Design and Analysis of a Coconut Harvesting Maneuver

A.P.Mohanraj, Raghul Krishna.S, S.S.Kannan, M.Rajkumar, A.Elango,

Abstract:
This paper describes the design parameters and analysis phase of a coconut harvesting maneuver. Our primary objective is to harvest the tender coconuts from the coconut tree efficiently through a remote control with maximum work volume covered. The design is made in such a way that the machine fits in various sizes and shapes of the coconut tree. The robotic arm will cut the coconut in more precise manner than any other machine do. It is controlled by an RF remote controller. The machine can be manually controlled under any required circumstances as per the necessity. The model has been designed and a prototype has been proposed.

Introduction :

In this project the major criterion is that in order to prevent the loss of lives in any such cases by putting up the conventional idea of man going up to the top of the coconut tree to harvest the tender coconuts, a robot is designed to take over the job .An exclusive solely new design is being made to develop up a machine for this specific purpose.

Our primary objective is to harvest the tender coconuts from the coconut tree efficiently through a remote control with maximum work volume covered.
The design is made in such a way that the machine fits in various sizes and shapes of the coconut tree. The robotic arm will cut the coconut in more precise manner than any other machine do. It is controlled by an RF remote controller. The machine can be manually controlled under any required circumstances as per the necessity. This was the project was initially pioneered by a student of Kerala in the year 1998. It has been found that back in the year 1998,a machine "DYN 2000" was built up in Kerala by an engineering student which got nation wide recognition. It is made of simple mechanical elements like sprockets and chain linkages, motors etc. And one more design had been found which has is a construction bars in order to put the man to the top of the tree, But it requires human effort as it is not automated. The DYN 2000 lags due to its lumpy size and difficulty in installation and the shape factor is not fairly good enough.

Hence our design crew decided to come up with a new design which overcomes from the above limitations . A new design is being made right from the scrap and turning out so feasible and reliable. As it is a long tree to climb, There has to be an induction of High torque rather than High speeds. As we all know a normal outward directed perpendicular force is required in order to move the machine from the bottom or base area to the position where the machine has to withheld. Hence one or two high torque stepper motors are essential as per the requirement.

- A.P.Mohanraj is currently pursuing Ph.D in Anna University and working as an Assistant Professor in School of Mechanical Engineering, SASTRA University, Thanjavur, Tamil Nadu, India. Ph: 09629375563. E-mail: apmohanraj@mech.sastra.edu
- Raghul Krishna.S is currently pursuing final year Mechanical Engineering in School of Mechanical Engineering, SASTRA University, Thanjavur, Tamil Nadu, India. Ph: 09600819618. E-mail: ragssalem@gmail.com
- S.S.Kannan is currently pursuing final year Mechanical Engineering in School of Mechanical Engineering, SASTRA University, Thanjavur, Tamil Nadu, India. Ph: 09791216177. E-mail: kanna.crazyboy.07@gmail.com
- M.Rajkumar is currently pursuing final year Mechanical Engineering in School of Mechanical Engineering, SASTRA University, Thanjavur, Tamil Nadu, India. Ph: 07402086597. E-mail: mraju2291@gmail.com
- Dr.A.Elango is currently working as Professor and H.O.D of Mechanical Engineering in Alagppa Chettiyar College of Engineering and Technology, Karaikudi. Tamil Nadu, India.Ph: 09843963007 E-mail: elango.arum69@gmail.com

Materials And Methods :

As this was a complete Machine Design project incorporating mechanical, electronic and software development, the different areas were developed synergistically thus allowing interactions between the disciplines to be viewed and managed. It also meant that all three core disciplines needed to be developed to a certain stage before any one area could be further worked on. Although it was physically possible to use other means to develop the core areas independently, a synergistic approach tends to be more efficient. Even though this parallel design approach was used, the areas of development shall be discussed in sections assuming that other sections have already been completed to a certain level and are referenced where necessary.

Fig1. High Torque DC Stepper motor.

Developments and implementation:

The development for this project can be divided into the major process, the mechanical design for mobile robot chassis, electronics design for channelized l motor driver and interfacing with microcontroller board and software development for motion control.

Mechanical Design:

The design is made in the PRO-E 3D modeling software from the actual conceptual drawing.

The Analysis part is to be carried out with the help of ANSYS software. With the help of the 3D model drafts we can conclude the final design and the fabrication and machining is to be carried out.

