

Design and Development of Solar Powered Autonomous Multi Crop Planting Machine

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ABSTRACT:

Turmeric is one of the most profitable cultivation for farmers.Planting of turmeric using manual methods is one of the tedious method followed by farmers even today. Large number of skilled labors are required for sowing turmeric tuber. One person digs the soil and the other person sows the turmeric tuber in the digged place. Availability of skilled labor is yet another concern for farmers. Due to the low market procurement cost for turmeric, farmers cannot get high profit as they need to invest more money. Hence, an alternate is required to find optimal solution for planting turmeric tuber. The objective of the proposed work is to design and develop an automatic planting machine without human intervention. Solar powered traction system is used for machine mobility which contains spades and storage hopper. The movement of machine can be controlled through wired and unwired techniques which reduces the planting complexity. Only one skilled labor is sufficient to carry out entire planting process. So, the expenses made

towards labor wages will get reduced drastically and thus enhances the profit for farmers. In addition, the effort and time of labor is saved. Compared to conventional techniques, the proposed machine reduces 70% of planting cost.

1 INTRODUCTION:

In India, turmeric is cultivated in an area of 0.18 million hectares with a production of 895.80 tons per year. The major turmeric producing states are Telangana, Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka [1]. Tamil Nadu shares 14.04% of the total production in the country. Turmeric and especially its most active compound curcumin have many scientifically proven health benefits, such as the potential to prevent heart disease, Alzheimer's and cancer [2]. It has a potent anti-inflammatory and antioxidant which helps to overcome symptoms of depression and arthritis. India is the world's largest producer of turmeric and produces 70-75% of world's total turmeric production. India's turmeric exports have touched \$236 million (around Rs 1,632 crore) in 2020. Mostly, the farmers follow traditional method of planting turmeric tuber. Traditional way of planting turmeric requires a large number of skilled labors which incurs high labor wages. One person needs to dig the soil and another person needs to sow the turmeric tuber in the digged area [2] [3]. This type of planting process involves more man power. Now-a-days labor wages are increasing enormously year by year which occupies more than 60% of total expenses and also due to insufficient skilled labors, turmeric planting takes more time and becoming more tedious [4]. Planting one-acre of land involves twenty labors and eight hours of time which costs about Rs.8,500 for sowing turmeric tuber [5]. In some parts of India, farmers are using mechanical setup attached with tractors for turmeric tuber planting [6]. In this method, two persons sit in the top trailer and they sow the turmeric seeds by breaking into several pieces. Then, they put the seeds into a funnel which is attached with a tube by which the seed has been sowed into the soil [7]. The turmeric seeds are sowed, at the same time the tractor also puts the path for sowing. Two processes are carried at the same time. This helps in reducing the time for path making and sowing of tuber. By tractors turmeric tubers cannot sow in the corners of land, and it also consumes more fuel. It is proposed to develop an autonomous turmeric planting machine based on needs of the different farmers' bases and can be used by every farmer. In the proposed method, planting of turmeric is done using a bot operated by both semi-automated and full automated methods. The bot is operated by battery, hence the

farmers need not depend on the fuel and the battery can be self-charged using solar panel [8]. In semi-automated method one person need to drive the bot by using switches. In full automated method, farmer needs to control the bot by using wireless methods and the farmer needs to fill the hopper when it is emptied. When the bot moves forward the spade arrangement provided at the front digs the soil and then the screw conveyor rotates to drop the turmeric seed sequentially in the dug pits and the pits are closed by another spade arrangement provided at the back.

2SYSTEM DESCRIPTION:

The Front Spade is fitted at the front of the bot which is used to dig the soil to create an opening of about 100 mm width and 100 mm depth, where the turmeric tuber will be dropped. The dimension of the front spade is 200 mm length and 100 mm width curved in structure with a support structure of 500 mm height. The spade is fitted to the frame at the front with the detachable bolts and nuts. The hopper is used for storage of the turmeric tubers that is used for the plantation process. The total volume of the hopper is of about to hold six kilo-grams of turmeric tubers. The conical structure provides a sorted seed drops to the conveyor. The Electronics Circuit Unit consists of Power Supply and Management Unit with Battery and Buck Booster Converter for step down and regulates the voltage for the controller. The Arduino Nanomicrocontroller having specifications as given in Table I is used for controlling the whole process in a user defined manner. The proposed machine utilizing AT mega 328P Processor [9] [10]. The controller used to control the speed and direction of the traction motors which is used for the movements of the machine. The PWM Motor Controller – RKI-1311 which operates at the voltage level of 12-18V is used. It consists of three control pins – PWM, BRK, DIR. The input is given by the controller to the control pins of the driver. The Bluetooth module HC-05 is used to receive the input data wirelessly from the user and sends the data to the microcontroller for controlling the machine. The user can control the bot by a mobile application named Arduino RC which consists of buttons for controlling the movement control of the bot. The bot can also be controlled by IoT using Google Assistant Commands interfaced with the cloud servers by MQTT protocol. The user gives the commands by voice to the Google Assistant, it process the voice data to the equivalent text phrases and send to the IFTTT cloud. The user predefines the applets and matches with the data from the Google Assistant. The processed data from the IFTTT is send to the Adafruit IO which consists of command blocks which again process the data and send the

data to the Node MCU module which is connected over the internet using WAP connection. It has been done by the ESP8266 which receives the data from the cloud and sends the trigger pulse to the driver/controller. Since, it is connected to the internet and the range is limitless while using this method. These methods are used for controlling the screw conveyor movements of the bot. The screw conveyor is used to transfer the turmeric seeds from the hopper to the digged area of the soil in a sequential manner. It is powered by 100 RPM, 60 Kg/cm² square gearbox DC motor and an additional gear setup to reduce the speed ratio to 2:1 in which the conveyor rotates at 50 RPM[10]. After dropping the seeds at the required area the back-spade arrangement with two discs of diameter 300 mm which was hammered at the center and the two discs inclined at an angle of 60 degrees which is used to close the soil and make the bed. Thus, the planting process is done in a sequence manner as shown in Figure 1 and the gap between each plant can be modified by controlling either the speed of the wheels of the bot or by controlling the screw conveyor speed.

