International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 6, Nov-Dec 2020

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Self-Stabilizing Platform

Kathiravan Sekar*, Ramarajan Thileeban**

*(Electronics and Communication Engineering Spec. in IoT and Sensors, Vellore institute of technology, Vellore)

** (Electronics and Communication Engineering, Vellore institute of technology, Vellore)

----------**********----------

Abstract:

The project uses PID and Kalman filter to obtain filtered values regarding the position of the accelerometer/gyroscope (MPU6050) as feedback which it then uses to remain in the calibrated position despite a displacement. Servo motors have been programmed to obey the microcontroller based on the feedback received from the gyroscope.

Keywords **—Kalman filter, Gyroscope, Displacement, Feedback, Stabilized Platform.**

----------**********----------

I. INTRODUCTION

A PID controller is an electronic device instrument utilized in industrial control applications to monitor temperature, flow, pressure, speed and different other process variables. PID controllers use a collision loop feedback mechanism to balance process variables and are the foremost accurate and well-balanced controller. PID control may be a well-established way of driving a system towards a target position or level. It is practically omnipresent as a way of controlling or monitoring temperature and finds application in various chemical and scientific processes also as automation. PID control uses closed-loop control feedback to stay the particular output from a function as on the brink of the target or point output as possible

In statistics and control theory, Kalman filtering is referred to as linear quadratic estimation, which is an algorithm that uses a sequence of measurements observed over time, containing statistical noise, other imprecision. It produces an estimation of unknown variables that tend to be more precise than those supported one measurement alone, by estimating a probability distribution over the variables for every timeframe. The Kalman filter is named after one of the first developers of its theory, Rudolf E. Kálmán. The Kalman filter has countless applications in technology. Kalman filters are also one among the most topics within the field of robotic motion planning and control.

II. BLOCK DIAGRAM

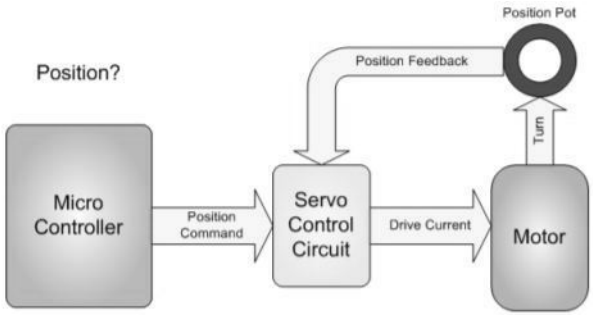

Fig 1.

The block diagram for the Feedback Servo motor is shown in Fig 1. A servo motor has very good accuracy in the position feedback, i.e. servo motor can tell you that how many degrees has the motor shaft has rotated. The potentiometer is connected to the output shaft and is proportional to the output shaft, every degree the output shaft rotated is counted

III. METHODOLOGY

Arduino Uno, Accelerometer + Gyroscope MPU6060, two servo motors and a platform which we needed to stabilized are needed to implement this project. The accelerometer gets the values of the orientation of the platform and with the assistance of the Arduino code of a PID controller and Kalman filter we see that the servo motors rotate such the platform remains at the stabilized level. IMU is an electronic device which is capable of measuring the force and speed of an object. Basically, it includes Accelerometer and a Gyroscope. Hence, an IMU doesn't calculate angles. Therefore IMU sometimes not directly, it requires some calculations so as to get the angles. The MPU-6050 is an IMU of 6DOF. This suggests that it's an accelerometer and a gyroscope, both of three axes (6 DOF). There are 9DOF IMUs; during this case, they also carry a magnetometer. Others may have 5DOF, during which case the gyroscope only measures two axes.

The operation Voltage of the "MPU-6050" is usually 3.3V, but some different models have regulators which allow it to connect upto 5V and it uses I2C communication protocol. The accelerometer is used to calculate the acceleration. The IMU present in it also monitors the acceleration of gravity. This IMU performs with 8 bits registers. Each of the acceleration value monitored is stored in two registers which are low and high bits. The sum of these two registers gives us 16 bits of data. Therefore the data will have two power times 16 value of acceleration value, including positive or negative sign when the IMU is perfectly aligned with any ground-level objects or floor. Then, as you see the Fig 2 below the Z axis will be g=9.8 and other two axis X and Y will be zero. When we rotate the IMU by 90 degrees, then the X-axis will be perpendicular to the floor, and thus it will have g=9.8

Fig 2

The value of the gravitational force is 9.8m/s^2, and to calculate the three axes of the accelerometer, we can calculate the angle of inclination. We can use the formula in below Fig 3, to calculate the angles.

$$AngleY = atan\left(\frac{X}{\sqrt{Y^2 + Z^2}}\right)$$

$$AngleX = atan\left(\frac{Y}{\sqrt{X^2 + Z^2}}\right)$$

Fig 3

As the angle is measured from gravity, we can not calculate the angle Z with the formula from Fig 3. So to find this another component we need a magnetometer which is a digital compass. The MPU-6050 does not have a magnetometer. The gyroscope is used for measuring the angular velocity, so if we know the initial angle of IMU, then the gyroscope will add the value to know the new angle at each moment.

$$AngleY = PreviousAngleY + GyroDataY \cdot elapsedTime$$

$$AngleX = PreviousAngleX + GyroDataX \cdot elapsedTime$$

Fig 4.

