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Design and Fabrication of a Semi-Automatic Flower Tying Machine

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Abstract

Flowers have been an integral part of India's rich culture and heritage and are used on all occasions for centuries. Whether it is a wedding, worship or medicinal practices; flowers form an important part of living in Indian culture and tradition. This has led to the appreciation of flowers not only for their aesthetic value but also for their economic importance. This paper aims in presenting a semi-automatic flower tying machine using conveyor belt, gripper assembly and the knotting mechanisms. Initially the flowers are placed on the conveyor belt manually by hand. The flowers are passed through the conveyor belt towards the gripper. Gripper assembly is fixed at another end of the conveyor belt which is used to pick the flowers. Then the knot can be made by the knotting mechanisms.

I. INTRODUCTION

Traditional process of tying flowers is a day to day affair in many parts of India. There are several types of flowers that are manually tied by hand using different procedures. Some type of flower garlands are used by women to be adorned on their hair, and some are used for decorative purposes for deities, festivities, celebrations etc. For some, it is a source of livelihood and also one of the honest sources of income especially in some regions of South India. With respect to flowers such as Jasmine, Marigold, Lily and other flowers that are used to make garlands, flowers are gathered together and knotted in a specific way to make a garland. When done manually, it is a time-consuming affair and a person ties each and every flower to produce a long garland. In the Udupi district of coastal region of Karnataka in India, jasmine flowers are primarily grown which are also named as Shankerpura Mallige [1].

The conventional flower tying process is a time-consuming affair and a person ties each and every flower to produce a long garland. This process is repetitive and the person may undergo fatigue after repetitive work. There is no known mechanism where the flower tying can be automated. There are several automated mechanisms for tying a bunch of flowers for easier transportation or storage, whereas an automated mechanism for tying the flowers to produce a garland is not known. Hence there is a need to automate the conventional flower tying process.

Anandhi et al. proposed concept for flower tying called "Flower Knitting Machine" in which a conveyor belt was used to carry the flower from one place to another. The belt was made up of fiber material so vibration would be less and the flower would not lose its freshness. Two DC motor were used to rotate the belt. A microcontroller-based pick and place robot was used that would transport the flowers from the conveyor to the sewing machine. Infrared sensors were used to sense the presence of flower as the transmitter to receiver path for infrared sensor was intermittent by placed object. Hence it picked the flower in the conveyor belt and placed it

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in the sewing machine. The needle descends to the bottom of its stroke, and simultaneously the shuttle slides, vibrates, or oscillates as far as the end of its backward movement. Then needle begins to rise, and the shuttle immediately after begins to move forward. It is long enough to cause it to loop while loop is formed then the robotic arm will place the flower in the loop and it is tied the speed of the sewing machine is also varied by using stepper motor control the diameter of the knot can also varied based on the thickness of the flower [2].

From the literature review and various studies carried out, it was found that there was no commercially available mechanism for tying flowers. Hence an attempt has been made to develop a mechanism to automate the conventional flower tying process.

II. PRODUCT DESCRIPTION

The design and the various parts involved in Semi-Automatic Flower Tying Machine are shown in Fig 1. The design consists of various sub-systems which are explained as follows with reference to fig. 1.

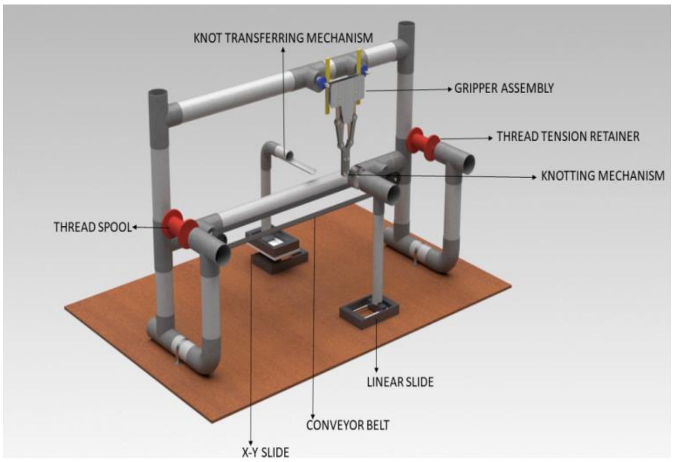

Fig. 1 Design of the Semi-Automatic Flower Tying Machine

2.1 Base

Base is the foundation for the model and supports other components. The material used is plywood as it is rigid, light, economical and easily available.

