



Palm Harvester Team

TEAM

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1. Functional Analysis

1.1 Project Function

The palm fruit harvester is built to easily and effectively harvest oil palm fruits for heights ranging from 13-35ft

1.2 How will the mechanism work?

The palm fruit harvester consists of a telescoping pole mounted to a heavy duty utility cart. A pulley system connects the telescoping pole segments together. When electric winch is connect to the battery, the winch retracts the cabling of the pulley system and drives the telescoping pole to a maximum height of 35ft. An electric saw is mounted to the top of the telescoping pole that will allow the user to harvest palm fruits.

2. Project/Product Specification

2.1 Telescoping Pole Dimensions

Figure 1, shows a schematic of the dimensions for each of the aluminum 6063 poles.

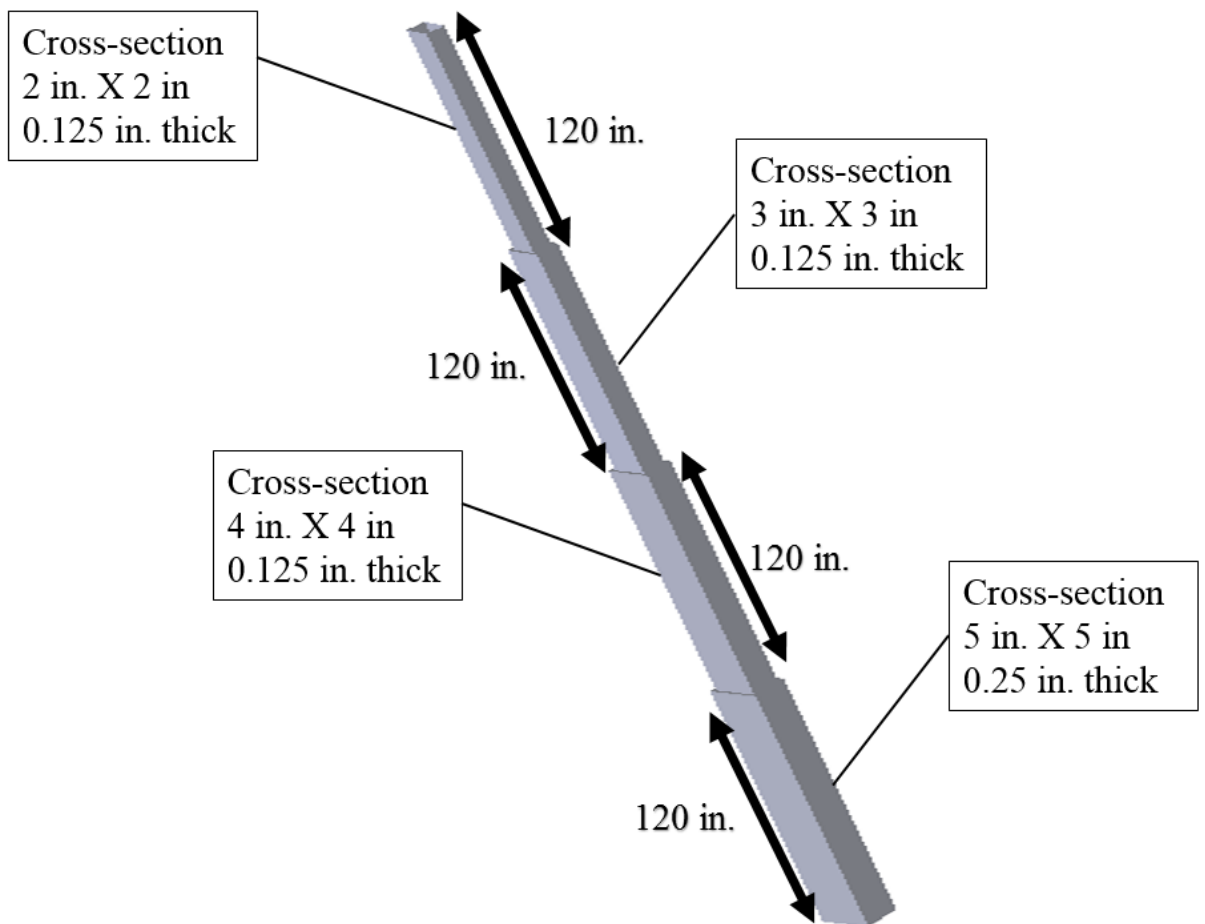


Figure 1. Schematic of telescoping poles with dimensions

2.2 Cart and Cross-bar Dimensions

Figure 2, shows the cart with its respective dimensions.

