

# Coconut Tree Climbing Device

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## **Abstract**

Service Learning is an opportunity for students to serve the community while gaining a meaningful learning experience directly related to school curriculum. Excited to learn while helping others, the Troy High School InvenTeam, in collaboration with the MIT-Lemelson Foundation, is creating a device that will climb towering palms to harvest (primarily) coconuts. With the help of advisors and mentors, this climbing mechanism will ultimately be designed and created by high school students. It will foster not only a love for engineering, designing, and inventing, but also a feeling of pride and accomplishment in helping people that live in coconut-harvesting countries.

There is no 100% safe coconut-harvesting device currently on the market. Although there have been efforts made by many inventors, the most similar contraption is a coconut-climbing assistance device that assures efficiency, but not necessarily safety. The Troy InvenTeam's coconut-climbing device will attempt to address both efficiency and safety. Although the Troy InvenTeam has great aspirations to help these needy people, many problems must be addressed before the final design. The design of the device has to be simple enough for villagers to operate, yet work efficiently to appeal to the majority. Other design obstacles include creating a multi-axis arm, allowing the villagers to observe what is happening at the top of the tree, maintaining friction between the device and the tree as the device ascends and descends, and finding trees to test

prototypes. The Troy InvenTeam will be presenting their prototype at the annual Odyssey presentation at the Massachusetts Institute of Technology in June of 2008, in hopes of saving lives and improving the living standards of many coconut-climbers.

## **Introduction**

In the mind of an average American, coconut trees invoke the soothing sensations of island paradise and ultimate relaxation. To a more scientific mind, coconuts are known to belong to the “arecacea” family, also known as the palm family, which is comprised of about 200 genera and 2,500 species. Palms range from tiny plants to towering trees reaching over forty meters (over 120 feet), and are found throughout the tropics and subtropics<sup>1</sup>. Commercially important palms include coconuts (*Cocos nucifera*), dates (*Phoenix dactylifera*), and oil palms (*Elaeis guineensis*), although the Troy InvenTeam’s main focus will be on coconut trees. With over five billion coconuts harvested every year<sup>2</sup>, coconuts play a huge role in the economy of several regions and countries. Prominent places of harvest are the Indian states of Tamil Nadu, Kerala and Karnataka, the Lakshadweep Islands, the Andaman Islands, Caribbean countries, Australia–Oceania countries, and many African and South American countries.

The majority of coconuts are harvested by climbing the tree and cutting the nuts down by hand. This process may seem simple; however, it is actually quite dangerous. In response, there is a genuine need to develop a device. In an attempt to assist the climbers, our group will devise a coconut-climbing device that meets the following goals:

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<sup>1</sup> McCurrach, James C. 1960. *Palms of the World*. New York: Harper & Brothers.

<sup>2</sup> US Library of Congress. Coconut Industry, retrieved July 2007.  
<http://countrystudies.us/philippines/63.htm>

- It will be controlled from the ground.
- Both men and women will be able to operate the device.
- The coconut climber will be able to harvest as fast or faster than present methods.

The team currently consists of twelve high school students, two advisors, and one mentor.

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10	Fady Barsoum	11	Philip Jia*
11	Allen Capatina	10	Jaebin Ju
11	Sophia Chung	10	Brian Kim
12	Amanda Eng	10	Quan Nguyen
10	Michael Forsuelo	10	Lisa Park
11	Melissa Jawaharlal*	10	Grace Qi

Advisors: Mr. Kent Goodman  
Mr. Mike Reid

Mentor: Dr. Mariappan Jawaharlal  
(Associate Professor in  
Mechanical Engineering at  
Cal Poly Pomona)

\* Co-leaders

This project’s basic design is still under construction and the project, therefore, is still in its primary stages. By the June MIT Odyssey event, a prototype that can successfully climb a coconut tree of variable diameters and height should be made. The finishing date of a device that can actually harvest coconuts has yet to be determined.