2.2 Frame

The frame holds the conveyor system and the gripper assembly. For the development of the prototype of the semi-automatic flower tying machine, PVC pipes were used as the material is light, rigid, economical and easily available.

2.3 The Conveyor System

The conveyor system is used to carry the flowers towards the gripper end. The conveyor system consists of a conveyor, a pulley and a DC motor that are used to form a simple belt drive system.

2.3.1 Conveyor belt

A belt is a looped strip of flexible material used to mechanically link two or more rotating shafts. The belt is looped over the pulleys. It contains projections which enable the belt to be properly positioned in the pulley to avoid the possibilities of slippage. The belt used is made of rubber having a length of 122 cm and width 2.5 cm.

2.3.2 Pulley

A pulley is a wheel spinning about its axis to aid the motion of a belt. Here two pulleys are used to create a simple belt drive system. One is a driver pulley which is driven by a DC motor. This transmits the power from the motor to another driven pulley to obtain the rotation of the belt. The pulley used for the model is made of plastic with a groove running all through so that the belts fits perfectly inside. The diameter of the pulley is 7cm and width is 2cm. Fig 3 shows the pulley used.

2.3.3 DC Motor

DC motor is used to convert the electrical energy into mechanical energy i.e. rotation of the shaft. The DC motor used for the carriage assembly is mounted on the frame and its shaft is connected to the pulley that drives the belt. The motor specifications are: 10 R.P.M., 5 kg-cm torque, 12 V supply voltage.

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2.4 The Gripper Assembly

The gripper assembly is used to pick up the flowers from the conveyor belt so that they can be knotted as per the requirement. The gripper assembly consists of a motor actuated gripper and rack and pinion arrangement. Fig 2 shows the gripper assembly implemented.

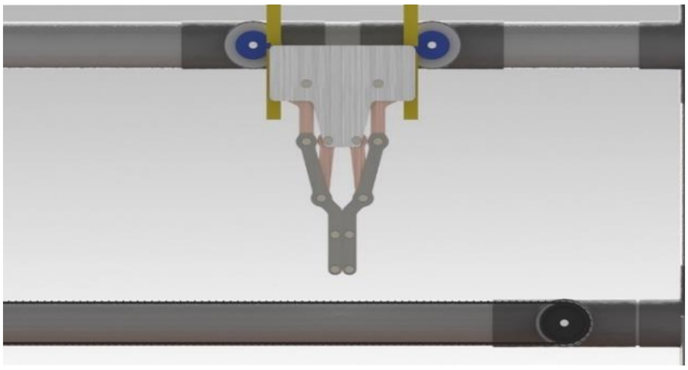

Fig. 2 Gripper Assembly

2.4.1 Gripper

The gripper used is an acrylic mechanical gripper that is actuated by using a DC motor. Change in rotation direction of the DC Motor, generates Jaw Open & Close Action. The motor used is a 5V DC motor. The DC motor can be easily being controlled with the help of DPDT Switch (manual mode) or with the help of any microcontroller along with L293D Motor Driver module.

2.4.2 Rack and pinion arrangement

The rack and pinion arrangement have been designed such that the gripper can move up or down as per the requirement. The racks are attached on either side of the gripper and are driven by pinion gears that are in mesh with the racks. The pinion gears are driven by 10 R.P.M. DC motors. The speed and direction of the motors can be controlled by L293D Motor Driver Module.

2.5 The Cam Assembly

The cam assembly is used to make a primary loop on the stalk of the flowers. The assembly consists of a motor driven circular pulley and a motor driven linear slide. Fig 3 shows the cam assembly implemented for the project.

Fig. 3 The Cam Assembly

2.5.1 Circular Disc

The circular disc is driven by a 10 R.P.M. DC motor that provides rotational motion to it. The disc consists of a needle that carries the thread through it. The needle is mounted eccentrically to the center of the disc. This arrangement therefore helps in forming loops around the stalk of the flowers which forms the primary loop and also the secondary loop.

2.5.2 The linear slide

The linear slide is used to transport the circular disc to the specified positions for the knotting operation to take place. In order to achieve this a DVD drive stock is used. The drive stock has highly finished guideways on which a laser head is made to slide. The sliding action is controlled by means of 3.5 V DC motor. The circular disc is mounted on the laser head in such a way that the movement of the laser head will move the circular disc linearly. Fig 4 shows the DVD drive stock used.