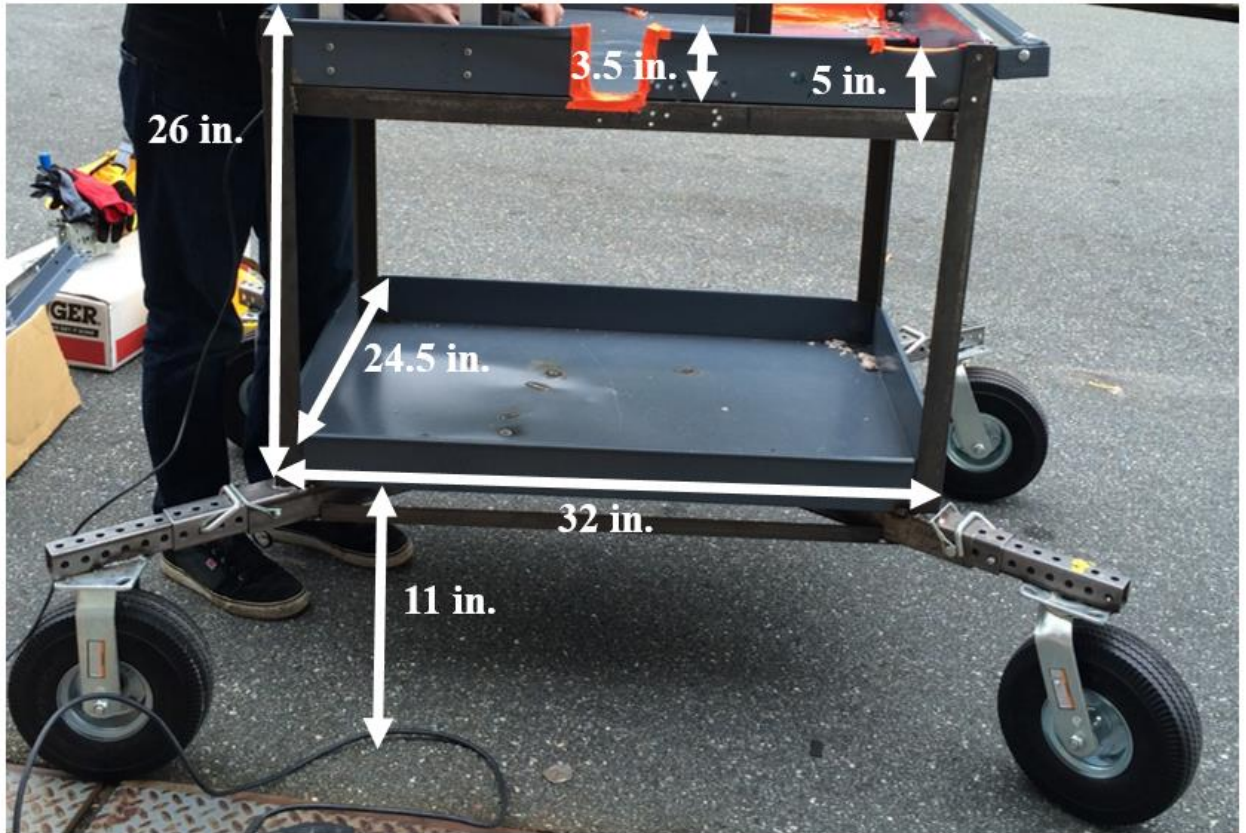


Figure 2. Cart with its respective dimensions

Figure 3 shows the cross-bar, which is attached to the underside of the bottom shelf of the cart, with its respective dimensions.

