

Smart Multi Utility Spice Pulverizer Machine

Dr.V.Bharathi¹, Dr.P.Raja² and M.Harikrishnan³

¹Professor, Department of ECE
Sri Manakula Vinayagar Engineering College

²Professor, Department of ECE
Sri Manakula Vinayagar Engineering College

³Assistant Professor, Department of ECE
Sri Manakula Vinayagar Engineering College

ABSTRACT

Indian foods are prepared tastily using variety of spice powders. However, Spice grinding is not that much easy and suitable for all households and chefs in restaurants due to lack of knowledge in proper proportion of ingredients and no machine for grinding small quantity. Many machines came but, the fineness of spice powder cannot be achieved even with the latest machines like mixer grinder. Hence, many households and chefs of restaurant using spice powder available in markets, but these powders had some preservatives and chemicals that cause severe health issues to human. The flour mills provide super-fine spice powder and excellent taste but it is more economic and requires high voltage for operation and produces more noise. In flour mill graining the quantity for graining should be high and for good taste, correct proportion of ingredients is to be chosen manually by experts. Hence, Smart Multi Utility Spice Pulverizer Machine (SMUSPM) is proposed which can grain and give required spice powder within few seconds by automatically selecting ingredients. Automatic selection of ingredients is controlled by programmed Arduino processor. The SMUSPM consumes less power for operation, it produces less noise while working and its blade is designed to provide fine grained spice without heat and it can operate in single phase supply. SMUSPM is user friendly and anybody can operate this machine without any technical knowledge.

Keywords: Pulverizer, Spices, Flour mills, Grinding, Blade designed, Automation

1. Introduction

India has come to be known as “land of spices”, Spices are integral part of Indian daily food items as well as part of pickles, sauces and chutneys etc. India is the largest producer and consumer of spices with a production of around 947,790 tones which is 60% of the world production. Indian spices are fine in quality and demand for it has been considerably increased from all the countries. The change in life style, especially in food habits, the use of powdered spices has been increased. The average spice consumption in a household of five members is estimated at 100 gm. per person per month. In which, powdered spice may be taken at 50%.

Powdered spices are used mainly in urban and semi urban areas and it may be conservatively assumed that 70% of the urban population uses powdered spices. However, Spice grinding is tedious process for households and hotels. Usually spices are grinded manually or grinded using flour mills and mixer grinders. Manual grinding and flour mill grinding consume more human effort and time, moreover flour mills are costly and consume more power. Mixer grinders could not produce fine grained powder and heat generated in mixer grinder affect the taste of spices. Spice packets available in markets had chemicals for preservation and artificial taste which causes many health issues to human. Similarly Spices crushing is an important activity in rural areas both for self- sustenance as well as source of subsidiary income to small farmers and agricultural labours. Hence it is in need of a better technology for spice grinding which requires less manual power, no mechanical troubles as well as good as economy. Hence to make the existing techniques more user-friendly, more intensive studies are carried.

The basic requirement of home maker as well as hotel management is,

- Spice grinding should be easy and cost efficient
- Taste must be good
- Cost of machine should be worth for purchase
- Automation in grinder for making the process easy and instant

The proposed Smart Multi Utility Spice Pulverizer Machine (SMUSPM) aims at production of production of chili powder, Dhal powder, coriander powder and mixed spice powder such as sambar masala, kolumbu masala, chicken masala, Gobi masla, channa malasal etc in required quantity. The Smart Multi-Utility Spice Pulverizer Machine (SMUSPM) is proposed to reduce the burden of home makers and hotel management in field of spice grinding

2. RELATED WORK

Automation is an important process for industrial world in the global economy. Always industries seek new technologies and designs in automation field to meet global competition. The automated systems reduces the cost of product, labor and waste and increases the production quality, repeatability, work safety.

