Needs Assessment

Team 11
Robo-Weeder

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Sponsor:
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Abstract:

The primary objective of the Robo-Weeder senior design project is to design and create a fully functional robotic platform to aid Mr. Jeff Phipps on his organic farm by removing weeds from the rows of planted vegetables. The team has contacted and met with Mr. Jeff Phipps, the project sponsor, to discuss design objectives and constraints. Constraints faced by team 11 include: a No-Till design that displaces roots of undesired plant one inch to the side, while staying under a $5000.00 budget. Team 11 began meeting on a weekly basis to discuss design options and delegate responsibilities among the group members. Several designs have been suggested by the group and these designs were presented to the sponsor as well as the faculty advisor. With a final design pending approval, analysis of the electrical system as well as computer models of the Robo-Weeder concepts has begun.

Introduction:

Current methods of farming use technologically advanced cultivating tools and genetically modified crops. This method is the currently the most used to maximize the possible yield of the crops. However, these processes are not only destructive to the environment, but also destroy microorganisms along with ground insects which would further contribute to the development of high yielding soil. Another flaw in current industrial farms is that there is large scale production of one single crop on a parcel of land. Also known as monoculture, is main reason synthetic fertilizers and pesticides are used. Monoculture decreases the diversity of the crop on a land plot, eliminating the natural biological controls that would maintain pest levels, disease, and soil degradation. [1]

Another negative attribute of using pesticides, herbicides, and insecticides, is many pests have already evolved and will continue to evolve to resist new chemicals. Therefore, the production of new chemicals to kill pests will need to be continuously developed. These pesticides, herbicides, insecticides, and fertilizers are derivatives of fossil fuels which are a limited natural resource. In addition to being a natural resource, fossil fuels also contribute to water contamination which is problematic because farms require the use of vast water irrigation systems. Currently irrigation systems extract water from reservoirs faster than they can be replenished, rapidly depleting this resource.

Due to the known fact that traditional farming leads to the serious consequences, organic farming has become a growing trend around the world. One might ask, "What exactly is an organic farm?" The answer is organic farming is done without using any chemically derived fertilizers, pesticides, herbicides, or is grown with genetically modified organisms (GMO)[2] There are many different methods to subsidize the effect of not using traditional fertilizers, pesticides, and herbicides. Some insecticides may be used such as rotenone and pyrethrum, which are both organic compounds. Another method of organic farming is using cover crops such as clover, a legume, to reduce unwanted weeds. Legumes also put nitrogen back in the soil once they are tilled out of the earth. That being said, legumes are natural fertilizers and promote healthy soil as well as improvements of antioxidant levels or a highly nutritious crop.[3] To combat the effect of pest while not using pesticides, organic farms do away with monoculture and diversify the crops.
This variation in crops allows certain crops immunity to pests that target a particular crop. The final method used by organic farmers is crop rotation which enhances the quality of the soil by placing vital nutrients back into the soil.

However, the downside of organic farming is the precise removal of undesired plants that grow near crops, and pest control. There are many different ways to combat these efforts but none of which work well with monoculture. Existing weeding machines are heavy, bulky and use gasoline engines which can adversely affect the crop yield.

Project Definition:

Needs Statement

The current sponsor for the Robo-Weeder project, Jeff Phipps of Orchard Pond Organics is located north of Tallahassee, FL and wants to develop a platform that will aid farmers in general crop care but mainly assist in the removal of weeds on his organic farm. The platform that Mr. Phipps desires must be robotic in nature and must an adequate shear force to the roots of undesired plants without disturbing adjacent crops. The platform must be able to accommodate future implements that the sponsor develops. In order to aid Mr. Phipps on his organic farm, an effective, reliable, and well-functioning platform must be created.

Goal Statement and Objectives

Thus far, the established goals for Team 11 is to create a machine that respectively effectively eliminate unwanted plants by the root, function remotely, be splash proof, and have an option to interchange weeding implements.

Constraints

The established constraints for the mechanism are as follows, function in "No-Till" fashion, not disturb one inch of soil, width shall not exceed 36 inches, must be tolerant to minimal water (splash proof). The budget set by sponsor is $5,000.