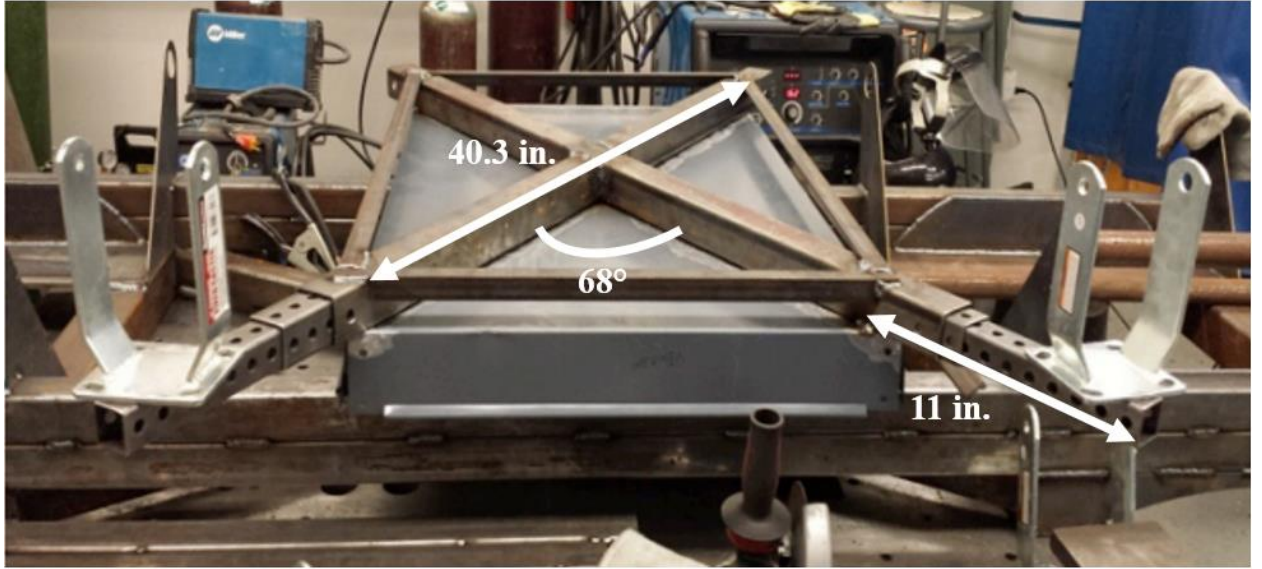


Figure 3. Cross-bar with its respective dimensions [1]

2.2 Alignment Block Dimensions

Figure 4 shows the alignment block, which holds the telescoping pole in place, with its respective dimensions.

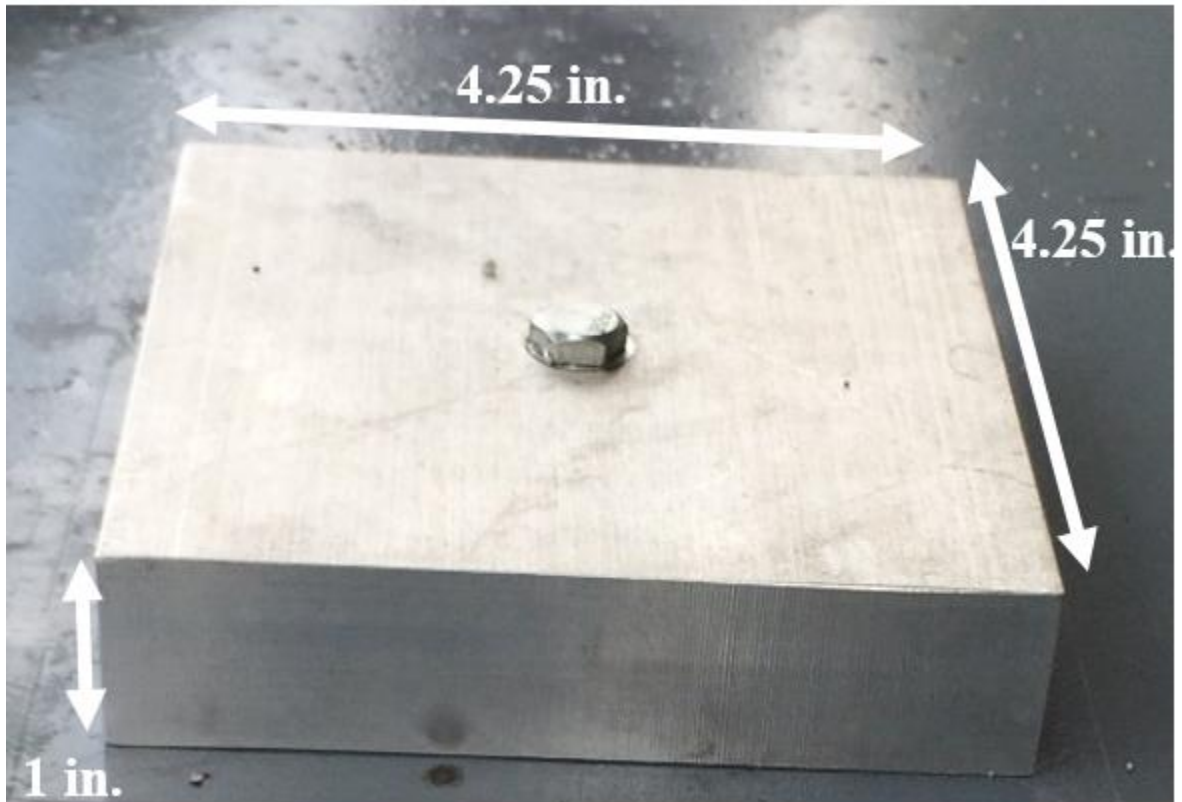


Figure 4. The alignment block with its respective dimensions

2.3 Motor Dimensions and Specifications

Figure 5 is an image of the electric winch motor with its respective dimensions.



Figure 5. Motor with its respective dimensions [2]

The specifications of the motor, are shown in Figure 6, explaining how its properties change based on line pull.

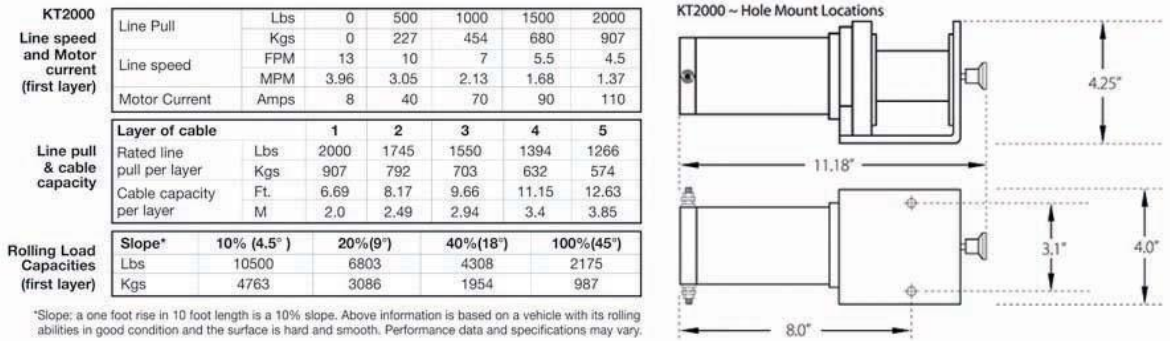


Figure 6. Motor specifications based on the line pull [2]

2.4 Battery Dimensions and Specifications

Figure 7 shows an image of the super start deep cycle marine battery use, along with its dimensions and Table 1 shows its specifications.



Figure 7. Battery with its dimensions [3]

Table 1. Battery Specifications [3]

Product Specification	Value
Battery Type	Deep Cycle
Cold Cranking Amps	550 CCA
Marine Cranking Amps	690 MCA
Group Size (BCI)	31
Reserve Capacity	210 min
Terminal Type	Top Post
Voltage	12V
Length	13in
Width	6-3/4in
Height	9-1/2in
Weight	59.5lbs

2.5 Pole Saw Dimensions and Specifications

Figure 8 shows an image of the pole saw with its dimensions and Table 2 shows its respective specifications.