Nigel gross[1] discussed various design merits and challenges in designing automatic machines. He also suggested automation in machine design can reduce human errors and improve the quality of production. Design of Automatic cutting and welding machine for producing railway Brake Beam-Axle is proposed in[2]. It is also proved that brake beam-axle produced by automatic machine increases security and stability in high speed railways and reduces the error in human welding. They designed the machine using PLC and microcontroller. Mechatronics principle to deliver the paper to the public by using the sensors and microcontrollers is used to design Automatic Paper Vending Machine [3]. Matthew Sunday Abolarin [4] proposed to design and fabrication of a powered paper perforating machine with efficiency and less cost for bindery department in printing industries. It is designed to compete with the manually operated ones and reduce human efforts with minimum time consumption. A low cost automated packing machine which can be used by small enterprises to reduce their cost of plant is proposed in [5]. An additional weighing and pouring mechanism has been added to increase the accuracy of the system which is used for selecting proportion of ingredients of SMPSUM.

T.R.Veena et al [6] proposed design and fabrication of the automatic glass or mirror cutting machine. In order to increase the accuracy of cut and production rate, decrease the production time and accidents caused due to manual cutting of mirror or glass using PLC. Arduino Controlled Paper Stamping Machine that works on an Arduino controller which controls feed and stamping mechanism of paper is proposed by authors of [7], which consumes less power and saves human time. Authors of [8] designed machine for automatic paper bag making which collects and folds the paper and prepares the paper bag in small time period. The paper folding models are specially designed. Design of automatic paper counting device is proposed in [9], they design and developed machine for paper counting. The paper are sensed using sensor and counters are designed to count papers in tray.

Several automatic machine designs proposed in [1-9] improves accuracy in production and reduces human stress, however there is no automatic machine for spice grinding, design of automatic smart spice pulverizer machine is in demand. K.K.Singh *et al*[10] proposed the design of smart cryogenic machine for grinding the spices, basically cryogenic means it uses liquid nitrogen to cool the machines in order to reduce the heat produced during grinding. This concept is utilized in the smart multi utility spice pulverizer machine to reduce heat.

Shino g babu *et al* [11] suggested a 4-phase, 8/6 switched Reluctance Motor (SRM) for driving a mixer-grinder for the specific application of mixer-grinder. They explained step by step procedure for the design of a four phase switched reluctance motor and verified the model using Maxwell software. It improves efficiency by 30% comparing with conventional universal motors used in Mixer grinders. Colloid mill was proposed by S.N. Solankia *et al* [12] and they evaluated proposed mill with domestic wet grinding systems such as a mixer grinder and a stone grinder for grinding of raw rice, parboiled rice and black gram. The wet ground samples are tested and finess are verified in variety of wet and dry mixes. However this mill is more costly and consumes more power.

Pankaj Sharma *et al* [13] analyzed duration of grinding over the particle size, impact on the starch damage as well as energy consumption in batch grinders. They also analyzed energy consumption of Stone grinder and mixed grinder and concluded that stone grinder are the least energy efficient. They also suggested all the three classical laws such as Kick's, Rittinger's and Bond's of grinding seemed to be applicable while Rittinger's law showed better suitability than the other two followed by Bond's law. In stone grinder, higher starch damage in batter occurs due to predominant compressive force. L.Initha *et al* [14] proposed a solution for the problem in performance of wet grinder industry. The major problem is longer grinding time, which leads to more energy consumption and higher torque. They mathematically described the design of the shell and identify the factor which affects them. Design of Blade is important criteria for any grinding machine, Authors of [15] discussed design of a Saw Blade for a Power Tool attachment, they designed variety of blades and Finite Element Analysis (FEA) of the proposed blades are carried out and compared with conventional blades, they given lot of ideas in blade designing. Atul D. Pisal *et al* [16] described

design and development of automatic grinder for band saw machine blade. They discussed about base material and sharpness of the blade for long life and fine graining. A detailed study of various parts of shredder machine like stand (frame), transmission system and cutting system are made and designed separately by authors of [17]. They deal with the study of cutting system of a shredder machine. They also discussed problem definition, objectives, procedure of design with the detailed design of each component of the cutting and transmission. Authors of [18] discussed a detailed design method of a micro grinding machine tool used for flexible joint blade machining. The micro grinding machine tool was built up with a combined support structure of both advantages of gantry column and single column structure, allowing more work zone and better static stability. They suggested an optimization target, and an optimization equation was established with the natural frequency as the optimization goal, mass and size as the constraint condition. Hence, Blade design plays an important role in spice grinding; blades are specially designed for proposed pulverizer machine and tested.

