Wireless Palm Tree Harvester

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ABSTRACT: This paper gives a prototype design of a wireless robot which provides a better solution for harvesting purpose in palm trees. In this system a robot with wheeled leg mechanism is used. Conventionally, harvesting has always been done manually and any device developed also requires a human labour to accompany it. Safety of the worker and the increased labour charges are the primary concerns of the farm owners now. In this design, Electric motors are used to control the movement of the robot. The robot is made adaptive so that it can adjust its wheels according to the dimension of the tree trunk by the action of compression springs. Controlling unit of the robot is a PIC 16F877A microcontroller. Robot is controlled by giving commands through PC using an application software. A robotic arm is provided for cutting purpose. Base, elbow and shoulder of the arm are servomotor controlled. Robot is controlled using wireless communication, for this purpose Zigbee module is used. It has also got a wireless camera interfaced to know the exact position of the cutting blade. The main aim of the project is to reduce human effort and to provide an economically feasible solution for palm tree harvesting.

KEYWORDS: Robot, Palm tree harvesting, Zigbee, Xbee RF module, Wireless communication, Robotic Arm

I.INTRODUCTION

Palm tree harvesting plays a very important role in the economy of many developing countries. Unfortunately despite its mass distribution and wide spread around the world, coconut harvesting is still done without proper safety measures which can lead to serious casualties. Usually all over the country, farmers practice conventional harvesting method in which coconuts and areca nuts are picked by specially trained, skilful and experienced climbers. Those who own the trees are finding it increasingly difficult to find professional palm tree climbers.
There is no longer a guaranteed labour force, tree climbers are a rarity these days in Kerala and other palm tree growing states of Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and Goa, with very few taking on the traditional profession. Tree climbers are a very vital link in the production chain. The scarcity of labour disrupts harvesting cycle's thus causing loss of income to the farmers. As against the general norm of harvesting cycles of 45-60 days, farmers are currently able to harvest only once in three to four months. In some places 2-3 meter long ladders are used for climbing palms for harvesting nuts. It has been reported that a simple palm climbing device has also been used by the climbers for harvesting nuts.
This project aims towards the designing and construction of a robotic system that can used for palm tree harvesting. A robot is an intelligent, re-programmable and multifunctional manipulator designed to work in inaccessible environment to do variety of tasks which are laborious, threatened and risky. The wheeled robots are simplest, energy saving and best suited for use on prepared surfaces. These locomotion systems have main chassis connected to a set of wheels through links and joints. The robot is equipped with a robotic arm for plucking the nut from the tree.

II.LITERATURE SURVEY

In the present day system palm tree harvesting is done without proper safety measures which can lead to serious casualties. Conventionally, harvesting has always been done manually and any device developed also requires a human labour to accompany it. Safety of the worker and the increased labour charges are the primary concerns of the farm owners now. Usually all over the country, farmers practice conventional harvesting method in which coconuts are picked by specially trained, skilful and experienced climbers. Knife sickle or iron hook attached to the plucking end of long bamboo poles are also used for picking nuts. Coconuts have to be harvested once every 45 days and those who own the trees are finding it increasingly difficult to find professional tree climbers. Normal operation is difficult, risky and time consumptive.

There are many prototype designs already put forward for harvesting on palm trees. Many of them involves manpower, some of them are costly in design. Most of them are wired structures which is not practically possible while commercialising. Another problem faced by the farmers is the cost of harvesting. Tree climbers should be payed around 50-65 rupees per tree. So a farmer with 100 trees should give approximately 5700 rupees per month for harvesting. This is not economical for ordinary farmers.

The alternative solution to all this problem is the use of robotic systems which can be used for harvesting purpose. This will take lesser time than the normal operation. The robot designed is able to give the conceptual scenario in palm tree harvesting which can be made in use by common man. By using this concept, robots for this situation can be made on large scale for harvesting purpose. It will be more economically feasible. This is a onetime investment which will help in reducing cost for harvesting. Since it's a wireless robot the control can be more easy compared to already existing systems.

III.SYSTEM MODEL

Wheeled leg mechanism is employed in this design for the movement of robot. The legs are circumferentially and symmetrically spaced out 120° apart. The robot is made adaptive so that it can adjust its legs according to the tree trunk dimensions by the help of compression springs. This structural design makes it possible to have the adaptation to the diameter of tree trunk and to have adjustable attractive force towards the trunk of tree. In this paper, the position of robot and rotor blade is captured with wireless Camera and monitored on PC. PIC16F877A microcontroller is the main part of the robot. The robot structure consists of power supply, robotic arm and gear motors. The robot is equipped with an arm for cutting purpose.

The whole system consist of the following parts:-

1)   Robotic Unit

2)   Controller Unit

3)   Display Unit

ROBOTIC UNIT

This unit comprises of 12V DC power supply, robotic arm, DC motors and servomotors. The motors are connected to the microcontroller I/O pins. Suspension springs are provided in all of the robotic wheels so that the robot is able to do straight and spiral climbs. Wheels are driven by three DC motors which are coupled to it.

Also four servomotors are used for performing the robotic arm action. Two motors are for base movement, one for elbow movement and one shoulder movement. At the tip of the arm there is a rotor blade provided which is used for cutting purpose, it is driven by a dc motor.

The robot locates at centre of mass outside of tree and uses wheels to climb vertically. The wheel mechanism is designed for a hybrid climbing method. The robot is able to switch between straight and spiral climbs using compression spring mechanism. The harvesting mechanism consists of an arm with three degree of freedom with a circular saw as end effectors. The bunch of nuts is located by a vision sensor (camera) which is placed at the wrist of the arm. The nuts are harvested using the saw based on the output received from the camera. The entire movement of the robot and the harvesting mechanism is controlled using a PC or android phones.

CONTROLLER UNIT

This unit comprises of PIC 16F877A microcontroller. This is RISC (Reduced Instruction Set Computing) based microcontroller having analog input channels, analog comparators and additional timer circuits. The microcontroller is enabled and act at commands given through PC. The video captured by the wireless camera is displayed on PC. The wireless communication between microcontroller and PC is done through Zigbee module.

DISPLAY UNIT

The robot is provided with a wireless camera which is placed on the robotic arm, it is used to locate the position of the fruit and also the accurate position of rotor blade. The video captured by the wireless camera is monitored on the PC so that we can precisely do the harvesting work.
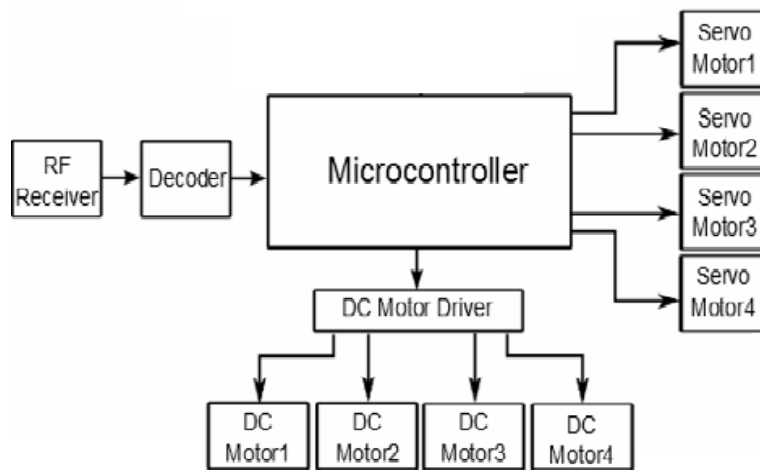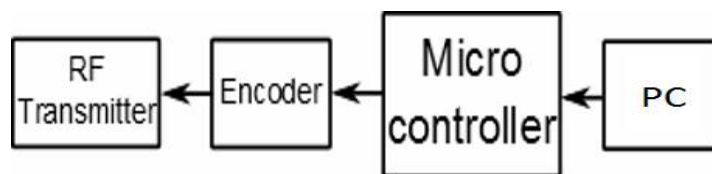

Fig. 1 Robot side

Fig. 2 PC side

IV.COMMUNICATION AND CONTROL

Wireless communication between controller and PC is done using Zigbee module. Xbee RF modules are used for zigbee communication. XBee RF modules are embedded solutions providing wireless end-point connectivity to devices. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are designed for high-throughput applications requiring low latency and predictable communication timing. Providing quick, robust communication in point-to-point, peer-to-peer, and multipoint/star configurations, XBee multipoint products enable robust end-point connectivity with ease. Whether deployed as a pure cable replacement for simple serial communication, or as part of a more complex hub-and-spoke network of sensors, XBee multipoint RF modules maximize wireless performance and ease of development.

The robot can be controlled using a personal computer (PC), Android phones or tab. An application software is developed with the help of visual basic and C programing, this can be installed in the pc or phone. This application contains controls of every motors and blade provided on the robot. When a command is given, the Xbee transmitter transmits the signal and the receiver receives it, the PC16F877A microcontroller detects the signal and the robot will work according to it. The video captured by wireless camera is received at the camera receiver as RF signal and the output can be obtained in the pc or mobile.