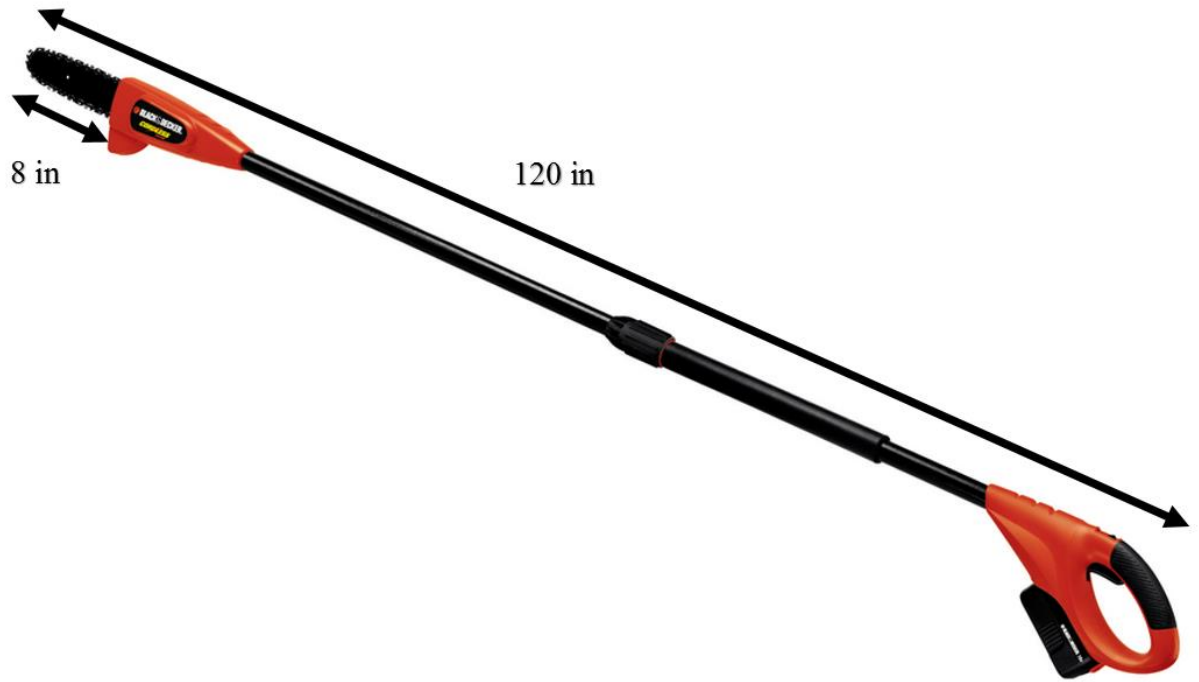


Figure 8. Pole saw with its dimensions [4]

Table 2. Specifications of Pole Saw [4]

Product Specification	Value
Cutting Bar	8in
Cuts Branches	Up to 6in in diameter
Length	10ft
Weight	7-1/2lbs
Battery Voltage	18V

3. Project Assembly

A three dimensional assembled model of the whole mechanism is shown in Figure 9.