## Background Research

Coconuts are exported by the tons around the world, bringing in revenue to various tropical countries. However, they also have other important uses. Appropriately referred to as “The Tree of Life” by villagers, every part of the coconut is utilized in some way. The outside husk is used to make strong ropes, while the leaves of the tree (keethu) are used as roofing material in villages. Inside, tender coconut milk is a delicious and healthy drink. More importantly, tender coconuts are used as a medicine for diseases such as

thyroid. Therefore, it is not an exaggeration to claim coconuts support many aspects of village life. In 1989, as one of the top five exports in the Philippines, 11.8 million tons of coconuts were produced. In 1998, the world total of coconuts imported was about 220,000 metric tons. In 1998, China was the largest importer of coconuts with 85,472 metric tons. The U.S. imported 23,377 metric tons and Hong Kong imported 16,393 metric tons.<sup>3</sup>

Primitive methods of collection provide a need for a new device. An experienced climber takes about 4-5 minutes alone just to climb the tree (this doesn't include cutting the coconuts and the return trip). In more developed areas, methods of harvest and coconut removal involving rope-climbing gears and spiked shoes are used, but are impractical and inefficient for use in large scale plantation harvesting. Most climbers, in developed countries or otherwise, must climb around 20-30 trees per day in order to earn a meager income—climbers are often among the country's poorest people. In the Indian state of Tamil Nadu, a climber makes the equivalent of fifteen cents per tree. If a climber climbs twenty-five trees in one day and works seven days a week for one month, he will make a mere 100 dollars. The Troy InvenTeam has come to the conclusion that nothing they make will be affordable to these people. Consequently, they hope to eventually get help from institutions like UNESCO, national governments, NGOs, etc. In addition to pitiable wages, harvesters are looked down upon for doing the country's "unwanted" jobs. Hardly anyone aspires to become a coconut harvester because of the unsafe conditions, low income, and social stigma, resulting in a virtual vacuum in the job market. Furthermore, most coconut harvesters are currently men. This is because of the

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<sup>3</sup> Food Market Exchange. World Coconut Imports, 200-2003. retrieved July 2007 from [http://www.foodmarketexchange.com/datacenter/product/fruit/coconut/dc\\_pi\\_ft\\_coconut.html](http://www.foodmarketexchange.com/datacenter/product/fruit/coconut/dc_pi_ft_coconut.html)

traditional idea of it being a “man’s job” as coconut harvesting is extremely strenuous. The Troy InvenTeam’s goal is to create a device that would also allow operation by women and older teenagers (as no hard labor would be necessary), thus creating an additional income opportunity for poor families.

## **Competitive Technologies**

Although there are many existing robots that can climb walls or trees, there are currently no robotic devices for climbing and harvesting coconut trees in specific. Stanford University’s Design Research team created a gecko-like robot that climbs walls using sticky fiber to remain securely attached<sup>4</sup>. Project RiSE (Robots in Scansorial Environments) at the Robotics Institute at Carnegie Mellon University has produced nature-inspired machines that can walk on land and climb trees or walls (as of March 8<sup>th</sup>, 2006)<sup>5</sup>. Slightly more related to our project, MIT graduate students developed a device to harvest bananas in a class known as “2.009.” The class focused their design work on agriculture-related products especially for developing countries. One drawback of these robots is they take much longer to climb a tree than humans. One of the few specifically related devices we have found in our research is an Indian climbing and harvesting device that aids in climbing a palm or coconut tree. The inventor asserts that his device ensures the user’s safety and quickens the climbing process. However, the device still requires a person to physically climb the tree and therefore does not properly address the society’s needs.

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<sup>4</sup> Engadget. Melanson, Donald, July 2006. Stanford gecko-bot.  
<http://www.engadget.com/2006/07/26/researchers-develop-sticky-gecko-like-material/>

<sup>5</sup> RiSE Robot-Projects-Microdynamic Systems Laboratory. CMU, 2007.  
<http://www.msl.ri.cmu.edu/projects/rise/>

## **Field Research**

Since the best way to understand real problems is to interact directly with people, a relationship was established with a village in the South Indian state of Tamil Nadu. This connection helped the Troy InvenTeam get further acquainted with the project in addition to bringing in much valuable information. The contact arranged for two videos to be made specifically for the Troy InvenTeam. These films showed a fifty-year old man by the name of Varghesse and a twenty-two-year old man by the name of Santhosh climbing a palm tree and a coconut tree, respectively. Everything they did, from their method of climbing to their way of dressing, has given our team a helpful insight to tree climbing in villages.