V. METHODOLOGY

PIC16F877A microcontroller is the main controlling part of the robot. The robot consists of three DC motors that are used to drive the body and four servomotors used to drive the arm.

The robot will perform the following steps for performing the task:
1)   One side of the robotic structure is screwed, it can be opened and fit to any tree. Then the structure is re screwed so that it will fit on to the tree trunk.
2)   The robot firstly moves upward through the tree trunk by adjusting its legs according to the dimensions. It is controlled by the operator by giving commands through PC.
3)   The wheel mechanism is adjusted according to the trunk dimension with the help of compression spring arrangement.
4)   The video camera mounted on it gives the precise view of the position and location of the target. This video will be monitored on the PC.
5)   The robot then perform the harvesting work by the help of robotic arm provided.
6)   The base, elbow and shoulder of the arm are controlled using servomotors.
7)   The robot harvest the nut using the rotor blade provided on the arm.
8)   Every action of motors are controlled using commands given through PC or android phone, for this purpose a program is developed using visual basic. Wireless communication is done using Xbee RF module.

VI. PROTOTYPE DESIGN

Designing of the prototype needs the right selection of motors and wheels. There are different types of motors to choose from so a comparison study is needed to choose the one that is appropriate for this project. Apart from the motors, the selected wheel also had to be tested several times before deciding. Dc motors and Servomotors are used in highly precise and accurate applications. Even though servomotors have very high holding torque, the high weight of the motor is a huge disadvantage. Keeping the light weight, cost and torque in mind, DC motors are chosen for this application. Side shaft DC Motor is suited for Robotics and Control Automation based applications. It is rated to operate at 12 V but it can operate at a wide range of voltage of 4 V to 24 V. These motors are available for different speeds and varying torque.

There are several advantages to a wheeled leg design. Eliminating the use of legs for climbing makes the design much simpler. With a legged robot, comes the problem of how to build the legs which need many degrees of freedom to allow for proper maneuverability on varying tree diameters. SO compressing springs are provided for every wheels so that it can adjust according to diameter of the tree trunk. The driving motors directly rotate the wheels. The wheel to be selected for the device must be of low weight and have a larger diameter for better contact with the tree trunk to provide tension. Due to the uneven surface of a coconut tree, the wheel must have tracks for better traction.
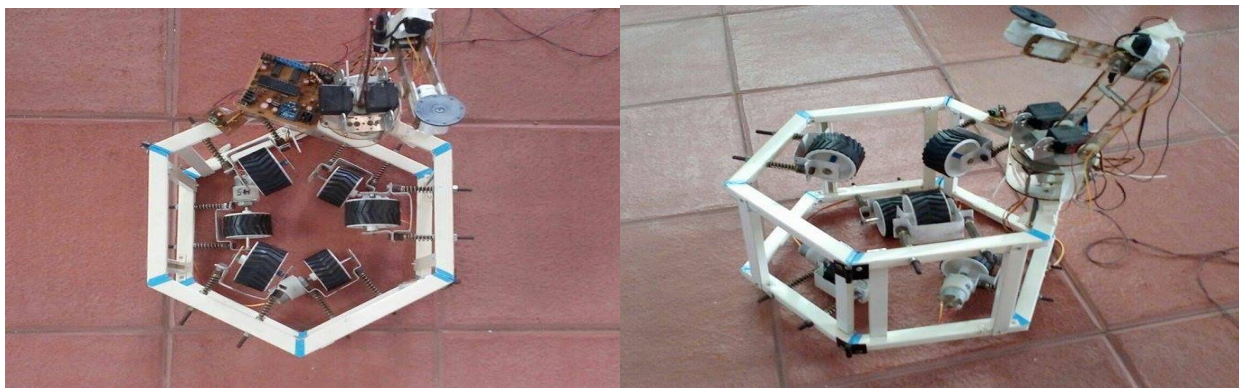

Fig. 3 Wireless Robot Prototype Design

VII.CONCLUSION

A novel method for coconut tree climbing and harvesting is proposed. In present day system, palm tree harvesting is still done with manpower involvement without proper safety measures which can lead to serious casualties. It is not economical and also very time consuming. This project is intended to reduce human efforts for palm tree harvesting. It can be controlled using PC or any android devices which makes the control easier and user friendly. This is a onetime investment so that it is economical. Since it is a wireless design the control and working will be easier when compared to already existing systems.

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