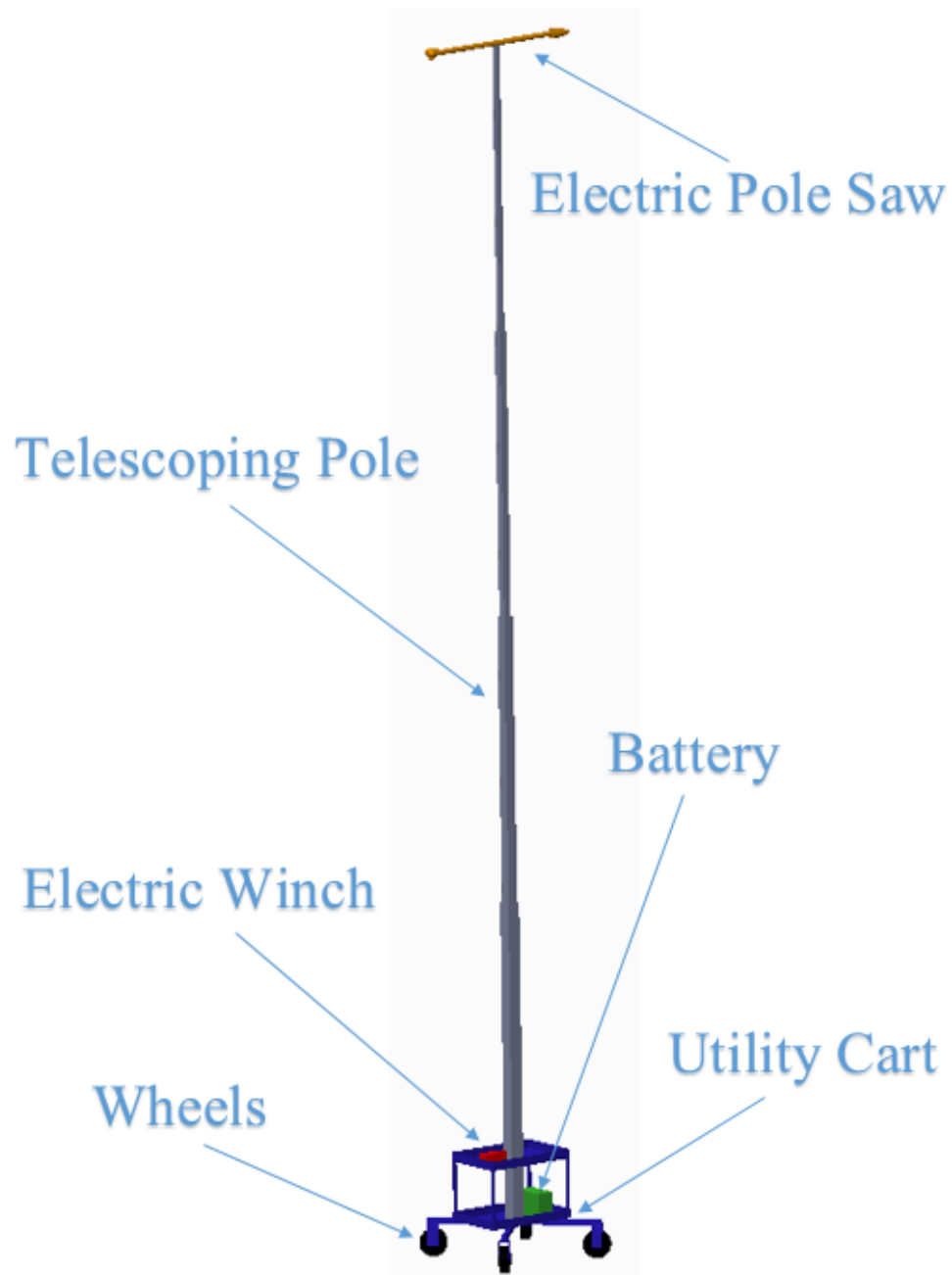


Figure 9. Three dimensional assembled model of the mechanism

In order for the mechanism to function, there are three crucial components require: an electric winch motor to extend the poles, a battery to power the motor, and an operation motor controller to allow the worker to control the telescoping process. These crucial components are shown in Figure 10.



Figure 10. Crucial components of the telescoping process [2,3]

4. Operation Instruction

Below are the steps required to operate the mechanism properly:

Step 1. Visually inspect the mechanism by looking for any sign of damage to the pulley system, poles, cart, battery, motor, and wiring. If any damage is present, make sure it is fixed before operation.

Step 2. Once the mechanism is damage free, maneuver the cart to five feet away from the base of the oil palm tree.

Step 3. Stabilize the mechanism by extended the telescoping legs out. The legs can be extended by removing the pins in each leg, extend the legs outward, and placing the pins back in each leg.

Step 4. Separate the two sets of wires running from the motor operation controller. Connect the set of wires containing the circuit breaker box to the battery, by matching their colors. Connect the remaining set of wires to motor, by matching their colors.

Step 5. Push the appropriate button on the motor operation controller to extend the telescoping pole.

Step 6. Allow the pole to extend to the desired height. The height can be measured using the reflective stickers on the poles. When the top of the largest pole reaches the bottom of the desired sticker number, the pole has reached its desired height.

Step 7. Once desired height is reached, release the button. Pole will remain at its desired position as the motor winches brake has been activated.

Step 8. Position saw in desired position using the cables attached to either side of the cutting mechanism and the cables attached to the lazy susan mechanism. Power saw on by holding the grey push button. Note: the cables attached to the cutting mechanism control vertical movement and the cables attached to the lazy susan control rotation movement.

Step 9. Once the harvesting is complete, release the grey push button, which will turn the saw off.

Step 10. Using the motor operation controller, push the appropriate button to allow the poles to contract to their original position.

Step 11. Contract the telescoping legs to their original position, reversing the steps explained in step 2.

Step 12. Mechanism is ready to be maneuvered to its next destination.

5. Troubleshooting

Below are the five most common problems that can occur with the mechanism.

Problem #1: Battery has died and telescoping pole is unable to be lowered

Answer #1:¹Hook up the replacement battery

²If replacement battery is not readily available, release the break on the motor and manually lower the poles by holding the cable that runs between the motor and the first pulley. Make sure cable is being held, otherwise poles will contract abruptly.

