Parabolic Trough-Tracking System

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Team 14

Mid-Point Project Progress

Document

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Introduction

The parabolic trough tracking system was successfully tested and operated. The Mylar and trim were also successfully installed to the system. The team connected the motor assembly with the gear box assembly and they are now placed at the trough. The progress in fixing the tracking system is almost complete, the only progress left is to program a PLC to automatically move the trough throughout the day. A complete design of the energy extraction system was introduced, but the team might make a few changes in the piping system component of the energy extraction. The current focus will be on purchasing the required parts to build the energy extraction system. A small damage occurred to the corner to the trough caused by the rope that was holding it down for the time the motor and gearbox was not operable.

Parabolic Surface

The damaged parabolic surface have all been repaired. Mylar is covering the once damaged areas. The trim is installed around the edges of the parabolic trough. One of the problems we have with the parabolic surface, is the adhesive used in keeping the Mylar in place, is bleeding through the reflective surface. Mylar leftover will be used to cover these problematic areas. Adhesive being used to keep the Mylar in place the second time around will be switched for better results. Another dilemma the team encountered is the rope that secures the parabolic trough snapped. The outcome of this is damage was done to the trimming. Once the snow has melted in the area around the trough, the missing parts will be located. When all the trim is accounted for, it will be reinstalled. The rope is no longer needed after the chain and gearbox were installed. The parabolic trough is now facing the solar shack at a downward angle due to complaints from the forestry building. This is good news for the team because the reflective parabolic surface is doing its job. The next task for the team is to determine the focal point on the parabolic surface.

Tracking Components

The most important milestone in the project so far has been to successfully install and operate the components needed to rotate the trough. This has been difficult due to the previous conditions of the trough as well as the lack of documentation for the previous components. Because of this, and through discussions and professional help, the team ordered a 1hp AC motor. The drive selected was an AC drive from Automation Direct, and a programmable PLC with a power inverter, also from Automation Direct. A control box will also be purchased to ensure the electrical components will be protected from various weather conditions.

Motor and Drive

The motor selected was a Marathon 1HP, 230V, three-phase AC motor. This will have the power and torque to turn the trough smoothly and efficiently. The next step to power the motor was to connect it to the drive. From Automation Direct, a GS2-21P0 230V drive was ordered. This, however, posed a problem for the team. Upon inspection of the solar shack, the 230V three-phase power supply needed could not be obtained without extra costs and time. To avoid this, a new drive was ordered. A GS2-11P0 drive was ordered, which has the same output needed to run the motor, but the input power is 120V single-phase, which is readily available in the solar shack.

Once the new drive arrived, the team went straight to connecting the two and testing motor function. The drive needed to be programmed to meet the specifications of the motor, which was a simple process and connections were made quickly. Shown in Figure 1 is the motor and drive wired together.

