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Compact, Handheld Dosa Bot Design

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***Abstract*— This typical robot is step further in robotics where technology is used in the automation of the food processing. This is an embedded system which works with the help of different algorithms of computer numerical methods for drawing similar dosas on the hot pan. This robot basically draws dosas on the hot induction plate, which enables to cook dosas of required size and shape. This prototype bot consists of a beaker containing the dosa batter with a small nozzle at its bottom. Beaker motion in the space is controlled through two axis X & Y, controlled by the stepper motors. Opening and closing of the nozzle is controlled by the servo motor and the amount of batter coming out of the tube is controlled by the pressure pipe connected at the top of the tube. Induction heating mechanism is employed for the heating of the nonstick pan. The shape of the dosa or an image is given to the Inkscape software which creates corresponding G-code files to make dosas of required shape and size. Motion of the beaker (end effector) is controlled by the microcontroller board which receives the G-code files from the universal G-code sender.**

Keywords—3D printing;Dosa;Induction heating;Handheld

I. INTRODUCTION

Science & technology is increasing rapidly day by day. Robotics is one of the area where science & technology can be used to do human work efficiently and accurately. This paper deals with the interconnection of fields where technology in one field that can be extended to other fields for our required purpose. Here some technological changes in traditional automation so that it is used to make dosas. This shows the sign of advancement of robotics in the processing of food artistically. This robot is capable of making perfect dosa with required size & shape without any human effort and with an advantage of high precision and accuracy. Preparing food with the help of robotics involves a lot of creation and innovation that is why Inkscape open source software, G-code sender and induction heating system are used in implementation of this bot. The working area of this bot is same as the size of the inducting pan.

II. MOTIVATION

Automation is one of the fast developing fields in the world. Almost every industry uses automation for their needs accordingly. Applying this automation technology in food making brings term "Food Automation". This food automation is the one attracting most of the peoples eye these days. Food automation is mostly used for industrial purposes. There comes our idea of bringing food automation for consumers with cost friendly designs. Dosa is one of the most favorite breakfast of India and involves a lot of man work. There are many automated machines to prepare batter but very few to make dosa. The major flaws of those machines is cost efficiency and huge size. In searching the ideas of implementing low cost and consumer friendly sized automatic dosa making machine we came across a very interesting question "If we find difficulties in finding a mechanism for a dosa machine why can't we mimic the same procedure a man uses to make dosa?". From this question we found the solution which resulted as the Handheld Dosa Bot (HD Bot)-An automatic dosa making machine which can make dosa according to the given size and shape.

III. RELATED WORKS

Automation is one of the budding fields in the ocean of robotics. Many attempts are made in the automation of food processing. One such attempt is our bot. There are different methods for making of foods. we found some innovative links between the robotics in food applications. Paper [1] describes about the making of dosa on different kind of metals. Heat transferred between the dosa and the pan are illustrated in this. Paper [3] deals with the manufacturing of low cost CNC machine. It is built by combining arduino ATMEGA 328 controller with features of pc. It uses the gcode for the system operation. There are some methods of dosa making machines available in the market. But they are too expensive and some of them are not consumer friendly. One such machine is called Dosamatic[4]. Compact in size but expensive. The batter falls along one of the sides of the pan. It has a slider/remover which spreads the batter and removes the dosa. Conversion of images into Gcode files and sending gcode files to the CNC machine using arduino for the drawing of image on paper is done in paper [5]. There are different robotic machines in the manufacturing of food products. The paper [6] deals with artistic way of making of food products in mass amounts with accuracy and precision. It describes the 3d printing technologies in food industry. Heating of food products through the mechanism of microwaves can be applied through the paper[7]. Different three dimensional layering techniques are used in many machines in food engineering. Paper [8] mix all the 3d techniques and analyse, differentiate and applies all the variety of methods for customized food processing techniques.3D printing is also employed in different weapon making purposes[11]. The concepts and applications of 3d printing are discussed in this paper[12] and [13]. Various

technologies can be implemented into food making as described in the papers [14] and [15].

IV. System Architecture

Before System architecture describes how dosa is cooked on this bot. To make the dosa on to the pan, first the required shape/image of the dosa is given as input through the Inkscape software. This software converts them into G-code files by creating a platform for the input images. Then the microcontroller board (Arduino) expedite the interfacing of the G-code files with the CNC shield. The motion in the belt is caused by the stepper motor rotation generated by the CNC shield using G-code files. The motion of the belt is synchronized and pours the batter on the hot pan accordingly. Refer to the block diagram in Fig.1.

