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THE VINE ROBOT

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Abstract: Nowadays robots are at a very perk and can be seen in every field, But the robots which are majorly used in Industries are of heavy body and large in size. As we know, when it comes to archaeological sites and rescuing people, we use heavy machinery to dig up holes and take off debris and skilled people who can effectively make the operation possible. So we have innovated a soft robot name "VINE ROBOT", which is based on pressure and eversion process. Our soft robot is divided into three parts 1). Robot base, 2). Growing part, 3). Output device.
ROBOT BASE is made up of a rigid body, which is the stable part of the robot and contains all the circuitry of the robot. GROWING PART(tail) is also the part of robot base, Hence the tail's one side is connected to the robot base from where the pressure is provided to the robot by the air pressure pumps, and on the other side of the growing part is called the tip where the camera and mic are mounted. And the third part is OUTPUT DEVICES where we will get the output response of the mic and camera.
Our project "VINE ROBOT " is a pressure based device for exploring the site to remove such heavy machinery to dig up the holes and use less manpower. The main aim of the proposed project is to develop a light weighted, flexible robot with a compact working body which will operate at very low electrical power. Another aim is to design a robot irrespective of the surface, which can travel over fields, under water, over sticky and sharp terrain. Here in this model the pressure will be provided from the Air pumps which are available in the circuitry of Vine robot, using this pressure the growing part (which is of non-stretchable fabric) evert and the movement occurs in the robot

Keywords: Vine, Robot, Rescue, Archaeological Sites, Air Pressure pump, Eversion process.

I. INTRODUCTION

This robot is a continuum robot which has recently been explored and characterized by tip extension having quality of significant length changing, and directional control. These types of robots are called "Vine Robots' ' due to their similar behavior to plants with a growth habit of trailing. Vine robots move via tip extension, which is similar to some forms of biological growth and distinct from locomotion or other animal-like whole body movements. Whereas movement strategies like locomotion are defined by translation of the body from one location to another (Alexander, 2003), movement by tip extension functions by lengthening the body (Goriely, 2017), reducing or completely eliminating the need to translate relative to the environment.
Our system must be usable in the field which means that it must be portable mechanically, and electrically robust enough to last through the lifetime of use and able to move fast enough to be practically useful. Tip growth has recently been replicated in a variety of robotic systems, referred to as "growing robots" or "vine robots," using a range of techniques. In addition to tip extension, vine robots are characterized by length change of many thousands of percent and control of their growth direction. We are going to work with one method for creating tip extension: pressure-driven "eversion" (i.e., turning inside out) of flexible, thin-walled material.

II. METHODOLOGY

As with many robots, vine robots present specific challenges for modelling, and even more so because growth is such a unique form of movement. As a result, models for growth and steering of vine robots draw inspiration from a variety of sources including models of naturally occurring growth and steering. Methodology of vine robot includes following point:

- Growth & Eversion
- Designing
- Modelling
- Control & Planning

Growth in Robots: Replicating elements of biological tip growth, i.e., vine robots, has two main benefits: First, because only the tip moves, there is no relative movement of the body with respect to the environment. This means growth allows for easy movement through constrained environments. Second, as the tip moves, the body forms into a structure in the shape of the tip's path, which can be used for payload delivery, force transfer or self-support, and physical construction.
Eversion Growth: Eversion, the opposite of inversion, is the process by which the material internal to a structure turns

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inside out and becomes part of the outside of the structure. Vine robots achieve growth through pressure-driven eversion of flexible, thin- walled material.

Designing: While the underlying principle of growth through pressure-driven eversion is shared by all everting vine robot designs, the implementation varies. These differences in design, produced by the choice of materials, growth and steering actuation methods, and payload deployment systems, result in different behaviours that must be carefully considered given a desired application. Mounting Sensors and Tools At the Tip: Because the tip of an everting vine robot is often the first point to enter a new space, this is an important area to mount sensors and tools that interact with the environment, can be used to sense properties of the environment and to provide feedback of the robot state during navigation and exploration. Meanwhile, tip-mounted tools, such as a gripper, enable environment interactions, such as picking up objects and pulling on the environment.

