

Inchworm Climbing Tree Robot with Plant Health Indication

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Abstract—this paper proposes a global path and motion planning algorithm that enables inchworm like robots to navigate their way up tree branches. The intuitive climbing space representation method proposed here greatly simplifies the path-planning problem. We wish for robots to manipulate objects and move flexibly in three-dimensional spaces. We describe a robot that can move on a web of surfaces oriented around arbitrary directions in three-space and a set of control algorithms that implements motion in three-dimensions. This robot is an inchworm-like robot with a simple, modular, and flexible design. And autonomous intelligent farming robot which indicates the plant health by observing the colour of their leaves and based on the height of the plant. The robot also notes the surrounding environmental conditions of the plant like temperature, moisture and humidity so that the robot will decide about health of plant and will display on the LCD. The robot has also watering mechanism it will water the plants according to their needs by observing soil moisture and humidity.

I. INTRODUCTION

This document is a template. An electronic copy can be downloaded from the Journal website. For questions on paper guidelines, please contact the journal publications committee as indicated on the journal website. Information about final paper submission is available from the conference website. Climbing robots have many applications and their capabilities of the robot differ according to the mechanical design. Climbing robots should be capable of dealing with different surfaces and adapt with a variety of cross-sections. The most critical challenge here is to move one part of the structure with respect to the other part against gravitational Force. The climbing mechanism used in this paper is inspired from the technique used by inchworm. Inchworm design is one system of legs that all move relative to each other in a gait. The simplest form of this includes two gripping points at each end of the robot along the climbing axis with an actuated, bendable set of connections between the grip points that allow the grippers to move relative to each other. With this designs gait, one gripper releases to move to a new position and re-grip while the other gripper remains attached to the climbing surface to support the robot. The simplest form of this includes two gripping points at each end of the robot along the climbing axis with an actuated, bendable set of connection between grip points.

The goal of this project was to build a tree-climbing robot to satisfy the various requirements. The robot works on two sub-mechanisms: (a) Gripping (b) Climbing. The movement of the machine is like an ape climbing the tree. First, the upper pair of arms grip the tree then the body moves up then the lower pair of arms grip the tree then the upper pair leaves the contact and the body moves up Tree robot is a tree-climbing robot composed of two grippers and a continuum body. Each of the grippers is attached to one end of the continuum body. The grippers are used to hold the robot on the surface of the tree, with the continuum body being used for manoeuvring. The continuum body has three degrees of freedom (DOFs) capable of bending and extending. The locomotion of Tree robot is similar to that of an inchworm that moves forward by extending and contracting its body. Leaf diseases on plant are the main element and having superior strength which appear as spots on the leaves. In case of severe infection, the leaf becomes completely covered by disease in terms of spots. Different type of leaf diseases on plant determines the quality, quantity, and stability of yield. Leaf miners are the larval stage of an insect family that feeds between the upper as well as lower part of leaves. Heavily diseased and damaged due to insect on large amount in plants.

Pesticide use in plant diseases treatment increases the proportion of toxic level on agricultural products leads to a major contribution to ground water pollution or making water much more hazardous, also large amount of pesticide use leads to increase in production cost. This can be done by identifying the severity of disease and target the diseases places, with the diseases in plant not only reduce the yield but also making progressively worse condition of plant. Increase in appropriate quantity and concentration of pesticide. The normal observation is generally used to decide diseases severity in the production practice but results are subjective and it's impossible to measure the disease severity. As one of the trends of development on automation in coming days is that all kinds of agricultural robots have been researched and developed to perform number of task like harvesting, weeding, pruning, planting, grafting, agricultural classification, etc.