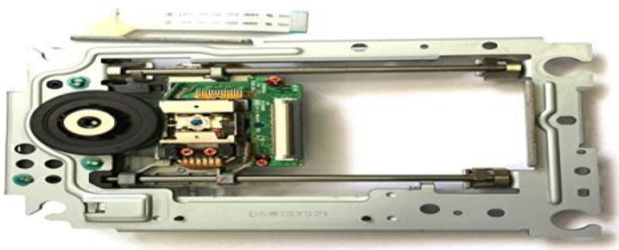

Fig. 4 DVD Stock Drive

2.6 The Loop Transferring System

The loop transferring system is used to transfer the secondary loop formed by the circular disc onto the stalk of the flower on the other side to complete the knotting procedure. The transferring system consists of a X-Y slide on which a pipe is mounted as shown in the Fig 5. The pipe is made of L shape and half sectioned at the end near the elbow. The pipe is designed in such a manner so as to carry the secondary loop produced by the circular disc to the stalk of the flowers. The half section helps in placing the loop on the stalk.

Fig. 5 The loop transferring system

2.6.1 XY Slide

The X-Y slide helps in the movement of the pipe both in X direction and Y direction to the specified positions so as to complete the knotting procedure. As the commercially available X-Y slide is costly, a customized X-Y slide is developed by using two linear slides of DVD drive stock which are mounted at right angles to each other. This helps in producing the desired motion. The details of the linear slide are discussed in the previous section. Fig 6 shows the customized X-Y slide implemented in this study.

Fig. 6 Customized XY Slide

2.7 Spools

The spools are provided on both the sides near the pulleys of the conveyor belt. Fig 1 shows the position of the spools. The spools are driven by 10 R.P.M DC motors. Spool 1 is positioned to the left of the conveyor belt. It supplies the sufficient quantity of thread or fiber for tying the flowers. It is also used to tighten the knot upon reversal of motor direction. The spool 2 is positioned to the right of the conveyor belt. It is used to carry the knotted flowers away from the gripper.

2.8 The Control Unit

The control unit is used to synchronize all the activities of the machine. It is used to independently control the individual motor movements. The control unit consists of Arduino Mega 2560 Rev3 microcontroller board and a L293D Motor driver board [3]. The Arduino Mega acts as the brain of the machine and the L293D module is used to control the motors in either direction.

2.9 Power Supply

The power supply is through a 12V DC adapter and 5V DC adapter. It can take any input from 100V to 220V AC and provide and output voltage of 12V DC or 5V based on the adapter. This is a replacement for a DC battery since it requires constant recharging.

III. CIRCUIT CONNECTIONS

Fig 7 shows the connections of the motors to the Arduino through the L293D motor driver. Seven of the ten motors are powers by a 12V DC adapter and three motors are powered by 5V DC adapter. Each L293D Motor driver can be connected to two motors and hence 5 driver circuits are used. Table 1 gives the details of the numbering of motors in the circuit.

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Table 1 Numbering of motors for circuit

Motor No.	Function
1.	Pinion Gear Motor
2.	Pinion Gear Motor
3.	Gripper Motor
4.	Conveyor Belt Motor
5.	Thread Spool 1 Motor
6.	Knotting Cam Motor
7.	Thread Spool 2 Motor
8.	Y Slide Motor
9.	X Slide Motor
10.	Linear Slide Motor