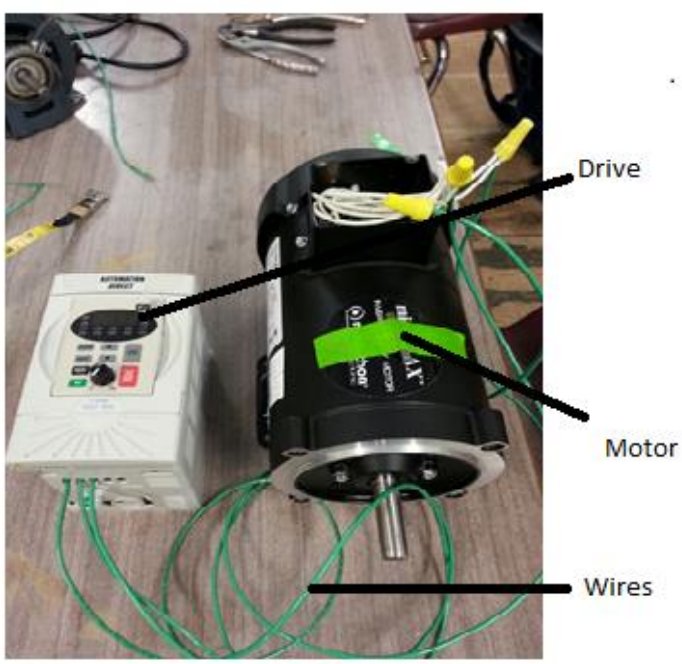
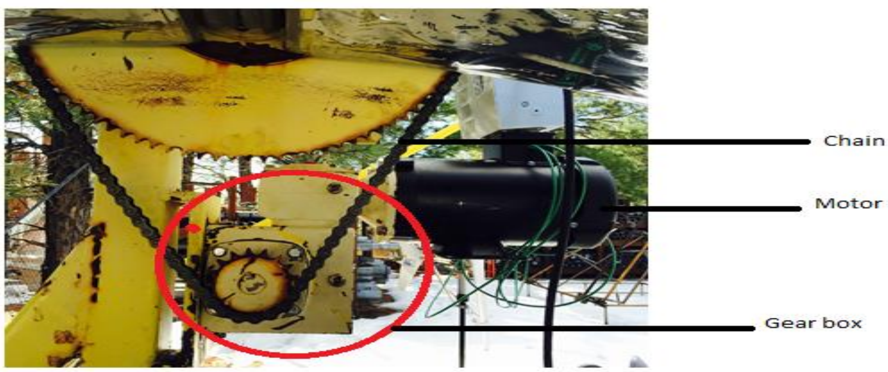


Figure 1- motor and drive wired together

Running the motor was then possible at this point. The motor was mounted to the frame of the trough and ran smoothly based on the parameters set. Once we knew the motor would run the way we wanted it to, all tracking components could be installed on the trough. The gear box, chain, motor, and drive were all installed and tested to make sure the entire trough would turn. Figures 2 and 3 show the entire tracking system installed together. The trough turned just the way we wanted it to, and the next step in the tracking system is to program the PLC so the motor will run based on a timer throughout the day to reflect the most sunlight.



Figures 2 and 3-Entire tracking system installed

Once final installations have been made, wires and electrical components will not be exposed to the environment, but rather enclosed, protected from the weather using a control box.

Programing

Using a Basic CLICK PLC from Automation Direct, the team will be able to control the drive and motor automatically to ensure the largest amount of sunlight is reflected towards the energy extraction system. Although the program included with the PLC is not something we have much experience with, but learning and progress is being made. Automation Direct has many helpful resources for their programming software, and so far a program to turn the drive on and off has been made. Next a timing program will have to be made, as well as a way to connect a thermocouple to the PLC and turn the entire system off once our energy extraction system reaches a certain temperature.

Control Box

To protect the drive, PLC, and power inverter from the elements, a control box will need to be purchased. Shown in Figure 4 is a schematic of each component and clearances required for each to determine the dimensions of the control box needed.

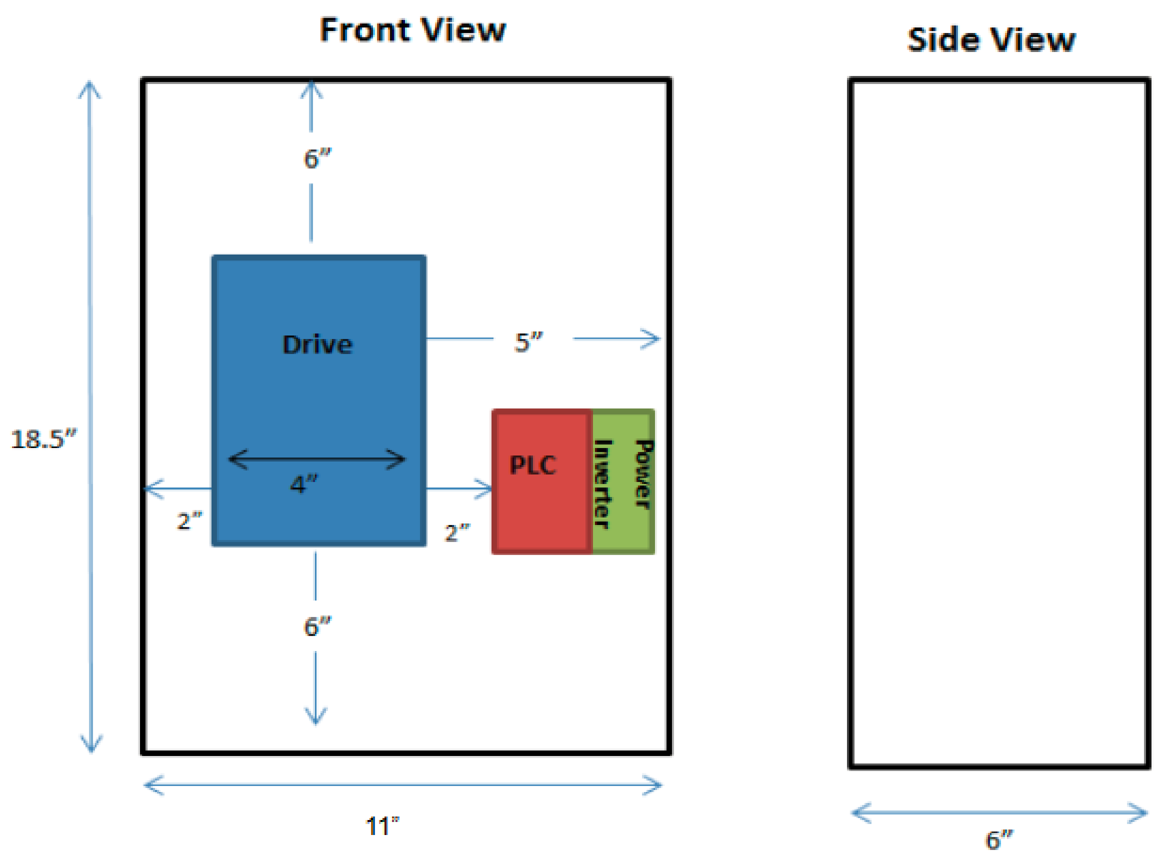


Figure 4-Control Box

Based on these dimensions, a 20" X 12" X 8" will suit the need for all components necessary to run the tracking system. From FactorMation.com, a box this size will cost $102 before shipping and handling.

Energy Extraction

The energy extraction system will be a closed system. We will be running water through a series of piping. The objective is to heat up this running water using the solar energy captured by the parabolic surface. The solar absorber will be placed at the focal point of the parabolic trough to absorb the most heat possible. The focal point will be decided by bouncing a laser pointer off the parabolic surface. A pump will be used to create a steady flow of water throughout the system. A water storage tank with an installed valve at the bottom of the tank will be used to store water. When the valve is open, water will flow into the pump, circulating through the system. Closing the valve will allow the water to build up in the tank, and this will be done after the water reaches a certain temperature. A piping thermocouple will be placed at the exit of the storage tank to show us the temperature of the water.

Design

Figure 5 below shows the schematic for the energy extraction system. The placement of the pump will be mounted on the frame underneath the motor/control box. The water tank will be mounted on the frame in a convenient location. The piping underneath the trough will be mounted to the underside of the parabolic surface. Flexible hoses will be needed to allow the system to rotate.