II. STRUCTURE OF TREE ROBOT

A linear motor is an electric motor that has had its stator and rotor "unrolled" so that instead of producing a torque (rotation) it produces a linear force along its length. Characteristically, a linear motor's active section has ends, whereas more conventional motors are arranged as a continuous loop. The most common mode of operation is as a Lorentz-type actuator, in which the applied force is linearly proportional to the current and the magnetic field. Tendon-driven robots (TDR) are robots whose limbs mimic biological musculoskeletal systems. They use plastic straps to mimic muscles and tendons. Such robots are claimed to move in a "more natural" way than traditional robots that use rigid metal or plastic limbs controlled by geared actuators.

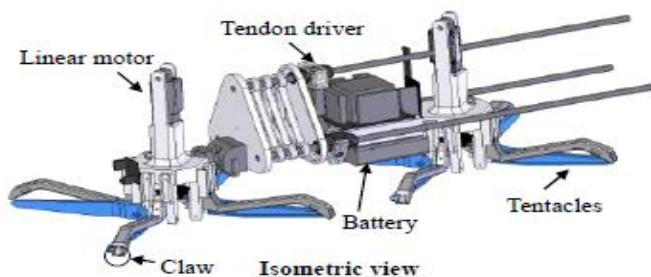


Figure 1: Tree Robot

TDRscanal so help understand how biomechanics relates to embodied intelligence and cognition. Challenges include effectively modelling the human body's complex motions and ensuring accurate positioning, given that the tendons are prone to stretch, which costs them strength and smooth operation.

III. CLIMBING SPACE FORMULATION

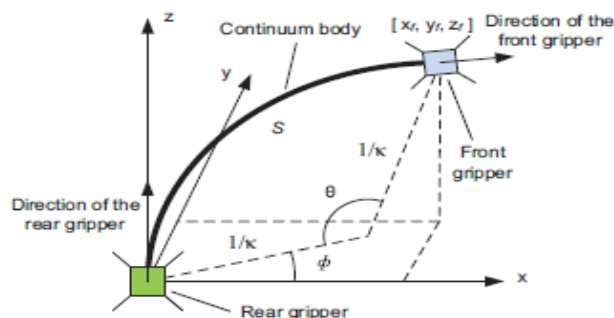


Figure 2: Notation and configuration of tree robot

Figure 2 presents a simplified model of Tree robot, showing that its continuum body is in the shape of an arc. According to Jones and Walker (2006), the shape of the Continuum body can be represented by three parameters, S , κ , and ϕ , as shown in Figure 2. S , κ , and ϕ denote the length, curvature, and bending direction of the continuum body, respectively. Assuming the rear gripper is located at the origin, putting the front gripper in the target position.

IV. PATH PLANNING

The basic requirements of path planning are to devise a path enabling the robot to reach the target position and avoid obstacles en route. To enable a continuum inchworm like robot to follow the planned path easily, the path should also fulfil certain additional requirements. To eliminate the pull-out force generated by gravity, the robot should climb on an upper apex of the climbing surface, as illustrated in Figure 3. Furthermore, a shorter path will reduce the robot's energy consumption, and a smoother Path will be easier for it to follow. As a result, the path should be optimized to minimize the pull-out force, climbing distance, and the angle of change.

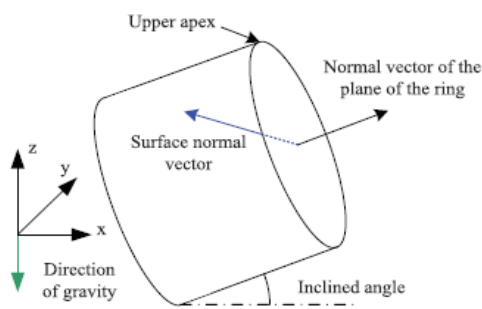


Figure 3: coordinates and notations of the shape of the tree robot

IV. PLANT HEALTH INDICATION STSTEM

Present system Automated plant health indication system required all system on robot, for that raspberry pi and PIC controller are used to perform robotic operation.