Amruta K. Wankhede *et al* [19] Proposed a design, Modification and Analysis of shaft of concrete mixer machine has done. The existing shaft of concrete mixer machine gets failed after approximately 150 hr of used. The efficient drum with blade designed in proposed pulverizer machine could produce fine grained powder with small energy consumption.

3. PROPOSED WORK

The proposed pulverizer machine is designed to have separate hoppers for each and every ingredients such as chili, dhal, coriander, turmeric etc. The valve of hoppers is closed and opened using servo motors. These servo motors are interfaced with microcontroller and its operation is controlled by program coded in microcontroller. Key board and LCD displays are also interfaced with microcontroller. User can select any spice and required quantity using keyboard. After the selection process, microcontroller opens required hopper's valve for predefined time period and mix proportion of ingredients required for the selected mix in selected quantity. Microcontroller is programmed to switch on ac motor to grain spice after mixed ingredients reaches graining drum. The blade and drum are designed such that it can produce fine grained spice in small time period and microcontroller switch off ac motor automatically after graining process is over and each process is displayed in LCD display. The machine consumes less power since it uses single phase AC motor, however it will not affect the quality of spice powder due to specially designed blade and drum setup. The blade and drum are designed for multipurpose grinding which is suitable for both dry as well as wet grinding. Fig. 1 represents basic block diagram of proposed SMUSPM.

The hopper is used to store the raw materials for grinding it and make it use ready to use in food processing. The hopper designed in such way the mouth of hopper is square shape and the end is in the shape of pyramid. In the bottom of each hopper, the metal door is used for opening and closing of hopper in order for getting the ingredients down the hopper and to make it into fine spice powder using the specially designed blade which is powered by AC motor 1 HP. Servo Motor is attached along with the Hopper for opening and closing of the shaft under hopper. In order to get the ingredients into grinding part. The AC motor is switched "ON" or "OFF" by microcontroller through the relay circuit based on the coded program. Drum setup is the main thing for spice grinding thus it must be strong and rigid to withstand the load and pressure. We have designed the drum and blade in such way that even small particles even get caught in blade and grinded down into powder. Some of major cons of the machine are that drum has sharp edges then when come to blade setup it is multipurpose blade setup we can grind any kind of spices using it. Drum and blade design are shown in Fig 2 and 3.

