Abstract

Keywords

Introduction

The “Android Enabled Programmable Camera Positioning System” student challenge from the Air Force Research Lab has two principle components: an android phone that controls the system and the motors that drive positioning. MSU’s ECE 480 Team 3 decided to use DC motors so the same power-supply that is used to drive the motors could also be used to power the phone and any circuitry/logic necessary to interface the system’s components. This decision reduced the list of possible motor choices to mainly two options: servo-motors and stepper-motors. Furthermore, the system needs to position a 30 lb. camera & optic. The motors will need to provide torque in the range of 70 N*cm to 350 N*cm depending on how the output of the motors are geared. Due to cost, only simple, cheap spur and bevel gears are to be used to gear the output of the motors. This limits gearing to about 5:1 if we are to keep gears at about 6 in. in diameter; equal to the height of the camera.

A stepper motor is a brushless DC motor that can reliably and consistently divide a full rotation into a large number of steps; each step representing a polar movement by some angular amount. For example: a 100 step stepper motor will rotate 3.6° per step. These motors are controlled precisely without any feedback mechanism and can produce high amounts of torque, both operational and holding torque. The motor essentially has 3 to 4 low resistance (< 5 Ω) windings around the drive axel that are separate from each other. Rotation is controlled by manipulating how and when these windings are energized. Thus these motors require external driving circuitry to correctly control the windings and produce “steps” from a square wave signal. Also, due to its design, these motors are constantly on during operation, even when they are simply holding a position.

Servo motors (see figure 1) are servo mechanisms consisting of: a small DC motor and housing (1), position feedback control and position input circuitry (2), gearing mechanism (3) and an actuator arm (4). The feedback signal is generally accomplished by having a potentiometer located within the gearing mechanism. This signal serves for error-correction to help control the position of the actuator arm. Because of this feedback scheme, servo motors generally have a limited range of motion (often 180° for the sizes applicable to our project). Continuous rotation servos that use a different feed-back mechanism/circuitry are available, but at a premium in price. Servo motors also provide little torque vs. cost as the small DC motor is geared up significantly in operation. Thus the torque from a servo motor is heavily gear-based torque and not actual torque from the DC motor housed inside it. This reduces its holding strength and makes its holding capabilities dependent on its feedback circuitry.

Hardware / software

Figure 1 – Servo Motor
Courtesy: HiTec RC Servos
Steps

Study

Results conclusions
We chose stepper motors due to their large torque capacity, precision and reliability even though they consume a lot of power by being constantly on and require external driving circuitry. The gearing nature of servo-motors provides very little holding torque, a large problem when the system requires a 30 lb. camera to be securely positioned. The price of servo-motors was another reason stepper motors were more favorable. To achieve the necessary torque, a servo motor with plastic gears would have cost us more than twice the price of an all metal stepper-motor and driving circuit. Still, we had to figure out how stepper motors work before we were able to make this decision.

References
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