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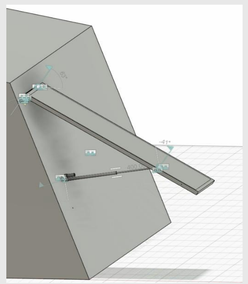
Sun tracker to optimize solar power

Introduction

(Figure.1)



(Figure.2)

Objective: Solve the problem of the low-efficiency of the still solar panel due to the altitude difference in different season in Nova Scotia.

Goals: Implement a solar panel tracking system with:

- Single axis mechanism system
- Control system
- Power system

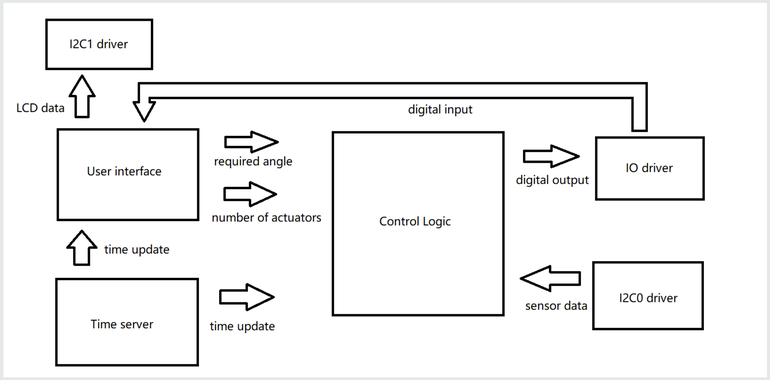
Deliverables:

Make the solar panel located on the side of the barn(Figure.1) move up and down with the sun in an optimal angle. The simulated motion is like Figure.2 shown

Design Process

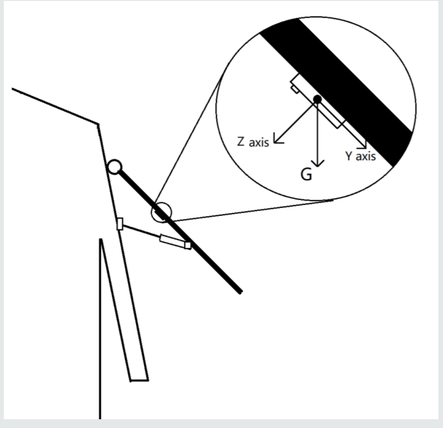
- Good conversation with client to find all the needs.
- Review the existed patterns and products.
- Brainstorm of what knowledge we have and how can we implement that.
- Distribute the task and estimate the time
- Figure out the physical characteristic and based on that choose the right lift component or system and the installation point
- Draw the physical structure and do simulation on software.
- Draw the structure of the control system, based on the system requirement and choose the desired microcontroller.
- Estimate the cost of the whole system and make a budget summary
- Build the physical structure for prototype
- Program the microcontroller and test the angle sensor
- Design and build the circuit of the power control system
- Do the integration test.

Details of Design



- In this project, a real-time control system is implemented. There are six active processes in the system. In order to control the actuator to move up and down, control process is going to send I/O command through I/O driver. Then the digital output will go through the motor driver to allow current flowing through the actuator motor to make it move. To enter a user command, the digital input from pressed buttons will be received by I/O driver and then forwarded to user interface process. The user interface process is responsible for handling user setting and display menu through I2C #1 bus which is connecting to LCD1602. There are four functions in user interface, time setting, target angle setting , number of actuator setting and solar panels retracting. The angle setting and time setting is going to be forwarded to control logic process where the decision will be made to adjust the solar panels. Every 10 minutes, the control unit is going to examine the angle of every solar panel to see if they are at target angle. If not, the control unit will try to adjust the specific solar panel by sending digital signal to I/O driver. The I2C #0 driver is designed to send angular sensor data to control unit so that the control unit will be aware of the angle on each solar panel.

- The sensor unit is an Inertia Measurement Unit.
- Model number MPU6050.
- It is mounted at the back of the solar panel for better resistance of weather factors.
- The sensor reads gravity from two direction to derive the angle of solar panel.
- Multiple sensors will share one I2C bus for transferring data to control unit.
- Digtal Low Pass Filter is used to eliminate noise
- Multiple range settings are tested



2g range & no DLPF	4g range & no DLPF	2g range & DLPF	4g range & DLPF
+/- 6 degrees	+/- 10 degrees	+/- 2 degrees	+/- 3 degrees

- Accuracy of the sensor

Conclusion and Recommendations

- Physical Frame: T shape
- Actuator: rod type
- Control Unit: we used a 32-bit Tiva microcontroller with time keeping function to determine the angle of the sun and communicate with the user interface as well as read the data from IMU
- We have succeeded integrating all parts into a whole, we have our microcontroller control the actuator through Motor Driver circuit, the microcontroller can perfectly make the actuator extend and retract. However, unfortunately because of COVID-19, we haven't gotten a chance to improve our control system on the frame. This results in a mediocre accuracy for our system. If more time can be provided, the system would be more complete and better performance can be achieved.
- There are a total of 4 accuracy tests

Trial #	Target angle	Actual angle
1	35	33
2	35	36
3	40	37
4	45	41

Things we can improve in the future:

- The accuracy of the sensor reading, which can be achieved by replacing an advanced sensor.
- The inertia of the moving solar panel, which can be achieved by improving software.
- The actuator can be replaced if it is unable to lock the solar panel in place caused the solar panel drop the angle due to gravity.

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