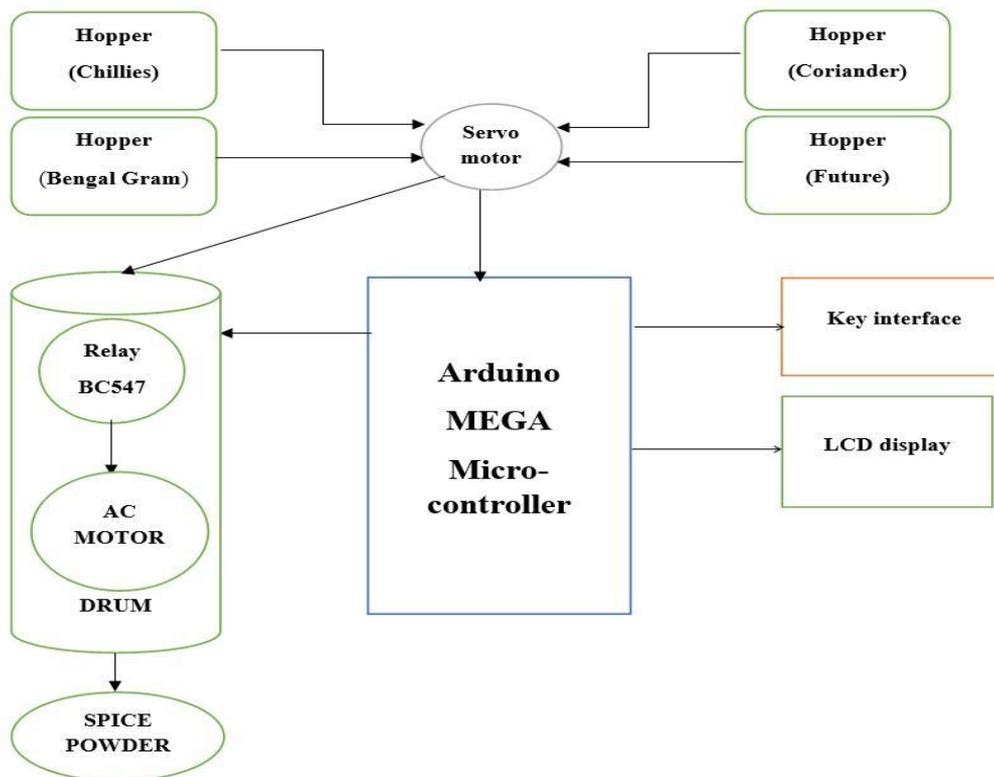


Figure 1 Block Diagram of Proposed SMUSPM

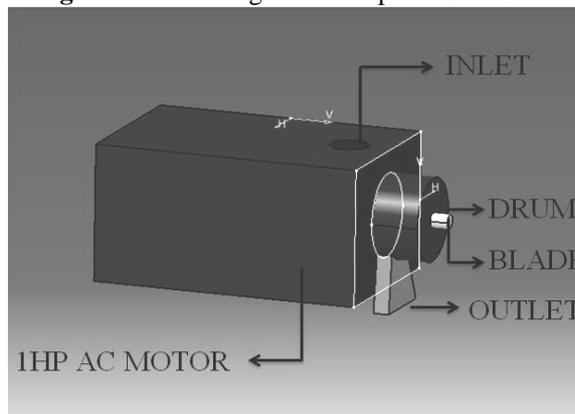


Figure 2 Design of Drum

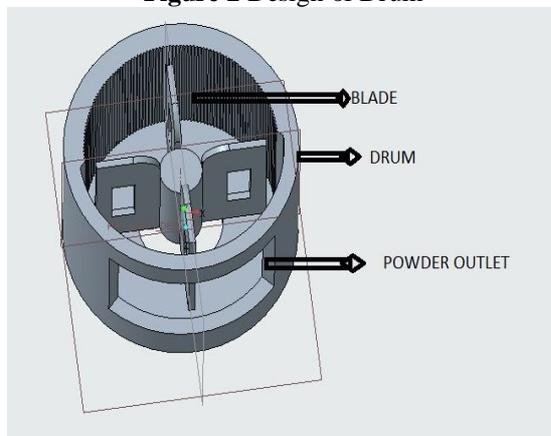


Figure 3 Design of Blade

METHODOLOGY

The proposed model uses timing circuits to control the servo motors which in turn control the opening and closing of the hopper. The program for variety of spice selection in required quantity is programmed in the microcontroller. The choppers are filled with the ingredients. User can select any spice or dhal powder in any required quantity through keyboard interface with microcontroller, Based on the selection the correct proportion of the ingredients is taken as input from the hopper, which is done using the time delay circuit. Then those ingredients is send into the drum, blade, motor part where grinding of species is done. The blade is designed in such a way that, it grinds the species fully and produces spice powder with correct taste and with good fineness. The main advantage of this method over other method is that, it works on single phase supply whereas conventional methods requires three phase supply. The pollution in the form of noise and dust is more in conventional methods whereas pollution is much reduced in this proposed model. The main advantage is that the cost and size of the machine is very low when compared with other methods.