Problem #2: When grey push button is held, saw does not turn on

Answer #2: Lower the telescoping pole to its original position. Inspect wires connecting the grey push button to the cutting mechanism, Make sure there are no loose connections. If there are loose connections remove the cutting mechanism from the pole and fix the loose connections. If there are no loose connections, check the voltage capacity of the battery, using a multi-meter, located on the cutting mechanism.

Problem #3: Saw is stuck on cutting surface

Answer #3: Release the grey push button to turn off the saw. Then wiggle the cables attached to either side of the cutting saw.

Problem #4: Motor operation controller buttons do not activate when pushed

Answer #4: Inspect wires connecting the motor operation controller to the motor and to the battery. Make sure there are no loose connections. If there are loose connections fix the connections making sure the wires are connected tightly. If there are no loose connections, check the voltage capacity of the battery, using a multi-meter.

Problem #5: The poles are deflecting excessively during the telescoping process

Answer #5: Lower the telescoping pole to its original position, immediately. Take the mechanism to the maintenance location and disassemble the poles from the cart. Thoroughly inspect the poles making sure there are no signs of yielding, each pulley is fully functional, and that there are no missing nuts bolts, or brackets. Additionally check each buffer strip, located on the inside of the bottom three poles, making sure they are not loose or damaged. Replace any damaged parts.

6. Regular Maintenance

Maintenance must occur at least once every work week in order to prevent injury to workers as well as to ensure smooth operation. Throughout this operation manual the telescoping pole segments will be denoted as follows: 5"x5" (segment 1), 4"x4" (segment 2), 3"x3" (segment 3), 2"x2" (segment 4).

6.1 Disassembly of Mechanism

The following steps will outline the procedure for disassembling the palm fruit harvester:

1. Ensure that all electrical components are removed from their respective power supplies.
2. Remove pole saw from lazy susan. Pole saw will be removed in two separate parts; the battery side and chain saw side.
3. Remove segment 4 (innermost segment) from segment 3 by lifting straight up on the pole. The pole should slide out easily and smoothly. Note: if the pole is not pulled out straight upwards, excess frictional forces will be present, causing difficult removal.
4. Place segment 4 to the side keeping in mind that the cabling attached to the bottom of segment 4 is also connected to the top of segment 2.
5. Remove segment 3 from segment 2 in the same manner as prior removal.
6. Place segment 3 to the side.
7. At this time the bracket that is located at the top of segment 2 can be removed in order to completely removed segment 4 from the palm harvester.
8. Remove segment 2 from segment 1 in the same manner as prior removal.
9. At this time the bracket that is located at the top of segment 1 can be removed in order to completely removed segment 3 from the palm harvester.
10. In order to completely remove segment 2 from the palm harvester, the excess cabling on the electric winch must be removed. In order to accomplish this task:
 - a. Start by pulling out the knob located on the winch in between the winch and segment 1.
 - b. Rotate the knob about ¼ turn in order to release the cable spool.
 - c. Pull the excess cabling from the winch.

- d. In order to detach the cabling from the spool, loosen the set screw located on the face of the spool.
- 11. Segment 2 is now completely removed from the palm harvester.
- 12. Remove segment 1 from the palm harvester by lifting it out of the utility cart.
- 13. The palm harvester is now ready from maintenance.

6.2. Maintaining the Key Components

The maintenance process should consist of checking the following key components:

6.2.1 Cart

- Ensure that there is no damage to the cart.
- Check all steel cart reinforcements for any signs of deformation
- Check alignment block for signs of wear and tear as well as nut and bolt that holds the alignment block in place.

6.2.2 Wheels

- Check all wheel treading for signs of damage.
- Make sure all wheel bearings are secured inside of wheel hub.
- Wheels should rotate freely, but not able to be moved with respect to the wheel's respective bracket.
- Check that both swivel wheels rotate freely 360 degrees.

6.2.3 Motor (Electric Winch)

- Check for physical damage to winch.
- Check battery for proper charge.
- Make sure no corrosion is present on battery terminals.
- Connect winch to battery and test the following:
 - Cabling is able to contract and retract smoothly and efficiently
 - Ensure that the controller is functioning properly by pressing buttons for five consecutive seconds. There should be no discontinuities in winch operation during this time. Perform this test for both the up and down directions.
 - The mechanical brake should engage upon release of button on controller.