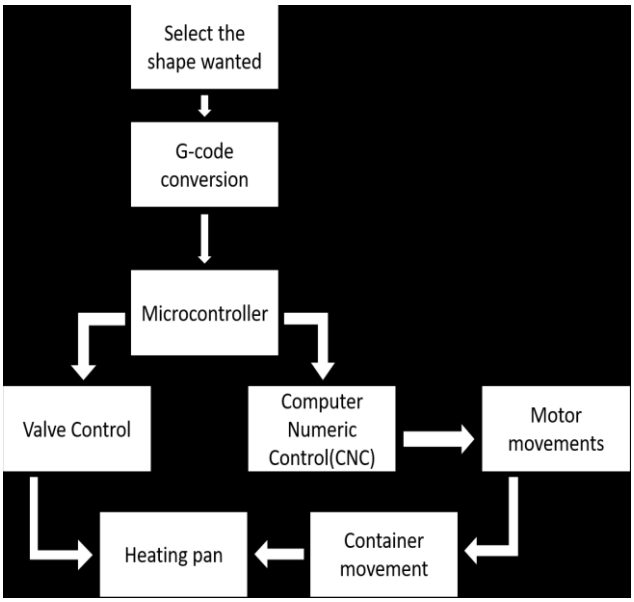

Fig.1 Block diagram of the Dosa Bot

A. Inkscape software-Gcode converter

Inkscape software is a user friendly open source software which converts any kind of image into the vector based platform where user can create and edit the required shape in vector based platform. It specifically denotes each and every position of the required shape in vector system. To interface with CNC we require gcode files. Place the required image (file) in the workspace of inkscape software and follow further steps for converting the files into G-code format.

B. Arduino Uno-Microprocessor

Arduino Uno is a microcontroller board based on ATmega328P with an operating voltage of 5V. It has total of 20 pins with 6 analog input pins and 14 digital pins. All the 14 digital pins can be used as either input or output pins. Among the 14 digital pins 6 are PWM pins. The board consist of a 16MHz quartz crystal, reset button with a flash memory of 32 KB. In addition to this, a USB connection so that it can be connected to a computer or to battery source in order to run the microcontroller with a clock speed of 16MHz. Arduino Uno is the basic and first board for USB type Arduino boards and Uno acts as the reference model for the Arduino platform. The SRAM and EPROM of the board is 2 KB and 1 KB respectively.

The moment of the bot in XY direction is controlled by the Arduino UNO and CNC shield. A GRBL program must be uploaded to the Arduino to establish a communication between the G-code sender and CNC machine. To establish the communication GRBL core-XY servo master is added to arduino.

C. CNC Shield V3

To convert the arduino into a CNC controller, a CNC shield is used, which is compatible with the arduino board. This compact design shield runs on 12-36V DC and converts the G-code files into stepper motor signals. The CNC controller can control up to 4 stepper motors with motor drivers like DRV8825 or A4998 by using an open source firmware.

D. Stepper motor

Two stepper motors are used to move two belts coupled to each of the motor. Stepper motor NEMA 17 is 4 phase motor. This is unipolar stepping motor with 200 steps / revolution with a 1.8° step angle. This 12V motor has a current rating of 400mA. It has holding torque of 2kg/cm and detent torque of 220 g-cm max with an insulation resistance greater than 1000M Ω.

E. Servo motor

Servo motor is used to allow and obstruct the flow of the batter from the batter beaker. A small piece if plate is coupled with the servo motor so that that plate can open and close the nozzle of the beaker. Servo motor offers an output torque of 1.6kg/cm operating at a voltage of 4.8-6V at an operating speed of 0.12sec/60 degree.

F. Air pump

In order to maintain a smooth flow of batter on the pan we need to create some pressure inside the batter beaker. This can be achieved with help of an air pump of with a power rated as 4.2 watts and 2*5.5 l/m pressure. This air pump is the one used in small aquariums/Fish tanks and is the best alternative to produce air pressure as we are aiming for cost efficiency.