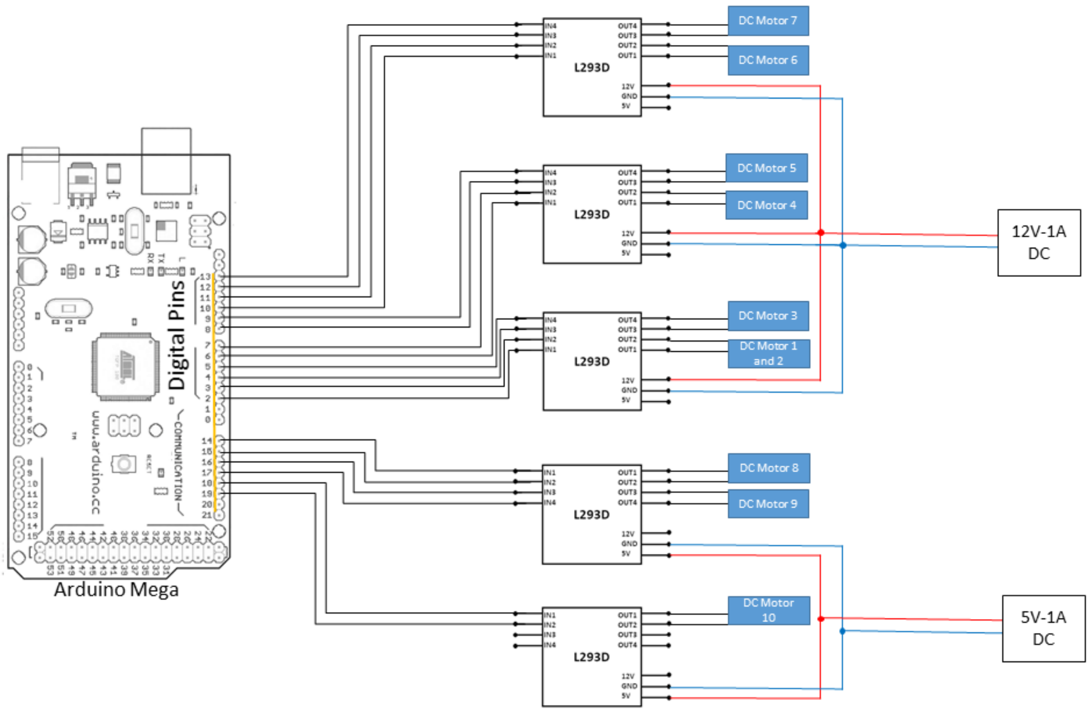

Fig. 7 Circuit Connections

IV. 4. WORKING

Fig. 8 shows the fabricated prototype of Semi-Automotic Flower Tying Machine. The design basically consists of a customized conveyor belt with driven by DC motors. Initially the flowers are manually arranged in alternate fashion two at a time on the groove of the conveyor. The conveyor transports the flowers on it exactly below the gripper. The gripper mechanism grips the flowers and lifts them up to a specific height. The cam mechanism is actuated to form a primary loop, the gripper still holding the flowers. After forming the loop, the cam mechanism retracts back by means of a DVD stock drive to form a secondary loop on to a semi- circular hollow pipe. The loop on the semi-circular hollow pipe is transferred onto the flowers by means of a customized X-Y slide made by two DVD stock drives. After transferring the loop, the mechanism retracts back to its position. The roller with the spool of the thread rolls back slightly to tighten the knot. The tension is retained through a tension retainer spool on the other end of the setup. Thus, the looping operation is performed on pair of flowers. All the motors required for the drives are controlled by Arduino.

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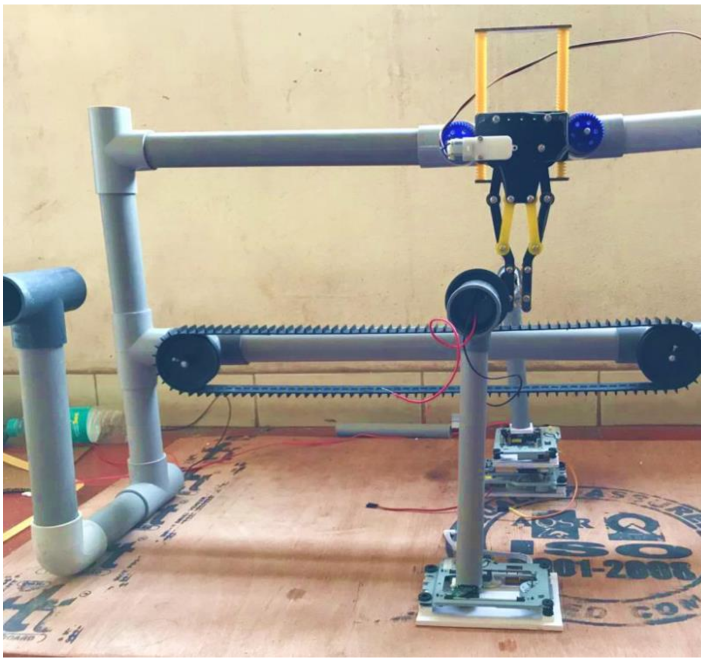

Fig. 8 Prototype of a Semi-Automatic Flower Tying Machine

V. RESULTS AND DISCUSSIONS

5.1 Diameter of Strings Used for Tying Flowers

The commonly used strings for tying flowers are either banana fiber or cotton threads. The diameter of the banana fiber used varies along the length since the fibers are extracted by hand. This test was carried out to find out the average diameter of the banana fiber that is used for tying flowers. Five samples of hand extracted banana fibers were chosen and the diameters were measured using a Tool Makers Microscope. Fig 9 shows the samples measured and the Table 2 shows the variation in diameter of the fibers.

