EGR 302 – Engineering Design and Documentation – Research Summary

The rotating light wand (RLW) will spin with the light wand perpendicular to the ground. Thus the rotating arm connecting the motor shaft to the light wand will spin parallel to the ground. There will be two separate electrical control systems each with their own power source. It will have a microcontroller to determine the logic for calculating angular velocity of the light wand, changing the lights with the input of angular velocity, and other input from sensors. The other system would be the main battery, controls for the motor to change speed, and the motor itself.

With the RLW it is important to know what the angular velocity is so that the system can get the correct timing for changing the LED band of lights on the wand. A single infrared LED and corresponding sensor would be effective to calculate the angular velocity. It is important to keep in potential frequency interference from sun light. To deal with that, have the infrared sensor be placed on the bottom of the rotating arm pointed straight down. On the RLW base have the infrared LED pointed up. There could be a second infrared LED placed next to it if necessary to get the sensor and LED to line up with each rotation. The sensor would be connected to a microcontroller to record each time the rotating arm crosses over the LED. With the radius physically set and programmed as a constant value, and measured time between each indication you can write a simple program to calculate the speed. With the RLW it is ideal to have a constant speed, any slight changes in speed could mess up the image. The program would be versatile enough to take in more data with each rotation and make adjustments accordingly.

One infrared LED should be enough but putting more around the whole base would create more and shorter time intervals to calculate the speed. This would allow for more accurate speed readings cutting down in time delays for error correction. Essentially if the speed changes part way through a rotation the system would not have to wait for a full rotation to know to make an adjustment. The extra monetary cost and programming time would not be that much more. Just need to make sure that they are spaced and isolated well enough so that there is no interference with one next to another.

With the RLW there is a safety concern with someone’s hand or object getting in the way of the rotating wand causing harm. Another issue is it falling over and the RLW system would not know it and keep the motor running. To deal with this issue you would need a pressure sensor to detect when contact has been made, and cut the power to the motor. You can use a piezoresistive force sensor that changes its resistance based on the amount of pressure applied. The sensor itself is thin and can be applied the leading rotating edge of the wand. It is also sensitive enough to detect someone standing nearby. Not sure how effective that feature is considering that it is going to be constantly rotating. That sensor goes for around $20. A much cheaper pressure sensor can be made using a strip of aluminum cover by paper. Not sure how effective that would work. Need to do more research on that.

When picking the motor the things to consider are the speed, torque, size, precision, and environment. For the RLW the ideal speed is going to be fixed, so factor that deal with changes in velocity are not a factor. The torque needed to rotate the arm, light wand, and counter weight should not be big enough that this is a factor. It is going to have to be small and light enough for the average person to carry. Since we want the RLW to run at a constant speed, precision is going to be an important factor. The RLW is going to be built to run outdoors where it is not raining.

Since the RLW is going to be running off a battery which will supply DC power it would be more effective and cost efficient to use a DC motor. The two most common are compound wound and permanent magnet. The primary advantages of DC motors are the speed variation and torque which explained earlier is not a factor for design the RLW. The motors can maintain a constant torque over a wide range in the speed. To control the speed of a DC motor you would just need a potentiometer that can handle the amount of power going through the system. The potentiometer would allow you to adjust the amount of voltage that will travel from the battery to the motor, which is directly proportional to the speed of the motor. It is important that once a speed is set that the motor will consistently rotate at that speed. The software if written well enough can have feedback loops to compensate for slight changes in the rotating arm speed. If energy usage time is a problem we can use a pulse width modulator (PWM) to generate the same speed but use less energy.

For the RLW the biggest benefit to using an AC motor over a DC motor is that it is preferred for fixed speed applications. What would hold back from being used is that you would need to get a DC to AC signal converter. There will be energy lost in the conversion making the whole system less efficient. It would also require a higher voltage to run which means a bigger battery or shorter run time. The controller would have to be more than just a potentiometer which would means it would be more expensive. So using an AC motor would be more expensive and less energy efficient but it would be able to provide a more consistent fixed speed.

The DC motor seems like the better chose in terms of cost, complexity, and efficiency. If not being able to maintain a consistent speed is a big enough factor, then the software can compensate for the control algorithm can compensate to get the correct timing. The program would have to written so that it is making adjustments with each rotation of the rotating arm. It would need a feedback loop to constantly be checking what the speed is with each rotation.