Spoon

Parkinson’s disease is a neurological movement disorder. Common symptoms include tremor, slowness of movement, stiff muscle, unsteady walk and balance coordination problem. The aim of this project is to make a stabilizing spoon that will compensate for unintended motions, such as tremors and people who are difficulties moving their hands. With a low budget, the goal is to make a highly efficient prototype that consists mainly of a microcontroller and servo motors. The spoon is intended to have two degrees of freedom, rotational movement around x- axis (roll) and yaxis(pitch).

A stabilizing spoon is a device which maintains a horizontal position of its front regardless of the motion it receive from the user at the rear end of the spoon. If the handle of the spoon is tilting an angle with a degree, actuators in the spoon’s construction will compensate with the same angle and put the spoon and bowl in its initial horizontal position.

The electronic parts of construction consist of an Arduino nano, 2 servo motors, and the IMU MPU 6050. The input to the system was the angles received from the MPU6050 and the output was the angles of the servos.

The software for the construction was programmed in Arduino IDE. The program is divided into four parts; the angle reading and data collection, the Kalman filter, the PID-controller and the motor controller.

***Kalman Filter***

An Inertial Measurement Unit (IMU) is a sensor consisting of three gyroscopes and three accelerometers, one for each coordinate axis. Combined they can detect angle changes. The angle readings from an IMU carries much noise. An IMU presents occasionally values that are incoherent and vary unreasonably to one another. To get proper values, clear values, a filter is needed. A Kalman filter is an optional recursive algorithm. The filter is useful when the information received from a dynamic system is unpredictable. Kalman filter is expected to be able to utilize accelerometer data to eliminate drift from the gyroscope output. In process, noise from the accelerometer will also be minimized and even eliminated.

***PID Controller***

The PID, proportional-integral-derivative, controller is a control function which applies corrections automatically given a feedback loop mechanism. With the steady-state error

e(t) = r(t) − y(t)

the input of the system u(t) can be calculated. r(t) is the desired value and y(t)

is the actual value. u(t) is calculated by the formula:

u(𝑡) = 𝐾𝑝𝑒(𝑡) + 𝐾𝑖 ∫ 𝑒(𝜏)𝑑𝜏 + 𝐾𝑑 𝑑/𝑑𝑡 𝑒(𝑡)

where KP, KI and KD are the tuning parameters for proportional, integral and derivative control respectively, and e(t) is the error between reference signal and output signal. The proportional part can compensate for disturbances but cannot eliminate their effect. The proportional part cannot eliminate the steady-state error. The integral part can eliminate the steady-state error but the system can be unstable for larger values of Kp and Ki. The derivative part grants improved stability overall.

The raw IMU data is pulled through the Kalman filter in order to obtain more stable signal, each filtered angle value is then compared to the reference value (set point), 90, followed by a PID controller. We made 90 degrees as center position because servo motor can’t move in negative direction. The direction of servo motor depends on the output signal from the PID controller the output signal is sent to the servo motor.A computer code with text

Description automatically generated