Block Diagram Description

a. Camera

It is used to take an image of crops it is directly connected to the raspberry Pi. There are two ways to connect camera to raspberry Pi first one is USB camera and second is camera module of raspberry Pi.

b. Temperature Sensor

Temperature sensor is used to detect the temperature of environment. Temperature sensor named as LM35 is used. This temperature sensor can sense and measure atmosphere temperature. The LM35 series square measure exactitude integrated-circuit temperature sensors, whose output in terms of voltage and linearly proportional to the Celsius (Centigrade) temperature. LM35 is associate degree analog detector and provides the output in terms of analog signal. This signal is feed to ADC leads the conversion into digital signal. Finally changing into digital signal, the microcontroller will method the digital temperature signal as per the appliance.

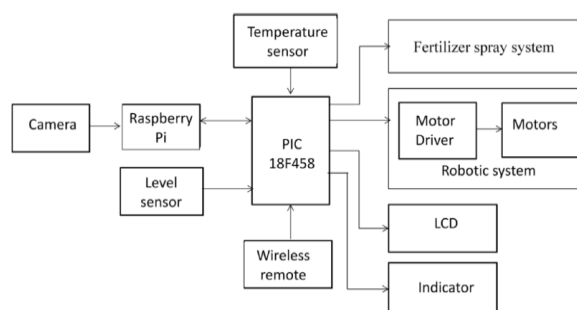


Figure 4: Block diagram of plant health indication system

c. LCD Display

Lampex 16*2, Backlit facility LCD is used in a project to visualize the output. 16x2 LCD is used in project which indicates 16 columns and 2 rows. So, total 32 characters we can display on 16x2 LCD. It can also use in a project to display the pesticide name to be spray on the crops. Thus LCD plays a vital role in a project to see the output.

d. Motor Diver

An L293d motor driver IC is used to control motors in autonomous robotics. Motor driver act as an interface between controller and the motors in the robotics. Motor driver are primarily used in autonomous robotics only. Also the controller operates at low voltages and requires a small amount of current to operate while the motors require a relative higher voltages and current. Thus current cannot be supplied to the motors from the controller. This is the primary need for the motor driver.

e. Fertilizer spraying system

Fertilizer spraying system is used to spray the fertilizer on crop. By using this system we cover large area in less fertilizer. When the fertilizer tank is empty then led indicator is activated and leads to show the level of tank on 16*2 LCD display.

f. Raspberry Pi

Raspberry Pi is used for image processing. Camera is connected to the raspberry pi, raspberry pi take image through that camera. After taking image of crop technique named as image processing is implemented on image. By using image processing we detect the disease on leaf. The Raspberry Pi is a credit card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of giving.

g. PIC18f458 Microcontroller PIC controller are used for control the all robotic operation, it give command to raspberry pi for image capturing and image processing. Autonomous robot system required more input and output pins for that PIC18f458 controller are selected. It has 40 pin controllers out of that 33pins are input output pins. It has 10bit ADC.

h. Wireless Remote a wireless oftenest (RF) transmitter and receiver are often simply created exploitation HT12D decoder, HT12E encoder and raise RF Module. Wireless transmission is often done by using 433 MHz or 315MHz raise RF Transmitter and receiver modules. In these modules digital knowledge is painted by totally different amplitudes of the carrier, hence this modulation is thought as Amplitude shift Keying(ASK), Radio Frequency(RF) transmission is additional robust and reliable than Infrared(IR) transmission owing to following reasons: 1. Compared to infrared RF signal will travel additional distance. 2. Line of sight principal is employed by infrared however RF signal will travel through any obstacle. 3. Infrared signals can get discontinuous by other IR sources but the signal outlined on specific waveband in RF won't mix in another RF signal band.

IV. CONCLUSION

Robot increases further accuracy of the system as it identifies colour very accurately than human. The system also observes different environmental conditions such as humidity, soil moisture and temperature which human cannot measure accurately by open eyes to decide the plant health so the accuracy of the system is high. It also involves watering mechanism and cutting process which reduces human labour and we can reduce labour further by modifying the system further for other agricultural work such as picking, harvesting, weeding.

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