G. Induction coil

An induction heating setup is placed under the mild steel pan to heat the pan instantaneously. Two small induction aluminium coils of diameter 6.2 Inch are used to heat the pan uniformly operated by two induction circuits (one induction circuit for one induction coil). AC power supply is directly provided for the circuit to heat up the system. Power rating for each circuit is around 1800 Watt. An extra manual option is

provided to change the temperature of the pan using a remote. Pan temperature is maintained between 180°C to 220°C (ideal temperature of the pan for cooking dosa is between 180°C to 220°C).

V. Design and Implementation

As we know the place (X-Y coordinates) where the dosa batter falls on pan, we use inverse kinematics to find the rotation of the motors so that the nozzle of the batter beaker (End effector) reaches there. This calculation is done is the software and the instructions are given to the microcontroller which in turn transfers data to CNC. Then CNC rotates the motors accordingly. But to move the beaker to the particular location motors are connected with a belt which moves as the motor rotates. Instead of just connecting belt to the motors we use four pulleys around which the belt travels. Through this construction we will be able to achieve two axis movement with just two stepper motors. This arrangement is shown in the Fig.2 and Fig.3 where beige colored parts are pulleys.

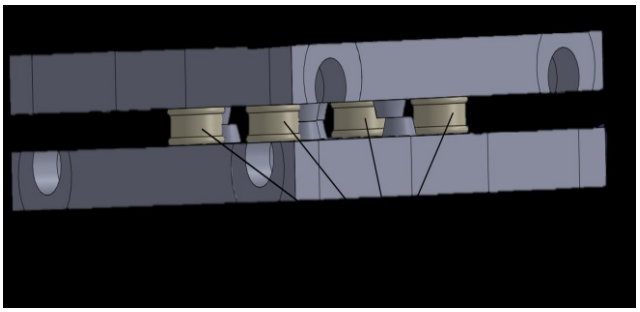

Fig.2 Pulleys around which the belt travels.

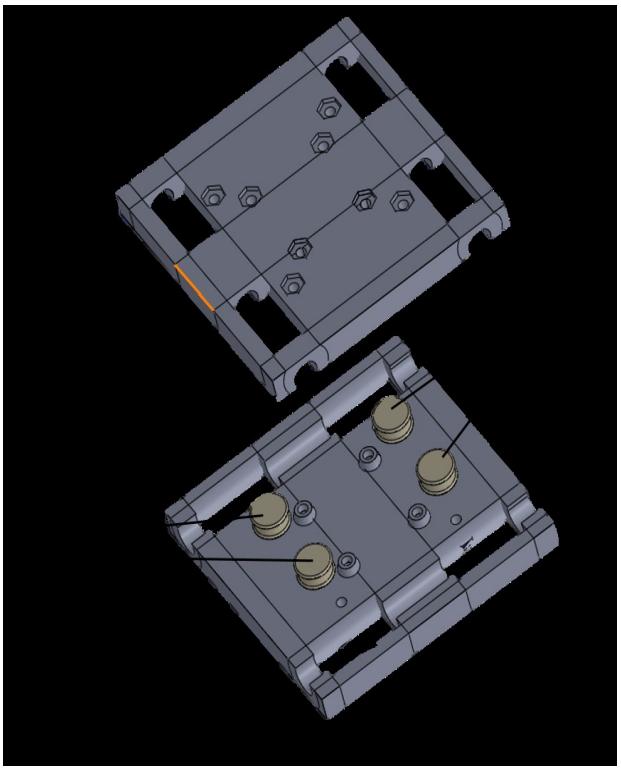

Fig.3 Four pulleys arranged as the corners of a square.

As seen in Fig.3 the pulleys are arranged as four corners of a square. Hence we call it a square arrangement. The belt travels along these four pulleys and follows a pattern of plus (‘+’) like structure. This can be well explained through the following figures. Refer Fig.4 and Fig.5