Modeling of Growth: An important portion of everting vine robot modelling has focused on understanding vine robot growth and retraction, including the forces at play due to interaction with the environment.

Control and planning: The unique properties and mechanisms of everting vine robot movement provide new opportunities and challenges for robot control and planning and autonomous. Considerations include what behaviours can be planned and how to bring a human operator into the control loop. The main everting vine robot control and planning topics studied thus far have been robot-level control of growth and retraction, interface design to allow human operators to autonomous everting vine robots, and planning methods that consider obstacle interaction models of everting vine robots.

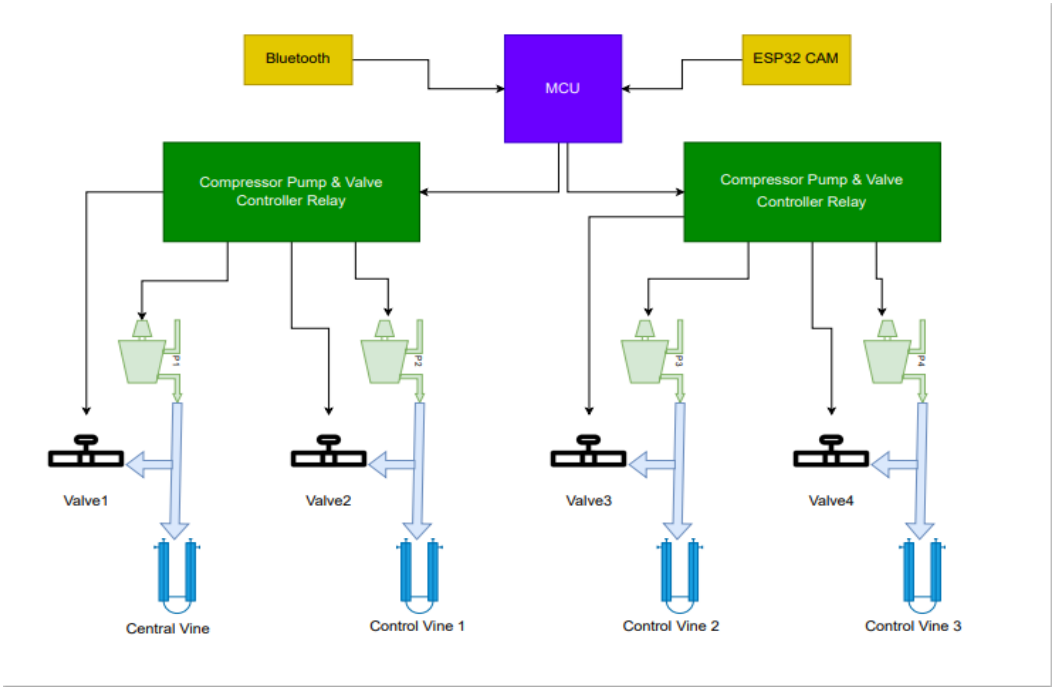

Fig. 1 Block Diagram

Following are the main components of the project.

1. **15 V AC-DC ADAPTER:** AC-DC adapter is a type of external power supply, often enclosed in a case. It is used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power supply.
2. **RESISTORS**: Resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.
3. **CAPACITORS**: These ceramic capacitors have a high dielectric constant, what makes possible a high capacitance values in reduced dimensions, however temperature coefficient and loss factor are greater than Class I.
4. **RELAY-SPDT**: A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. An SPDT Relay or Single Pole Double Throw Relay is a type of relay that has one input and two outputs. Including the coil terminals, it has a total of five terminals. It not only provides the switching function even it can also route the signal. An SPDT relay can control two electrical or electronic circuits.
5. **LCD** (LIQUID CRYSTAL DISPLAY)**:** it is a type of flat panel display which uses liquid crystals in its primary form of operation. LCD has liquid crystal material sandwiched between two sheets of glass. Without any voltage applied

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between transparent electrodes, liquid crystal molecules are aligned in parallel with the glass surface. For instance: preset words, digits, and seven-segment displays, as in a digital clock, are all good examples of devices with these displays. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 means it display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7-pixel matrix.