WORKING

The hoppers are present in the top of the machine. Each hopper used to store different ingredients. The different ingredients stored in the containers are chilies, Coriander, Bengal gram etc., The input ingredients are fed up into the hoppers. After the selection through the keypad, the ingredients with correct proportion must be grinded inside the drum. The correct proportion of inputs obtained by opening and closing the hoppers with correct time delays. The opening and closing is done with the help of the servo motors. The servo motors work on the basis of angle provided to them as input. By providing the necessary angle input, the correct proportion of ingredients is obtained. The angle is provided to the servo motors with the help of the Arduino mega microcontroller. The embedded c program is could be uploaded to the microcontroller. Then based on the key selection, the correct hopper is opened for predefined time. The ingredients from the hopper is sent to the blade and drum setup through the funnel. The drum setup run by means of relay circuit. The relay is connected to the Arduino microcontroller. As per the condition given in controller, the drum connected with motor runs. The drum consists of a 1 HP AC motor. The blade is designed in such a way that all the ingredients grinded to full fineness. Different powders like sambar powder, chili powder, coriander powder etc., are grinded using this drum and blade setup. The selection is done through the key interface. All the above process is displayed through the LCD display setup. The final output of the drum is the fine grinded powder. Fig 4 shows the Design diagram of SMUSPM

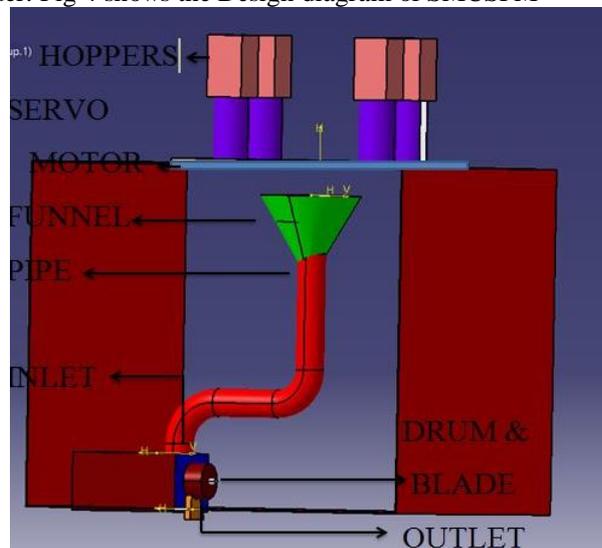


Figure 4 Design of SMUSPM

4. HARDWARE DETAILS

ATMEGA 328 is the major component of SMUSPM, it is used to close and open the valve through interfaced servo motor. Fig. 5 shows the interface diagram of servo motor with arduino.