Expected Results

The expected result for this design (Robo-Weeder) is to have the ability to at least remove (cut) the grass down to a depth of 1 inch below the surface of the soil, successfully removing grass at a rate of greater than 70% per square ft.

Methodology

After preliminary research was conducted on current and traditional farming techniques as well as till designs, senior design team 11, constructed a House of Quality. The HOQ relates key customer requirements to important engineering characteristics unique to the design by way of a relationship matrix. The HOQ was created to help the team identify key design aspects that should be monitored during the design process. The three most important aspects as identified by the HOQ were stability, durability and strength of components. The complete HOQ can be viewed in Appendix A. After completion of the HOQ brainstorming sessions, the mechanical engineers on team 11 presented several conceptual designs to the sponsor, as well as the faculty advisor.

Steven's Design:

Figure 1: The articulating tractor was the inspiration of Steven's Design.

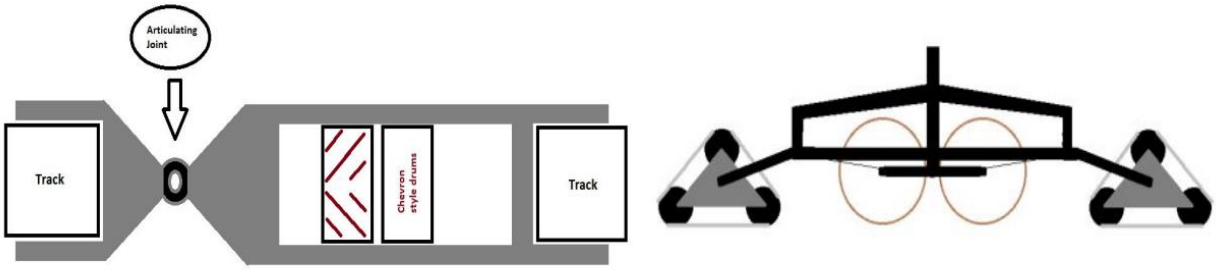

Figure 2: (Left) Top down view of the design; (Right) Side view of the design.

Chris' Design

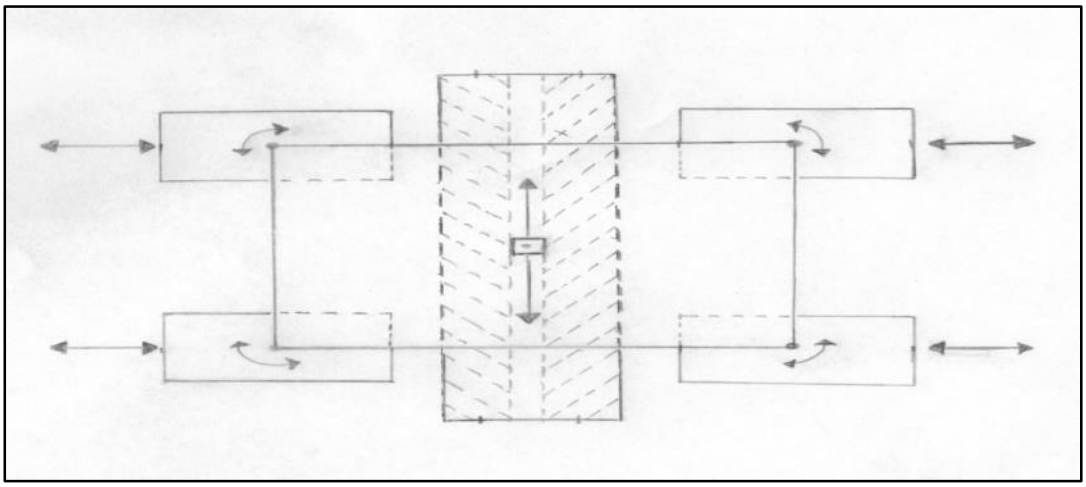

Figure 3: Top view of Chris 'design.