6. PUMP/VALVE CONNECTORS: A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. We have used 6 valve for vaine robot. We have used 4 air pressure pumps in our vine robot from which 1 is 150psi and 3 are 200-300psi.

Fig.2 Solenoid Valve 24V & Air Pump (150psi/200-300psi)

7. ATMEGA 328: The ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core. The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and 5 software-selectable power-saving modes. The device operates between 1.8 and 5.5 volts. The device achieves throughput approaching 1 MIPS/MHz.

8. ESP 32 CAM MODULE: ESP32-CAM is a low-cost ESP32-based development board with on-board camera, small in size. It is an ideal solution for IoT application, prototypes constructions and DIY projects. The board integrates WiFi, traditional Bluetooth and low power BLE, with 2 high performance 32-bit LX6 CPU.

9. **HC05 MODULE**: HC05 is a Bluetooth module designed for transparent wireless serial connection setup. Its communication is via serial communication which makes an easy way to interface with controllers or pc.

10. **L298N:** The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A. This is used as an interface between the motors and the control circuits. Motor require high amount of current whereas the controller circuit works on low current signals. So the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

11. **LM7805**: The LM7805 is a voltage regulator that outputs +5 volts. Like most other regulators in the market, it is a three-pin IC; input pin for accepting incoming DC voltage, ground pin for establishing ground for the regulator, and output pin that supplies the positive 5 volts. It's a linear regulator IC its input voltage can range from 7-35V DC and its output is fixed 5 V at over 1A of current and upto 2.2A of surge current.

12. **ULN 2003A**: It is used in driver circuits for relays, lamp and LED displays, stepper motors, logic buffers and line drivers.

13. **CH340G**: CH340is a USB bus conversion chip, it can realize USB to UART interface or USB to printer interface

III. RESULTS AND DISCUSSION

The objective taken is fulfilled at the most extent and we have designed a prototype which successfully moves toward and backward through air pressure by using an eversion process. It is also able to change direction but sometimes lacks, we can say that sometimes it lacks while changing direction. The movement of the Vine is also shown in the LCD as it shows the commands given through the program for different movements.

The camera provides a clear picture which is stocked at the tip of the main Vine and the live video can be seen at the fixed end of the robot by using Laptop/Mobile.

Firstly, we provide the power supply through the 24v battery and 15v adapter. in this project we use HC-05 Bluetooth module which will help in controlling the robot and transferring data and commands for operating the pressure pumps. For this 1stly we connect our device Bluetooth to the HC05 Bluetooth. By using the Bluetooth Tethering application, we can give command to our robot to move in different direction.

There are different commands for movement of vine in different direction which are given below:

- 0 for stop

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- 1 for forward movement
- 2 for backward movement
- 3 for Left side movement
- 4 for Right side
- 8 for the upward direction.

by using the ESP32 cam we are able to watch Live video in different direction and at different places, places like to which a person is unable to see.

Fig.3 (A) Vine Robot (B) Laptop screen showing Live Video

Fig.4 Different commands for Vine Movements

IV. CONCLUSION

Vine Robot is designed by using different technologies like pressure eversion process for giving growth to the Vine and wireless technology for viewing video or movement of other end. It is designed to work under negative conditions like non- destructive exploration, small spaces or archaeological sites which become easy for our robots with their soft body (vine). The Future scope of this robot is very bright as by using latest technologies or silent machinery, it can be used for spy work also and the scope in the medical field is also vey vast. By using the best Vine material for different pressure conditions it can be used for different work and situations, for weight lifting also. There isn't any field in which it cannot be used for completing tasks, it just needs the mix-up of different technologies and little hard work.

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