Table 2 Variation in diameter of the banana fibers

Sample No.	Diameter in micro meters (µm)
1.	676.0972
2.	690.3640
3.	520.9061
4.	501.1170
5.	709.9373

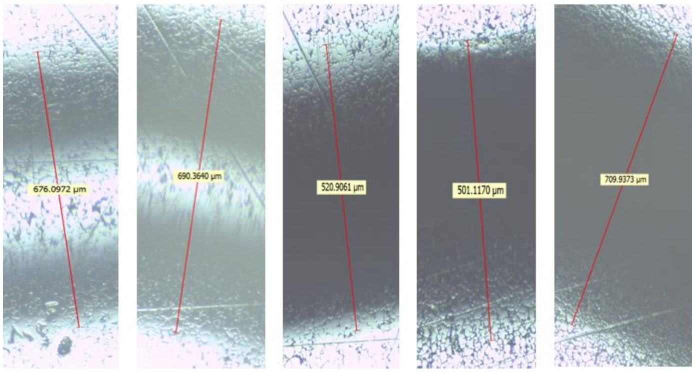

Fig. 9 Tested Fiber Samples

In order to approximate the diameter of the fiber the average of the five samples was taken which was 619.6843µm. In case of the cotton threads there was no much variation in the diameter since the threads are manufactured in the industries. The average diameter was found to be around 500µm.

5.2 Motor Torque Calculations

Motor torque calculations are done to justify the selection of the motors used for the various components.

5.2.1 Torque calculation for the circular disc

The motor has to carry the weight of the circular disc and the needle mounted on it which is approximately 200g. The coefficient of friction between the motor shaft and the disc is assumed to be 0.1 and the frictional force is calculated as per eqs. (1) and (2).

$$F = \mu * N \qquad \text{i)}$$

$$F = \mu * m * g \qquad \text{ii)}$$

Where F= Frictional force in N

µ= Coefficient of friction

m= mass of the disc =200g

$$F=0.1*\frac{200}{1000}*9.81=0.1962N \qquad \text{iii)}$$

$$T = F * R \qquad \text{iv)}$$

Where T= Torque in N-m

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F= Frictional force in N

R= Radius of the disc in m

$T=0.1962*\frac{35}{1000}=0.00687N\text{-}m$ v)

The torque provided by the motor=5kg-cm 0.4905N-m

Since 0.4905>0.00687, The motor overcomes the friction force of the disc.

5.2.2 Calculation for the rack and pinion

Number of teeth on pinion gear, Z= 36

Pitch circle diameter of pinion, d = 40mm

Therefore, module, m $=\frac{d}{Z}=\frac{40}{36}=0.9$

Total length of the rack = 145mm

Number of teeth on the rack = 46

Distance between 10 pitches = 30mm

Therefore, module, m $=\frac{(Distance\ between\ 10\ pitches\ /10)}{\pi}=\frac{(30/10)}{\pi}=0.95$

C factor: The c-factor is linear rack travel per one full revolution of the pinion.

In one full revolution of the pinion (360 degree), the rack travels a distance of 120mm.

Therefore, C factor $=\frac{120}{360}$ = 0.33mm/degree.

VI. CONCLUSIONS

As flower tying plays a major role in the current scenario, there is a need for automation and the authors have made an attempt to bridge this gap by developing a semi-automatic flower tying machine. The following conclusions can been drawn from this study.

- A “Semi-Automatic Flower Tying Machine” has been designed and fabricated successfully which is the first of its kind.
- A practical understanding of the challenges faced in developing the mechanisms and manufacturing the same as accurately as possible.
- By the implementation of this machine, it is possible to reduce the manual work and the time consumed in the flower tying process.
- This innovative idea may help people to lift their lifestyle who are involved in this field.
- In the long run, this machine can be proved to be efficient and economical.

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