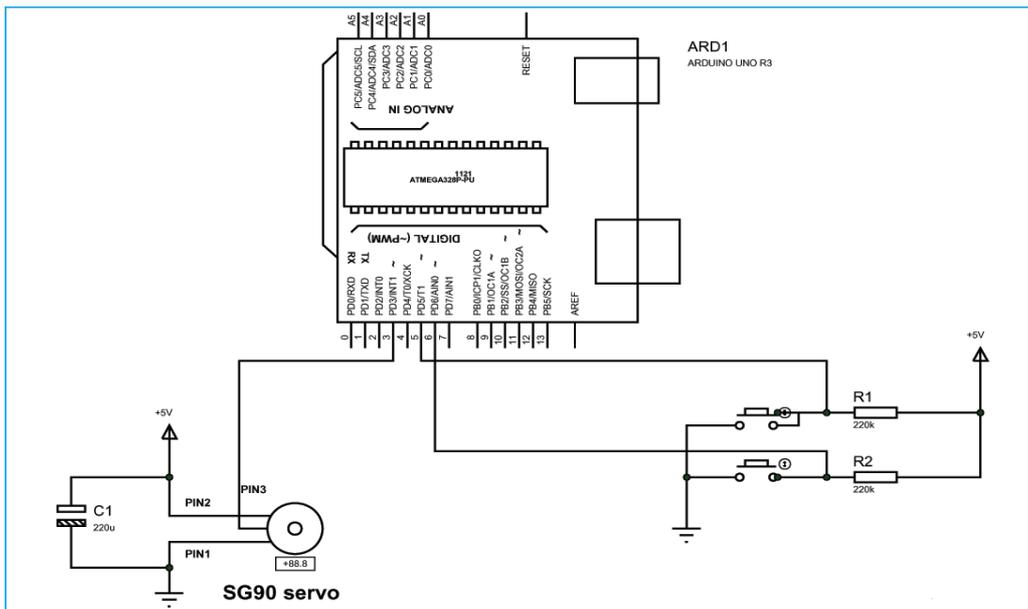


Figure 5 Circuit diagram of Servo motor interface with ARDUINO

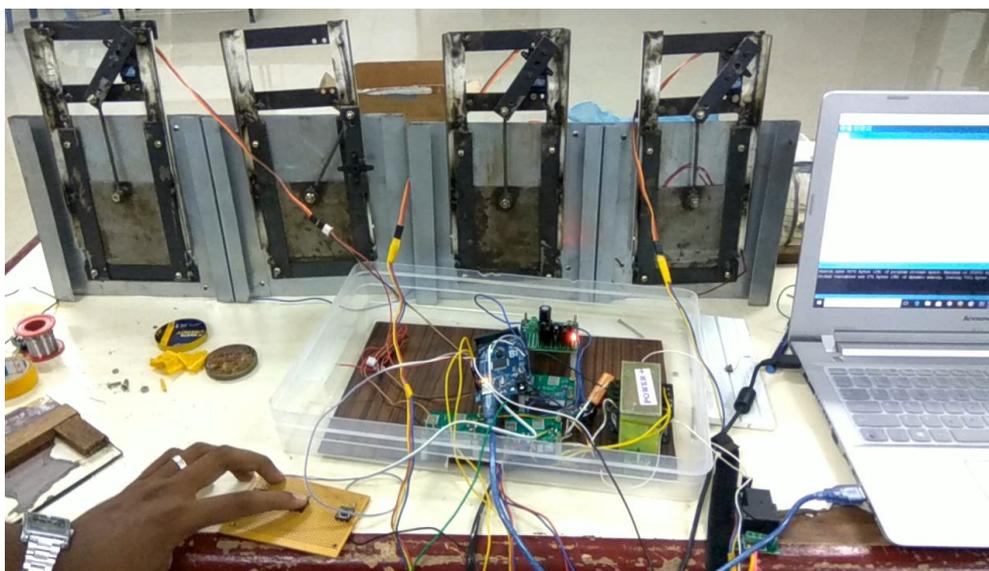


Figure 6 Container close/open system

Drum setup is the main thing for spice grinding thus it must be strong and rigid to withstand the load and pressure. Fig.7 shows the blade of SMUSPM



Figure 7 Drum and blade



Figure 8 Front view of SMUSPM

5. CONCLUSION

Smart multi utility spice pulverizer machine (SMUSPM) is designed to produce fine grained spice in required quantity with quality. The process is automated using microcontroller and it consumes low power with less noise. This low cost SMUSPM can replace existing grinding machine like mixer grinder, Cryogenic, Conventional type of spice grinders.

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AUTHOR



Dr.V.Bharathi received Bachelor of Engineering from University of Madras in 1999, Master of Technology in 2003 and Ph.D from Pondicherry University in 2016. She is working as a Professor of Electronics and Communication Engineering, Sri Manakula Vinayagar Engineering College, Puducherry, India. She has more than 25 publications in National / International conferences and Journals. Her areas of interest include Wireless Networks, Wireless Communication and Signal Processing.



Dr.P.Raja received Bachelor of Engineering from University of Madras in 1999, Master of Technology in 2007 from IIT and Ph.D from Pondicherry University in 2015. She is working as a Professor and Head of Electronics and Communication Engineering, Sri Manakula Vinayagar Engineering College, Puducherry, India. He has more than 25 publications in National / International conferences and Journals. His areas of interest include Wireless Networks, Wireless Communication and VLSI Design.



M. Harikrishnan received Bachelor of Technology in 2011 and Master of Technology in 2013 from Pondicherry University in 2011. He is working as an Assistant Professor in Sri Manakula Vinayagar Engineering College. His area of interest includes wireless communication.