Electronic design:

Channelized bi-directional motor driver been design to drive all the wheels.
The specifications developed for the necessary driver board were:

- The circuit should be compatible with a single logic-level PWM input signal for speed control of each motor and a single logic-level input line for the direction of motor rotation for each motor.
- The circuit should be able to operate with a high PWM carrier frequency from the microcontroller (20 MHz) to provide inaudible operation.
- The circuit would require four independent H Bridge drivers for bi-directional motion.
- Each H-Bridge driver circuit must be capable of providing suitable continuous current at 12V DC. The prototype motor driver was develop using 2 units of LMD18200 IC manufactured by National Semiconductor that capable of 3 amps continuous current at up to 55V DC and also had extra integrated features including current sensing and thermal overload.

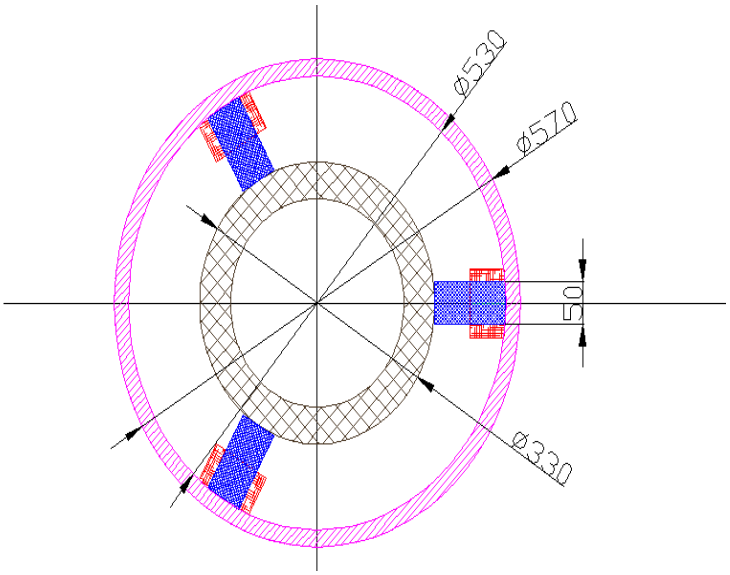

Fig 2. AutoCAD diagram of the Top view of Top Ring with wheels

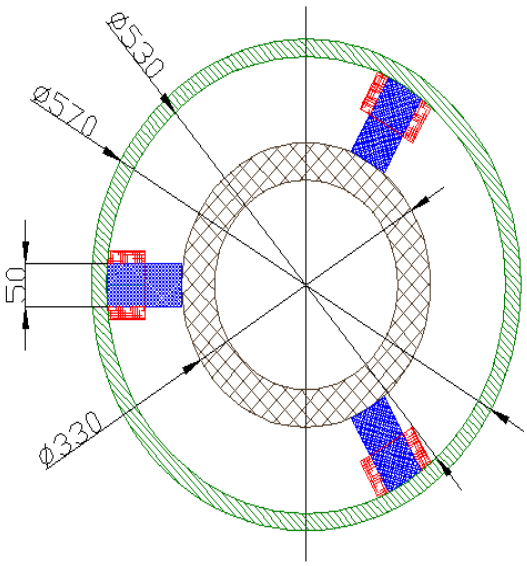

Fig 3. AutoCAD diagram of the Top view of Bottom Ring with wheels

Input Data:

Readings based on true observation of the circumference of the Tree Trunk

All in cm	*Reading 1*	*Reading 2*	*Reading 3*	*Reading 4*	*Reading 5*	*Reading 6*	*Reading 7*
Base (~abv 5 ft)	*91*	*107*	*96*	*78*	*82*	*73*	*114*
Middle (~abv 12 ft)	*74*	*91*	*79*	*70*	*91*	*82*	*95*
Top (~abv 20 ft)	*80*	*75*	*70*	*72*	*81*	*76*	*98*
Average	*Base*	*91.5712*	*Middle*	*83.1429*	*Top*	*78.8571*	

Microcontroller:

In order to give the existing robot any Real-time functionality some form of on-board processor was essential. Microcontrollers are ideally suited for such an application as they are compact, have many built-in hardware features such as timers and UARTS, have a significant number of digital I/O lines and have low power requirements. The essential microcontroller specification for this project was its ability to generate independent PWM signals .Other general requirements were; high Torque and low speed operation to ensure environmental data could be processed at real-time.

BASIC Stamp micro-controllers have been chosen this project for well-known for their ease of use, comfortable programming language and easy debugging using a PC.

Work Part:

The Robot is equipped with two manually adjustable horizontal offset rings wherein the 1st ring the a hollow track is made for the cutter arm to follow in a revolutionary path around the trunk of the tree .The wheels are placed in 1,3,5 Positions at the top ring and 2,4,6 position at the bottom ring and 3 Wheels in the (3) adjustable middle support arms. The wheels are placed in such a way in order to maintain the dynamic stability of the Working medium. A High torque developing motors are used to drive these wheels.

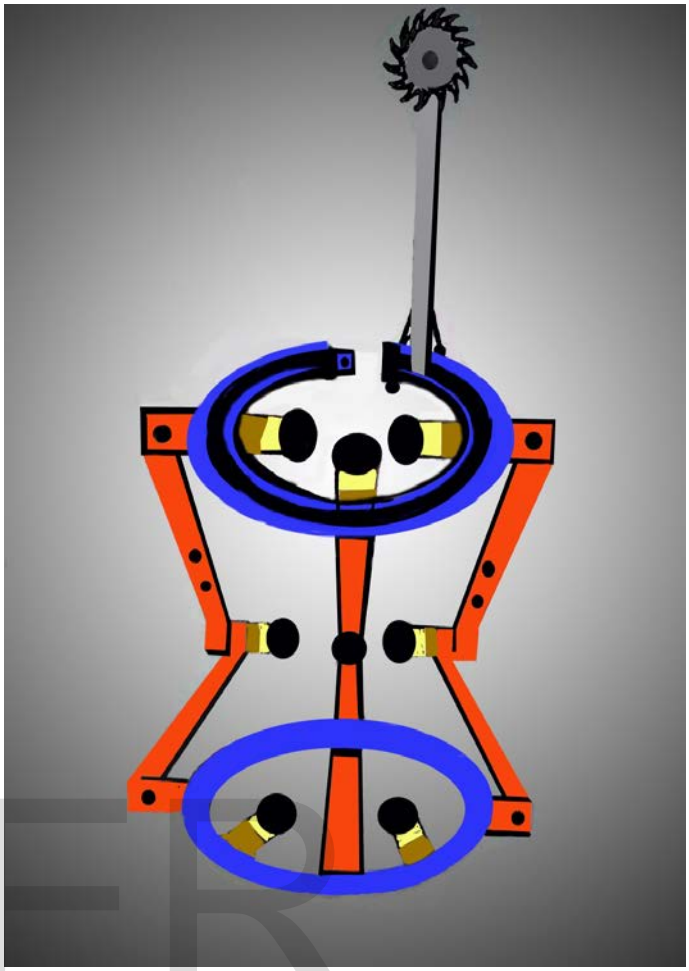

Fig 4. Full view of Coconut Harvester design

- To calculate the maximum work volume the horizontal and inclination with respect to the normal surface is computed by distance b/w the top part of the tree to the machine position and the radius of the targets from the center.

Fig 5. Work volume space Real-Time display

Conclusion:

This paper presents an overview over the primary design stage of Coconut Harvesting maneuver robot Considering the real-time parameters. The strength of this Maneuver is the enhanced maneuverability of the mobile robot that needs extreme maneuverability in congested environment. Maneuvering mobile robot research addresses many problems in the practical Engineering Modules such as System integration, real-world modeling, actuator and sensor control, path planning and navigation, task-level planning and execution and the control of the robotic system as a whole. Moreover, building a Maneuvering mobile robot provides a stringent test bed for new concepts and approaches in both mechanical design for Indian needs such as farming elements and overall mobile robot chassis and also the design for electronic hardware.

References :

1. Fiegel, O., A. Badve and G. Bright, et al., 2002. Improved mecanum wheel design for omni directional robots. Proc. Australasian Conf. Robotics and Automation, 27-29 Nov., pp: 117-121.
2. Phillips, J.G., 2000. Mechatronic design and construction of an intelligent mobile robot for educational purposes. Master of Technology Thesis, Massey University, Palmerston North, New Zealand, pp: 150.
3. A. Gloye: "Learning Methods for Autonomous Mobile Robots", PhD thesis, Freie Universit¨at Berlin, 2005.
4. A. Gloye et al.: "Learning to Drive and Simulate Autonomous Mobile Robots", RoboCup-2004: Robot Soccer World Cup VIII, Springer-Verlag, 2005.
5. M. Oubbati et al.: "Velocity Control of an Omnidirectional RobCup Player with Recurrent Neural Networks", RoboCup-2005 - Proc. of the Int. Symposium, preprint, 2006.