thermostat mechanism. The thermostat, serving as the linchpin of temperature regulation, enables precise calibration of the desired temperature, orchestrating the activation or deactivation of the heater as per the exigencies of maintaining the prescribed temperature threshold. Moreover, to counteract any potential temperature fluctuations during the wax's transit within the machine, we strategically implemented nichrome wire windings around the tubing infrastructure. This proactive measure serves to insulate against temperature deviations, thereby upholding the integrity of the wax's thermal equilibrium during the filling process.

The second pivotal challenge that we encountered in our quest for operational excellence in candle production revolved around devising an efficient methodology for dispensing molten wax into the containers. Initially, our contemplation gravitated towards the deployment of a flow sensor to gauge the wax volume accurately. However, the prohibitive temperatures inherent in the process necessitated a strategic pivot towards alternative avenues. Subsequently, we embraced a weight-centric approach, leveraging the intrinsic significance of weight in candle crafting. The integration of a load cell into our operational framework emerged as a pivotal milestone, facilitating precise weight measurement and conferring a newfound simplicity upon the wax-filling process. Moreover, instead of the unfeasibility of employing a flow sensor, we ingeniously devised a servo valve mechanism. This bespoke solution furnishes us with granular control over the wax's dispensation, affording us the dexterity to regulate the flow rate with surgical precision. By embracing these ingenious solutions, we have seamlessly surmounted the cardinal challenges bedeviling our candle production endeavors, thereby attaining a commendable equilibrium between operational efficacy and fidelity to quality standards.

The third juncture of challenges encountered during our developmental odyssey revolved around effectuating a seamless integration between container positioning and the load cell for optimal wax filling. Divergent strategies, encompassing proximity sensors, ultrasonic sensors, and infrared sensors, were meticulously scrutinized to discern the optimal path forward. Within the realm of proximity sensors, the dichotomy between inductive and capacitive variants unfolded, each bespeaking distinct advantages and limitations. While the inductive iteration proved financially prudent, its inability to discern glass containers precipitated its dismissal. Conversely, the capacitive counterpart exhibited unparalleled efficacy in glass detection, albeit at a prohibitive cost juncture. Upon contemplative deliberation, we adroitly elected to embrace the pragmatic efficacy of infrared sensors. This judicious decision was underpinned by their ubiquitous availability at a modest cost threshold, aligning seamlessly with our overarching imperative of fiscal prudence. Furthermore, the innate capacity of infrared sensors to discern glass containers ensures the requisite fidelity in container detection, underscoring our commitment to operational precision without undue financial extravagance.

4. HARDWARE

Our machine's hardware components were selected based on their accessibility and affordability. We decided to make use of the Arduino Mega microcontroller to control the automated procedure. Thanks to its abundance of digital and analog ports, it can be effortlessly connected to a wide range of sensors and peripherals.

We used an HX711 A/D pressure sensor together with a 5 kg maximum weight load cell to precisely measure the weight and interpret the load cell's output. We included a 4x4 keypad module containing alphabets from A to D and numerical digits from 0 to 9 to input weight values. Function keys for operations like clear and enter are represented by alphabets which can be assigned while programming. We included a 16x2 LCD module that displays the weight of the filled container in real time, helping us to confirm the entered weight.

We chose a servo motor with a 20 kg torque rating for the servo valve mechanism. As valves tend to be tight, this high-torque motor guarantees that the valve can be opened or closed. The actual valve is a ¼-inch brass ball valve which was selected due to its smaller diameter, which reduces wax overflow when opened and enables simple flow management.

We chose to use a NEMA 17 stepper motor for the conveyor belt system. Accurate container movement toward the filling part of the machine becomes achievable by its precise control over torque and speed.

We chose an Infrared sensor to sense the container and stop the motion of the conveyor belt when the container reached the load cell. It has an LM393 comparator chip and a detection range of 2 – 30 cm, which is suitable for our application

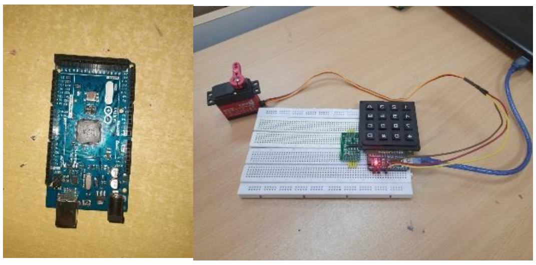

Fig -2: Components

5. SOFTWARE

No additional software is needed to operate the machine; all functions can be executed directly by the Arduino controller, relying on the provided input. The

Arduino IDE's extensive collection of example programs and downloadable libraries tailored for the specific components utilized can facilitate calibration if required.

Furthermore, the Arduino IDE serves as the platform for uploading the machine's code, streamlining the programming process, and ensuring seamless integration with the hardware components. This approach simplifies development and maintenance, as adjustments and optimizations can be made directly within the familiar Arduino environment.

By utilizing the Arduino ecosystem, we can use its user-friendly interface and extensive community support, which allows us to efficiently program and control the machine's operations without needing further dependencies or complicated software frameworks. This straightforward approach increases scalability and flexibility, which makes it simple to adapt to changing needs and potential enhancements.

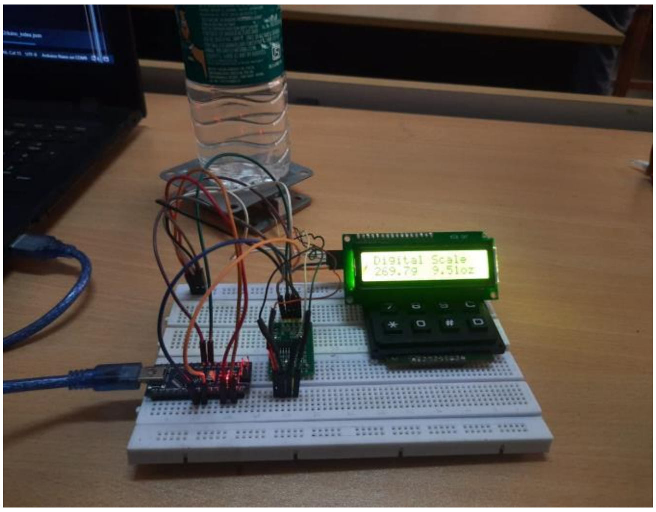

Fig -3: Calibration of load cell

6. CONCLUSION

The development of the Automatic Wax Candle Machine addresses a pressing need within the candle-making industry in India, where high demand is often hindered by the labor-intensive process of candle filling. By automating this procedure, our machine significantly reduces both time and wax wastage, benefiting small-scale businesses and streamlining production processes.

Through meticulous design and engineering, we have ensured that the machine operates efficiently and reliably. The use of an Arduino Mega microcontroller provides ample flexibility for integrating various sensors and peripherals, while also simplifying programming and control.

Furthermore, the decision to rely solely on the Arduino controller for operation eliminates the need for additional software, simplifying both setup and maintenance. Leveraging the Arduino ecosystem provides a familiar and robust platform for development, enhancing flexibility and scalability for future enhancements and adaptations.

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