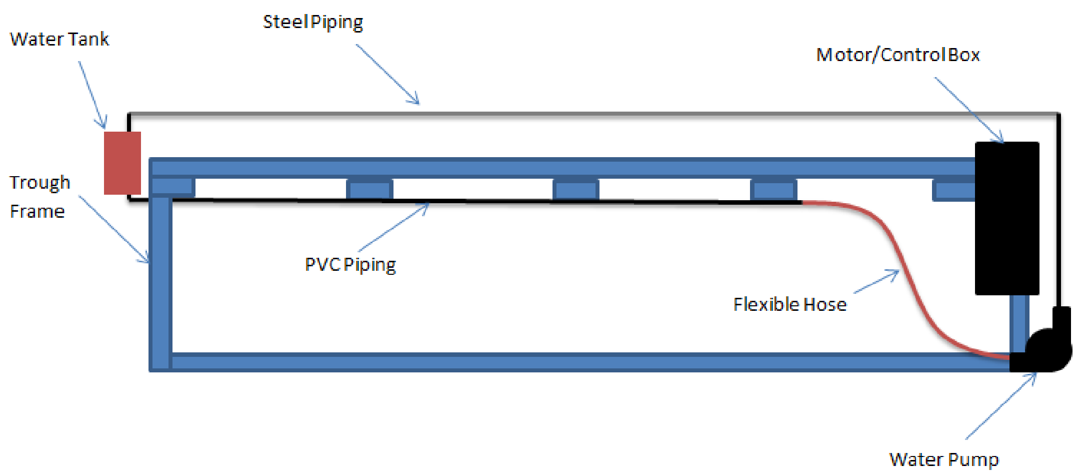


Figure 5-Solar extraction design

Materials

Most of the materials of the extraction system will be found at a local hardware store. For the solar absorber, EMT steel that will be painted black will be used. Calculations will need to be done still for deciding upon a storage tank. The piping mounted to the underside of the trough will be a cheap galvanized steel tubing from the hardware store. Temperature resistant flexible hoses will be needed in this design. At the 90 degree angles in the schematic, a temperature resistant flexible hose would be the ideal choice to maximize the efficiency of the flow rate. Mounting brackets for the underside as well as the solar absorber are needed. A drill is already owned by a group member, however the correct drill bit may need to be purchased.

Conclusion

A complete tracking system of the parabolic trough was tested to check if the gear box, motor and control box would be able to operate together to rotate the parabolic trough. The test results were successful, and the trough is able to rotate in both clockwise and counterclockwise directions. The older 230V three-phase input power control box was replaced by a new single-phase, 120V input power control box, since the 230V power source was unattainable. The current control box only can turn the motor on and off. However, the team is working to provide a PLC programming system that will create new operating options to the system. The control box and motor both need covers to be supplied to protect them from the snow, rain and dust. An energy extraction system design was introduced to the client. However, there is still some concerns that was not approved by the client. One of those concerns was to make sure that the fixable hose is able to sustain the high temperature of running water inside it without breaking. Another concern is to decide where to locate steel pipes on the trough, since there is a huge gearbox that might cause spacing problems.

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Gantt Chart

The Gantt Chart shows the timeline of the tasks of the project. Although the project is in its early stages, a general timeline has been made for the total projected outcome. The generated Gantt Chart for Team 14 may be seen in figure 2. Because our team has not been able to fully assess the current conditions of the parabolic trough, only a general estimate of designing and building can be made at the moment. Once a full inspection is done, further revisions to the project plan/timeline will be made.

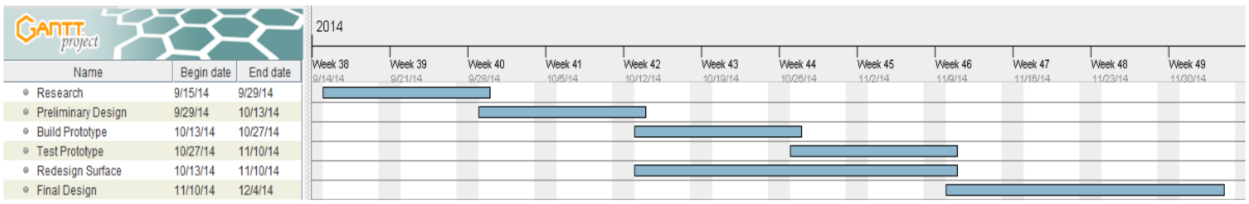

Figure6: Gantt Chart