Our device passes which have the values obtained from the gyroscope then will pass through a Kalman Filter which analysis the info and normalizes it to offer an unruffled gradient of variation within the values of the gyroscope. This enables for adjustments to be made supported the feedback during a much smoother and error-free method. The gyroscope values are skilled a PID system which processes the feedback and provides output values which permit the servo motors to shift during a way that the reference position is maintained without error and with quick reaction time.

IV.HARDWARE MODULES

ARDUINO UNO

Arduino Uno is a microcontroller that has 14 Digital input/output pins and in that 6 of them can be used for Pulse Width modulation. This electronic device is base on ATmega38. The board can be powered by a Type B USB cable or any external battery. This UNO board is the first one to be released in a series of USB Arduino boards.

SERVO MOTOR

Servo motors are very high torque motors devices which are mostly utilized in robotics and a number of other applications thanks to the very fact that it is easy to regulate the rotation. Servo motor has a geared output shaft which may be electrically controlled to show one degree at a time. For the sake of control, unlike DC motors, servo motors have further pin asides the two power pins which is that the signal pin. The signal pin is employed to regulate the servo motor, turning its shaft to any desired angle

INERTIAL MEASUREMENT UNIT(IMU)

The IMU sensor is a device which can be used to calculate and reports a particular force of body, the angular rate also because of the direction of the body which it is rotating, which may be achieved by employing a number of sensors like Gyroscope, Magnetometer, and Accelerometer. These electronic sensors are normally used to plan aircraft including UAVs, between several others, & spacecraft, comprising landers and satellites. Recent developments permit the manufacture of IMU-based GPS devices to function in an area where GPS signals are not available like tunnels or inside buildings. An IMU sensor unit working is often done by noticing linear acceleration with the assistance of 1 or additional accelerometers & rotational rate is often detected by using one or additional gyroscopes. Some also contain a magnetometer which may be used as a heading reference. This sensor includes some usual configurations which include gyro, accelerometer, and magnetometer for every axis used for each of the 3-vehicle axes like roll, yaw, and pitch.

V.APPLICATION

In these modern days, the technology to assist the people who are physically challenged has been improved significantly. This project with today's technology can help people who are suffering from Parkinson disease, which is a disorder that leads to hands shaking and has some difficulties with walking, so with the help of this self-stabilizing platform, it can reduce the shaking and help them to eat, draw or write. It can be also be used in several stabilization application like camera stabilization in any moving platform. Moreover, it can be used in boats, vehicles and ships to develop an automatic motion sickness seats and can be used to make earthquake protection building

VICONCLUSIONS

We have concluded from this project that we can stabilize a platform using basic components and a smart implementation of statistical models. We got the inspiration for this project after seeing that, there are many people suffering from tremors, and this is highly problematic for people as they cannot hold anything stable in their hand. To solve these many people have researched on it but all the solutions which came forth were that of high expense, and they weren't feasible for the layman. So we used cheap components in net worth around Rs. 1500 and built a self-stabilizing platform which was much cheaper than any product in the country

REFERENCES

[1] Tiimus K and Tamre M, "Camera Gimbal "Control System for Unmanned Platforms", 7th International DAAAM Baltic Conference "INDUSTRIAL ENGINEERING", Tallinn,Estonia, 22-24 April 2010.

[2] Ole C. Jakobsen and Eric N.Johnson, "Control Architecture for a UAVMounted Pan/Tilt/Roll Camera Gimbal", InfoTechAerospace,Arlington, Virginia,26 - 29 September 2005.

[3] P. Dietz, W. Yerazunis, D. Leigh, Very Low-Cost Sensing and Communication Using Bidirectional LEDs, UbiComp 2003: Proceedings, vol. 2864, pp. 175-191, 2003.

[4] Raghavendra.R, Dr S.A Hariprasad ―Implementation of Flash ADC using Multisim Technology, International Journal of Computer Trends and Technology (IJCTT) – volume 4 Issue 6 June 2013 pp 18251830 ,2013.

[5] Vladimir Popelka A self stabilizingplatform 2014 15th International Carpathian Control Conference 10.1109/CarpathianCC.2014.6843648

[6] Ramsey Faragher Understanding the Basis of the Kalman Filter Via a Simple and Intuitive Derivation IEEE Signal Processing Magazine 29(5):128-132 DOI: 10.1109/MSP.2012.