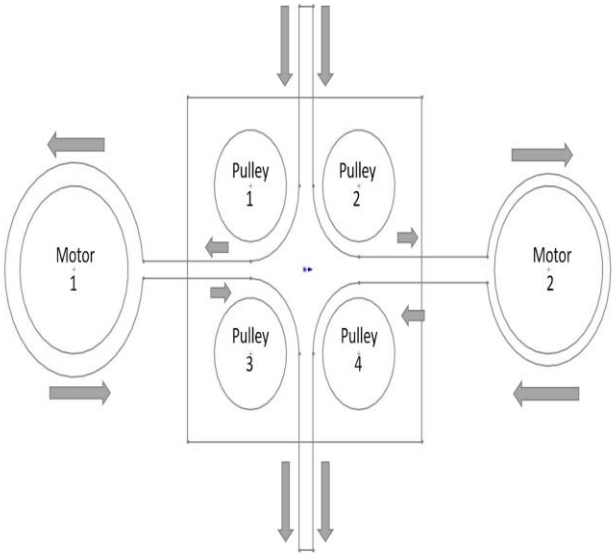

Fig.4 Motors are moving in opposite direction so the beaker will be moving in Y-axis (here downwards)

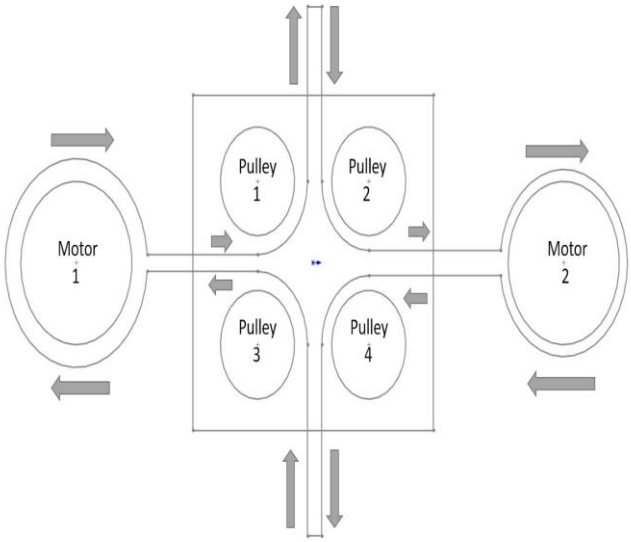

Fig.5 Motors are moving in same direction (clockwise) so the beaker will be moving in X-axis (here towards right)

As the two motors move in clockwise/anti clockwise direction, the beaker moves along X-axis. And when the both motors move in opposite direction the beaker moves along Y-axis (Refer Fig.4 and Fig.5). Combination of these two methods we can achieve the required location where the

beaker has to reach. CNC along with the commands of G-code manages the motion of motors to make the beaker reach its destination. The whole setup is illustrated in Fig.6, Fig.7 and Fig.8.