6.2.4 Telescoping Pole

- Check inside and outside faces of all four pole segments for signs of yielding.
- Ensure that no cracks are propagating near all drilled holes.

6.2.5 Buffer Strips

- Should be clear of debris
- Ensure that buffer strips are proper thickness:
 - White buffer strips that are mounted to inside face of segment 1 should be between 0.22 and 0.23 inches in thickness.

- Black buffer strips mounted to inside faces of segments 2 and 3 should be between 0.35 and 0.36 inches in thickness
- If buffer strips have been worn down to any less than their respective thicknesses then replacement is needed.

6.2.6 Pulleys

- Pulley wheels, when spun, should not rotate side to side. If this occurs the bearings inside of pulley are broken and entire pulley should be replaced.
- Ensure that brackets used to mount pulleys to outside face of segments 1-3 are not deformed in any way. If deformed, then replace.

6.2.7 Cabling

- Inspect entire lengths of all three cabling segments for defects.
- If any defects are found then replace entire cabling segment.

6.2.8 Pole Saw

- Use multimeter to ensure that battery provides correct voltage to saw.
- Connect all pole saw segments together and ensure that all connection points are ridged.
- Use push button to ensure proper operation of electric saw.

6.3 Assembly of Mechanism

Once maintenance has been completed the palm fruit harvester can be put back together using the following steps:

1. Insert segment 1 into the cart with the pulley facing in the direction of the winch by sliding the bottom through hole located top shelf of cart. Ensure that segment 1 fits snugly over the alignment block.
2. Locate bracket at the end of the cabling connected to segment 3. Secure bracket to face of segment 1.
3. Slide segment 2 into segment 1 with the pulley facing in the opposite direction of the pulley into segment 1. During the mounting process of segment 2 make sure that the cabling is aligned properly with the pulley on segment 1.
4. Secure the end of the cable into the winch and tighten set screw over the cable to lock into place.
5. Connect winch to battery and wind up excess cabling. Wind until cable is taught.
6. Disconnect winch from battery.
7. Locate bracket at the end of the cabling connected to segment 4. Secure bracket to face of segment 2 opposite the pulley.
8. Slide segment 3 into segment 2 with the pulley facing in the direction of the bracket mounted in step 2. During the mounting process of segment 3 make sure that the cabling is aligned properly with the pulley on segment 2.
9. Slide segment 4 into segment 3 with the face with the cabling attached facing in the direction of bracket mounted in step 7. During the mounting process of

segment 4 make sure that the cabling is aligned properly with the pulley on segment 3.

10. Attach both segments of pole saw to the extension pole on the top of segment 4.
11. Insert battery into electric saw.
12. Connect electric winch to battery.
13. Now the palm harvester is ready for operation.

7. Spare Parts

A set of major replacement parts are provided with the mechanism, in case there are any disruptions in operating the mechanism due to damage or low battery. Table 3 shows all the spare parts provided with the mechanism.

Table 3. List of spare parts provided with the mechanism

Part	Quantity
Super Start Deep Cycle Marine Battery	1
Black and Decker Pole Saw Battery	1
Buffer Strips	24
Never Flat Wheels	4
Ground (Black) Wire	1 spool (100 ft)
Positive (Red) Wire	1 spool (100 ft)
Pulleys	5
Steel Pulley Cables	1 (50 ft)

8. References

[1] "Palm-harvester." *Palm-harvester*. Web. 31 Mar. 2015. <<http://david1boswell.wix.com/palm-harvester#!deliverables/cubz>>.

[2] "Keeper Corporation KT2000 Trakker 1-horsepower Electric Winch - 2,000-Pound Capacity." *Amazon.com: : Automotive*. Web. 31 Mar. 2015. <<http://www.amazon.com/Keeper-Corporation-KT2000-1-horsepower-Electric/dp/B0017M8HPA>>.

[3] "Super Start Marine - Deep Cycle Battery." *Super Start Marine 31DCM*. Web. 31 Mar. 2015. <http://www.oreillyauto.com/site/c/detail/SSB2/31DCM/N0056.oap?ck=Search_N0056_-1_-1&pt=N0056&ppt=C1980>.

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