Table I: Specifications of system components

System Parameters	Specification
Battery	12V,240W
Arduino Nano	7 PWM pins, 13 Digital I/O Pins and 8 Analog I/O Pins
PWM Motor Controller – RKI-1311	Peak current 20A
Bluetooth HC-05	Range – 10m,Frequency band - 2.45 GHz

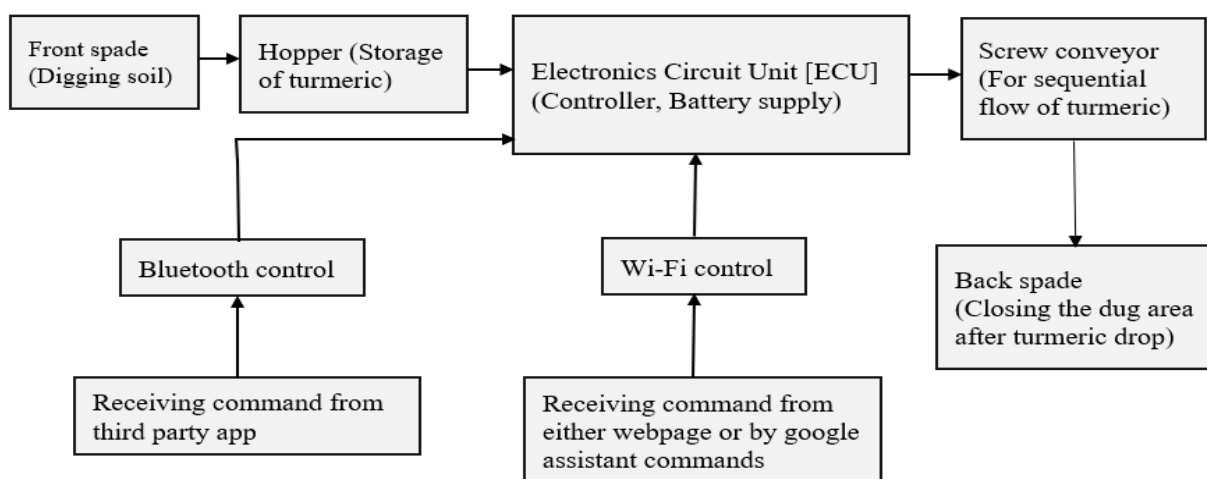


Figure1Block Diagram of the Proposed Machine

3 RESULTS AND DISCUSSION

It is inferred from Table II, that the planting turmeric using proposed machine requires single labor which is very less when compared with existing manual labors where 20 labors are used for planting. Usage of less labors than manual method helps in reduction in labor wage. In manual method of planting turmeric with 20 labors requires labor wage of around Rs.8000 per day. But using proposed machine the labor wage is reduced upto of Rs.400 per day. Planting turmeric with the help of proposed machine will save the expenses of around Rs.7600. The proposed machine can plant an acre of land in eight working hours. In the proposed machine, the distance between turmeric plant to plant is fixed as 0.5 feet for uniform distribution of tuber which intern helps the farmers to enhance the production. With this proposed machine turmeric tuber can sowed at correct depth so that all the seeds will get grow effectively. Hence, with this machineturmeric plantation done effectively and farmers get more profit as the plantation cost get reduced drastically.

Table II: Operational Statistics of Proposed Machine

Type of work	Manual labour's	Hand drive	Wireless
Labours required for one acre	20	1	1
Labour cost	8,000	450	450
Work done in a day	1 acre	1 acre	1 acre
Required turmeric per acre *	720 kg	680 kg	720 kg
Depth of sowing	Varies	0.5 ft	0.5 ft
Plant to plant distance	Varies	0.42 ft	0.42 ft

4 CONCLUSION

In the proposed machine, with the help of the screw conveyer the falling of turmeric tuber is sequenced and the timing for planting of turmeric is reduced. It is easily affordable and portable. With the help of wireless control, the farmers can control the machine operation remotely. The machine can also be driven manually using the switches based on the farmer's interest. This machine is easy to maintain as it runs with the help of the batterycharged through solar panel as shown in Figure 2 and also the machine is eco-friendly to the environment. The machine does not need skilled labor to operatewhere even the illiterate farmers can easily operate

it. Since only one skilled labor is required for planting, the plantation cost is drastically reduced. So, the labor wages are also reduced. With the help of proposed machine the small and medium farmers will get more benefits. Additional features like pesticide sprayer, water sprinkler and stem planter can also be included to enhance the usage of machine. This helps the farmers to use machine for multiple purposes after planting the turmeric. In this machine by adjusting the pitch level of the screw conveyer, the crops like ginger and potato can also be planted.



Figure2 Real Time Prototype Model

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