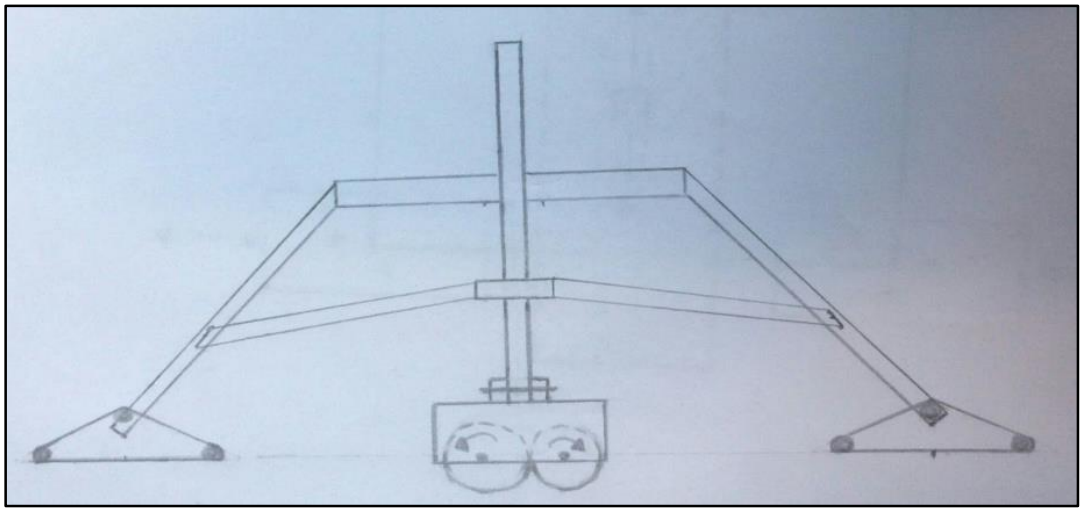

Figure 4: Side view of Chris' design

Xiang's Design

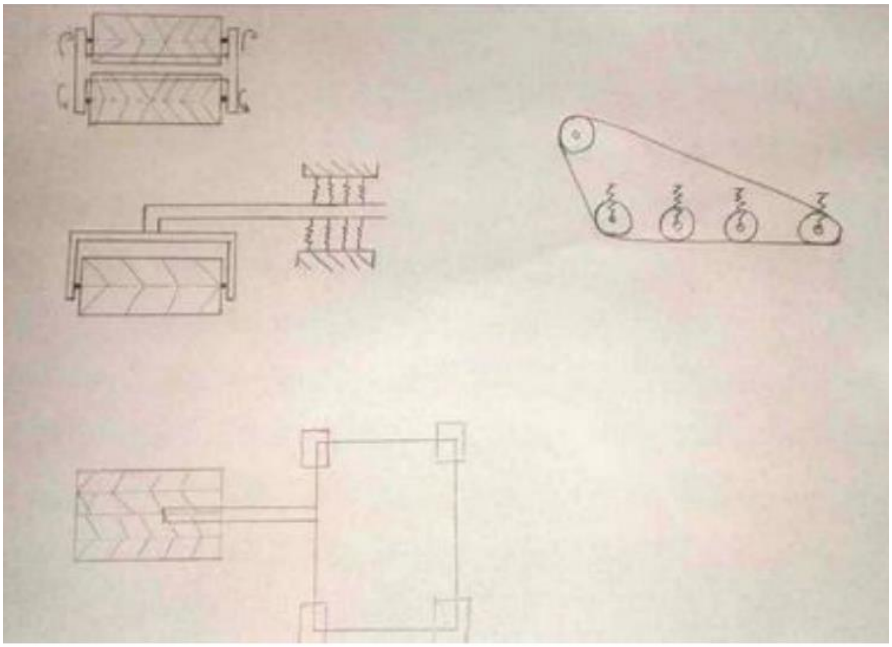

Figure 5: Aspects of Xiang's design.