Koanamkaadu village is located in the coastal district of Kanyakumari. 10,000-15,000 people in the Kanyakumari district are tree climbers. Coconuts are plucked once every forty-five days. A good yield for a coconut tree is about 700-720 coconuts a year. Coconuts grow out of special flowers called paallai. Rather than plucking the coconuts, some cultivators will drain the natural wine (kallu) out of the paallai. Also, lethal yellowing, potassium deficiency, bud rot, gandomera, palm aphid, and coconut are all common diseases that have proven to be deadly to coconut trees. Another attachment that the team has thought seriously about is a pesticide being sent up to rid coconut trees of the above maladies. In addition to quantitative data, the relationship also bore qualitative data. The Troy InvenTeam was essentially able to ask current harvesters if they would welcome some sort of climbing device that would aid their work and not require them to continue climbing towering palms. The answer they got was a definite “yes.”

## **Challenges**

The current invention comes with many challenges. The device must attach to the base of the tree and be easily removable, the wheels must maintain adequate contact with the tree as the tree diameter decreases during ascension, and a single user must remotely control it to a height of approximately 100 feet. Designing, building and testing the device to meet the challenges will require all the time from the October selection date through the Odyssey in June. However, the ultimate goal is to mount a camera and actually harvest coconuts. Once the basic tree climber is completed and it can ascend and descend a tree successfully, the Troy InvenTeam will face three more major challenges as we embark on the harvester design: the lack of vision as the device climbs upwards, the development of a multi-axis robotic arm for harvesting, and finding an actual fruit-bearing coconut tree. The lack of vision requires the human operator on the ground to have live video signal from a camera mounted on our device. Further, developing the robotic arm to harvest the coconuts is a difficult engineering task and will require a great deal of time. Finally, testing the prototype on actual coconut trees will be difficult. Research shows no fruit-bearing coconut trees in southern California. There are, however, many palm trees with similar trunks to coconut trees near Troy High School. Once the Troy InvenTeam reaches the harvester design stage it may consider traveling to Mexico or Hawaii where coconut trees grow to greater heights and bear fruit.

## **Design**

The current concept design for the device is in essence a single hexagonal ring that will fit around the coconut tree with spring-loaded wheels to drive up and down the tree by a remote operator. The hexagonal chassis will be able to be opened with hinges at one or more corners (or with another method that we may find during actual designing), and adjustable to fit the varying diameters of coconut tree trunks. Three wheels will be attached to the inside of the hexagon and spring-loaded inward to create pressure on the tree and allow for traction when driven. To conserve energy and costs, we will likely only use remote-controlled motors on one or two of these wheels, with the other wheel(s) being idlers (the decision of how many motors to use will come through testing). The top of the chassis will be used as a base for future attachments that will be developed. These attachments include, but are not limited to, a pesticide-spraying attachment and a harvesting attachment with video camera and cutter mounted on an articulating arm for remote controlled harvesting. These attachment concepts are still very preliminary and speculative and will likely change during the design process. Power sources for the device are also still speculative, but battery or solar power is seriously being considered due to the tropical and rural regions where coconuts grow.

## **Collaborations and Resources**

California Polytechnic State University in Pomona has offered its support. Dr. Mariappan Jawaharlal, a mechanical engineering professor at the university, is currently working with the Troy InvenTeam as a mentor. Moreover, as he has lived in India, he gives the team precious insight into the typical coconut climber's lifestyle. Cal Poly Pomona is also

providing support by granting our team \$500 worth of materials. They have also generously allowed the use of their Rapid Prototyping Machine (more commonly known as a “3-D printer”) for quick and inexpensive evaluation of our design before final manufacturing. Finally, Raytheon, a local company in which Troy has a strong internship program, has graciously offered their engineers as volunteers for Troy High School’s InvenTeam.

## **Conclusion**

A coconut-climbing device that will ultimately harvest coconuts would be a significant innovation for many people. Overlapping the fields of education and community service creates a fantastic opportunity for the young inventors of the Troy High School InvenTeam. This learning experience will allow us to serve not just the local community, but the world at large. It is an opportunity of a lifetime.

Present method of climbing/harvesting coconuts in rural villages:



Current design climbing tree:

