Solar Tracker

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Abstract

Solar tracker is a mini robot that aims to maximize the power production of a solar panel. The robot was developed as prototype to evaluate the idea of rotating a solar panel to track the sun so that it maximizes power production. The robot was developed using the Lego EV3 robot kit, and was successfully tested in the laboratory as well as in open space.

Introduction

Solar trackers are devices used to orient photovoltaic panels, reflectors, lenses or other optical devices toward the sun. As stated in [1], “The generation capability of a photo voltaic power plant is largely dependent on the intensity of the sun radiation. On the other hand, the changing of position causes the sun to have a variable shining intensity in different seasons and different times of the year; therefore, some of the solar power plants possess solar tacking systems.”

Tiberiu Tudorache in [2] proposes the design of a single axis solar tracker system that automatically searches the optimum panel position with respect to the sun.

Solar tracker is a simple implementation of a single axis solar tracking system based on EV3 robot parts that receives input signals from a light intensity sensor and rotates the panel to its optimal position.

Robot Construction

The robot (Img.1) was constructed using Lego EV3 brick and several lego parts and sensors. It is a lightweight robot that intents to maximize the power production of a small solar panel.

The robot consists of:

a) the Lego EV3 brick,
b) two servomotors,
c) a color-light sensor,
d) a solar panel and
e) a number of Lego bricks and cables.

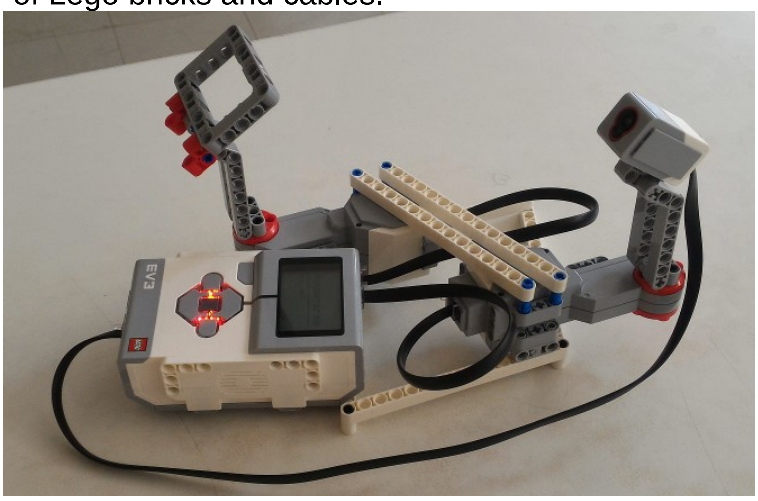

Image1, Starting the robot. Both the light sensor and panel base should face the same direction. The two motor Axis are parallel to each other.

The rotation axis of the two servomotors are parallel to each other. On the top of the first axis a light sensor is attached, while on the top of the second motor axis a solar panel is attached. The two motors can rotate independently and direct the light sensor or the solar panel to any angle between 0-360 degrees.

Robot Software

Solar tracker robot software was developed using the “Lego Mindstorms EV3 education development kit”®.

The algorithm uses two nested loops. Initially measured rotations of the motors are set to zero. Then the main (outer) loop begins setting maximum light intensity (*Fmax*) to zero (the light sensor returns values between in[0,100]) and the angle maximum intensity was measured (*maxAngle*) to 0 degrees.

The internal loop uses a step of 5 degrees to perform a full rotation, 360 degrees, of the light sensor. For each step light intensity is measured and compared to the maximum intensity measured so far. When the measured intensity is higher than *Fmax* the *Fmax* value is updated to the new higher intensity and *maxAngle* is set to the angle of the motor the light sensor is attached.

When the inner loop ends *Fmax* variable holds the higher light intensity measurement while maxAngle the angle this intensity was measured. Subtracting *maxAngle* from the current angle of the solar panel motor, results the degrees the motor should rotate to “look” at the maximum light intensity.

The light sensor motor rotates back to zero degrees so that the cable does not twist around the motor axis, and the panel motor rotates to the *maxAngle*. The outer loop repeats infinitely so that the panel adjusts its angle continuously.

Iimage 3 presents the flow chart of the robot algorithm

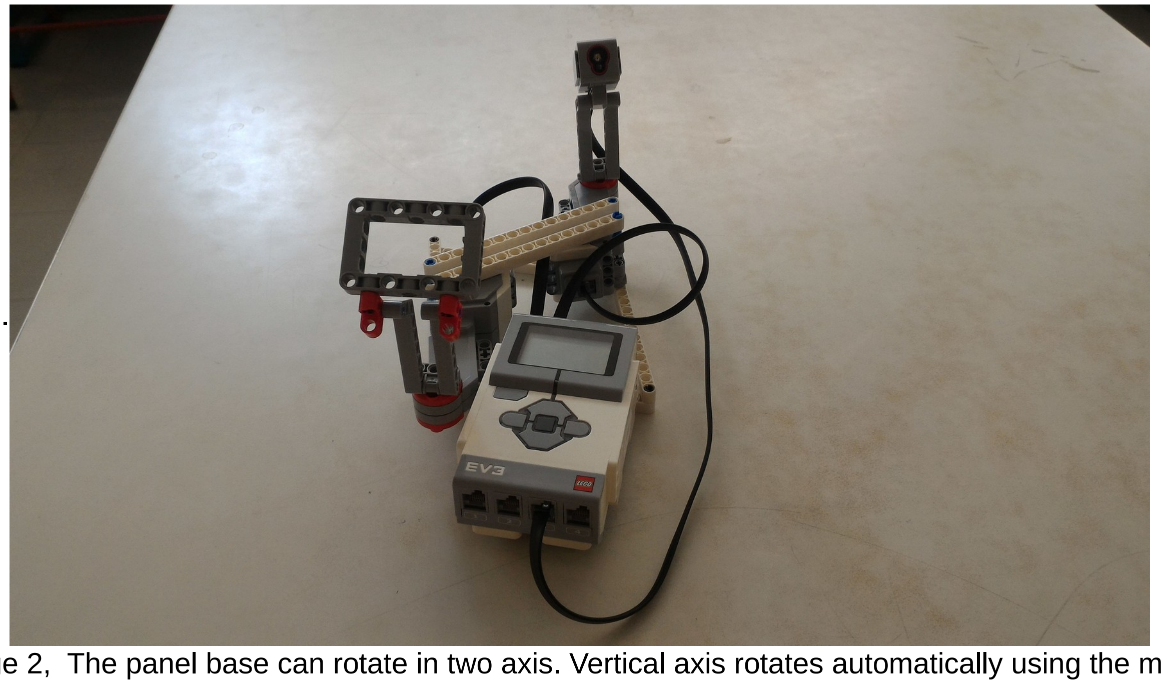

Image 2, The panel base can rotate in two axis. Vertical axis rotates automatically using the motor and Horizontal axis may rotate manually so that different panels can be attached

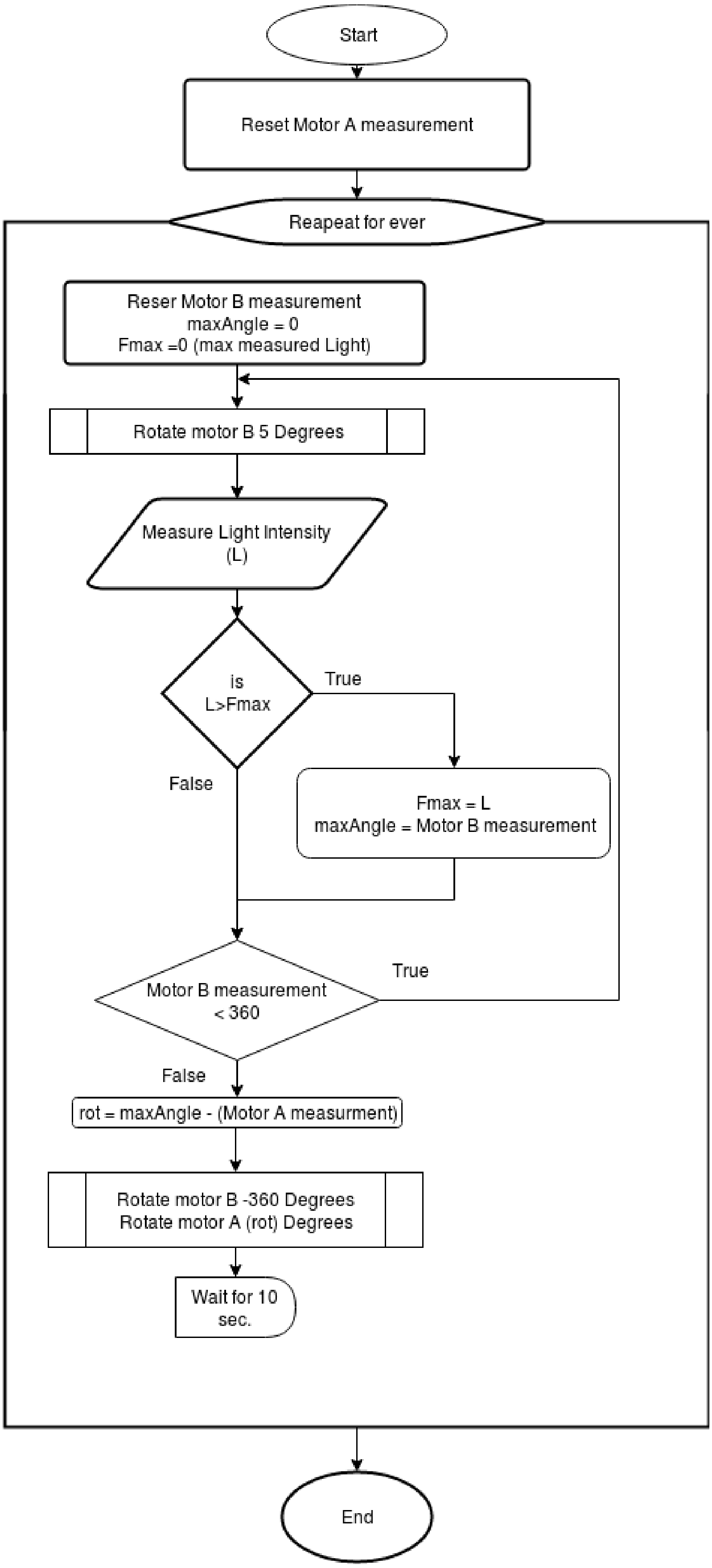

Image 3. Flow Chart of the robot program.
(Motor A,B measurement are the degrees of rotation measured for motors A and B respectively by the robot. Reset Motor A, B sets the measurement of the motor to 0 without rotating the motor.)

Robot Testing

Two tests were performed to evaluate the robot. The first test was performed in the laboratory and the robot task was to track an electric powered light. The second test was performed in open space in a sunny day under real conditions. Both tests showed that the panel was approximately turning to the expected angle. A voltmeter was connected to the solar panel and output voltage was measured. Both tests showed an increased voltage measurement.

Other uses – Future work

Other possible uses of a solar tracking robots could be to adjust solar panels for water heating, or to rotate a sade to maximize the shadowed area.
Our plans for next year is to improve the solar tracker from a single axis tracking to a two axis tracking system and probably to integrate it with stronger motors so that it can drive a medium size solar panel.

Acknowledgments

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References

[1] Shahriar Bazyari, Reza Keypour, Shahrokh Farhangi, Amir Ghaedi, Khashayar Bazyari "A Study on the Effects of Solar Tracking Systems on the Performance of Photovoltaic Power Plants", Journal of Power and Energy Engineering, 2014, 2, 718-728

[2] Tiberiu Tudorache, Liviu Kreindler "Design of a Solar Tracker System for PV Power Plants", Acta Polytechnica Hungarica, Vol. 7, No. 1, 2010