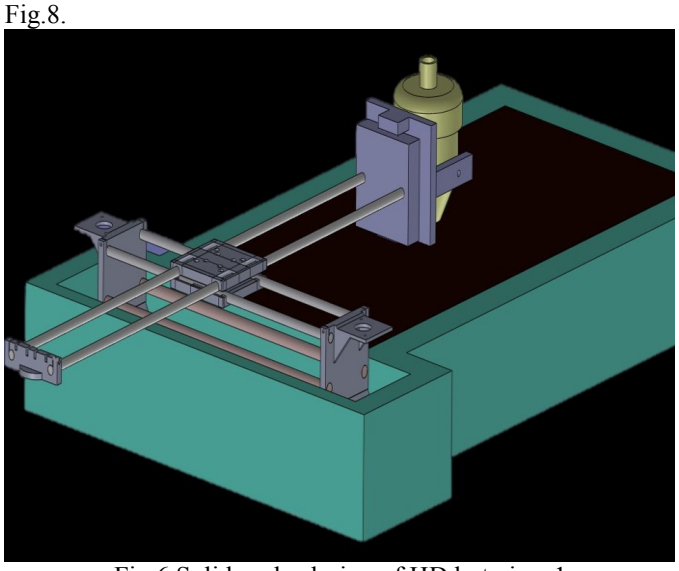

Fig.6 Solidworks design of HD bot view 1

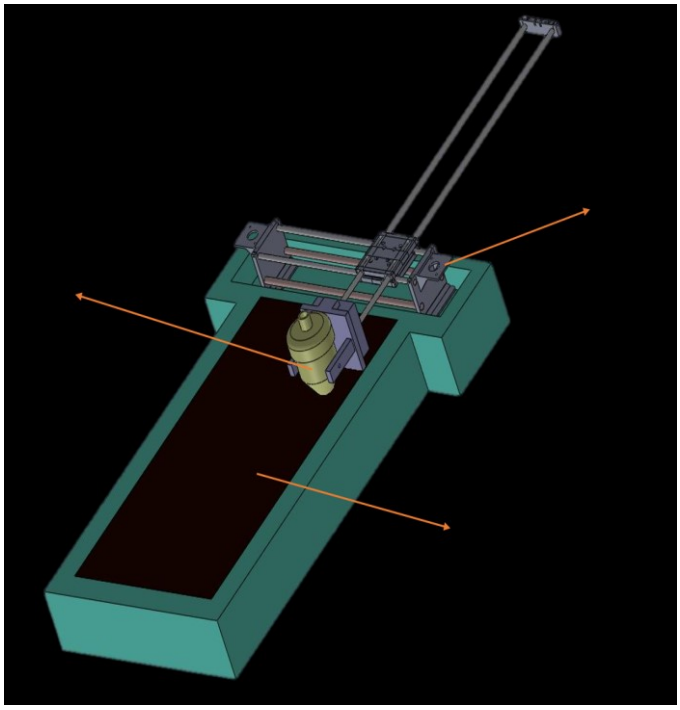

Fig.7 Solidworks design of HD bot view 2

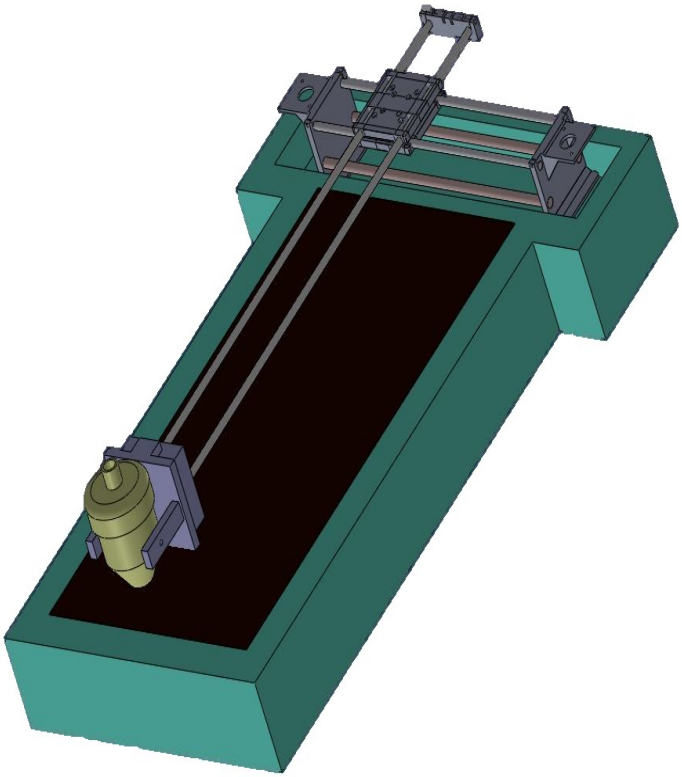

Fig.8 Solidworks design of HD bot view 3

After the entire mechanism is setup, the beaker moves to its destination location and its nozzle gets opened by the servo motor. Batter falls on the hot pan. This servo motor operates according to the instructions given it. There is an air pump which pumps air continuously into the beaker to create pressure in order to push the batter. The heating of pan/thawa is achieved through induction coils placed beneath the pan. The temperature of the pan can be controlled using the control panel. After finishing the dosa the beaker moves to its original position and holds.

VI. Future Plans

Our future goal is to make it work much effectively in the real world. We can try different varieties of dosa of various sizes and shapes. We plan to introduce a slider which can remove dosa from the pan and serve in the plate. We also have a plan to fully automate the bot so that it can spread the oil and remove the traces of dosa from the plan. We aim to make the process simpler for the consumers so that the dosa can be prepared in just some couple of clicks. We have an idea to replace the pan with a vessel and make some Indian snack items (jantikalu/Murukulu/Chakli).

VII. Conclusion

We presented our conceptual prototype of the Dosa making bot in this paper. We did a very detailed research on this project to make this bot set aside from the crowd for its unique features and abilities. We are confident enough that our

interpretation of the bot is very close to the reality and the same would be resulted when comes to the real world implementation. Despite of its unique functionalities we always stick to the low cost implementation and consumer friendly design for the bot.

VIII. ACKNOWLEDGMENT

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