Arriana's Design

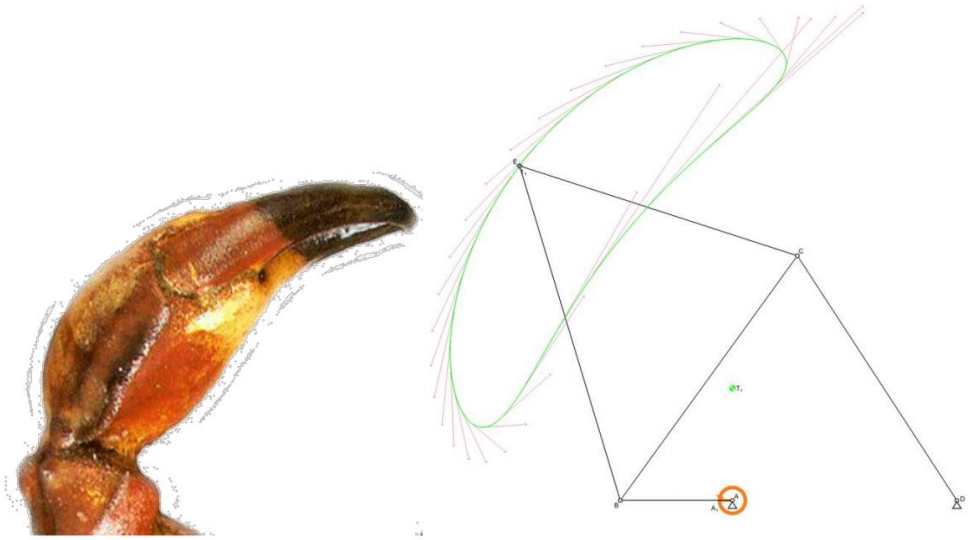

Figure 6: (Left) Inspiration for Arriana's design; (Right) Coupler curve of 4-Bar design.

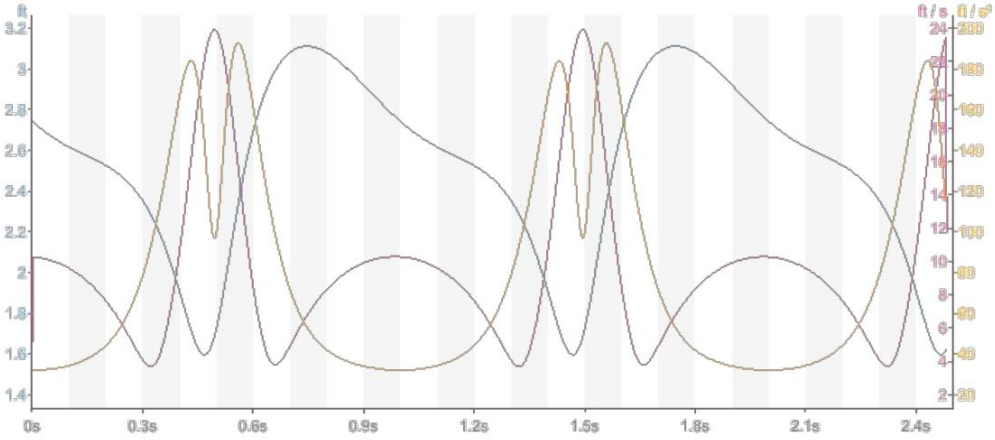

Figure 7: Velocity and acceleration curves for Arriana's design.

Conclusion

The traditional farming methods that have been implemented on a large scale are having a detrimental effect on the environment and the quality of today's crops. These negative effects range from the widespread use of herbicides, pesticides and fertilizers, to the massive amounts of water being drained to provide the needed water demand of large scale farms. These less than environmentally friendly farming practices have been the driving force behind the rise of the organic farm.

Senior design team 11 is working in conjunction with Mr. Jeff Phipps, the team's sponsor, to design a remotely operated vehicle to aide in the task of weed control on his organic farm, Orchard Pond Organics. Through several meeting with Mr. Phipps and the team's faculty advisors, Team 11 has currently defined specific objectives to be achieved during this project as well as defined the constraints that will shape how the ROV will achieve its task. Through the early stages of the design phase the design team constructed a house of quality to aide in the design process. The results of the HOQ identified stability, durability and

strength of components to be the engineering characteristics that have the most importance during the project.

Currently, team 11 is in the early stages of the design process and has yet to determine a final design. Each member is working diligently to perfect potential design considerations that will be presented to Mr. Phipps, as he will make the decision on the vehicle's final design.

References:

[1] http://12.000.scripts.mit.edu/mission2014/problems/ineffectiveinadequate-agricultural-practices

[2] http://www.ofrf.org/organic-faqs

[3] https://www.ocf.berkeley.edu/~lhom/organictext.html