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Implementation of Two Axis Gimble using Arduino

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Abstract

Nowadays everyone is trying to record the moment everywhere and wants it to be perfect. Beyond resolution, stabilized shots inspite of the external conditions are expected. The gimbal system ensures a smooth video by damping shakes. Because of Gimbal, perfect images can be achieved by minimizing the vibrations while jogging, climbing or coming down stairs, cycling, or using any kind of vehicle. It is envisaged that gimbal stabilization system will be needed in many scientific studies in the following periods. In case of three axis gimble, three separate servo motors are mounted on each axis for damping shakes. The gimbal is also equipped with an inertial measurement unit consisting of a gyroscope and accelerometer close to the camera mount point. Controlling is done by PID controller which are simulated by using Arduino IDE. Here the proposed system is two axis gimble using Arduino.

Keywords—*Brushless DC motor, IMU sensor, Camera gimbal, gimbal stabilization.*

I. INTRODUCTION

Active stabilization has been around for a very long time especially in the film industry where the application has been used to stabilize video footage. Today camera stabilization has been made easily accessible for new aspiring filmmakers and regular people so that anyone can simply attach their smart phone (that has a camera) on a three-axis gimbal and get smooth video footage relatively cheap. It damps 80-90% of the vibration. It is based on accelerometer and gyroscope feedback, Gimbal is the system used to prevent the shaking, There are two or three motors on the systems called as actuators and they aim to prevent to eliminate vibration. The basic logic of this system which can minimize the vibration in video recording devices is to create a reverse motion in the opposite direction of the vibration. This reverse motion is provided by the Inertial Measuring Unit (IMU)Sensor which is placed on the camera. The IMU Sensor detects the camera movements and reports motion to three brushless servo motors positioned in line with the camera lens. The sensor detects the relative position of the camera according to the ground. Based on the predetermined optimum position, it is detected how much the optimum position defined in each movement of the camera deteriorates. The main aim is to protect this optimum position. The information received from the sensor is processed on the electronic board and transmitted as a command to the brushless servo motors, which provide smooth motion. Thus, the brushless servo motor that produces the opposite movement of the camera allows to obtain a smooth image.

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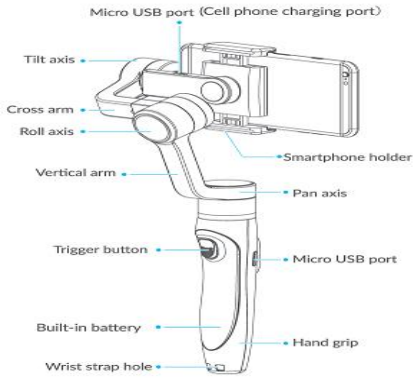

Figure 1. Gimble Structure

II. LITERATURE SURVEY

In This Paper [1], the 3-axis gimbal consists of three revolute joints and it has yaw-roll-pitch axis representation. Here θ_1, θ_2, θ_3 represent yaw-roll-pitch angles. The schematic diagram of gimbal kinematics with 3 revolute joints, gimbal frame and that helped us to construct the gimbal frame. Which is the body of the project, Gimbal is a rigid body which uses motors to stabilise itself.

In this paper [2], project is based on PID and it continuously calculates the error value as the difference between the desired value and the measured process variable. The controller tries to minimize the error over time. such as power fed to a control valve. Transfer function of PID controller: KP: proportional gain, Ki: integral gain, Kd: derivative gain. the proportional gain (Kp) reduces the rise time and the steady-state error (but never removes it). The integral gain (Ki) removes the steady-state error but can worsen the transient response. Derivative gain (Kd) increases the stability of the system, reduces overshoot and improves the transient response.

In this Paper [3], the advanced control theory for 3-axis movements with a microcontroller is explained. Arduino UNO is used for this experiment and to design a motor driving control logic for 3 axis movement. And the filtering of unwanted signals is executed in the Arduino. An inertial measurement unit (motion sensor) (IMU) sensor block is drawn to circuit only with gravitational force function of it only to sense the inappropriate alignment of the hardware circuit and give the error feedback to the Arduino so the servo system can maintain the axes as per requirement
In this Paper [4], finished version of the gimbal two out of the three axes is presented. The third axis which is the yaw axis in this case was not implemented . The reason behind this is that the magnetometer which was initially planned to be used to calculate the yaw was working on a testing breadboard. However, when the sensor was mounted on the gimbal we discovered a lot of random values and very unreliable readings yielding this method of calculating yaw non-functioning on our prototype.
In this Paper [5], The calculated model of a 3-axis motion simulator is developed, then linearized using Taylor series expansion in this paper. Subsequently, a linear quadratic regulator control law is developed to minimize both tracking error and control effort. The simulation results have verified the correctness and accuracy of the proposed control law despite the presence of unknown bounded disturbances and atmospheric turbulence.

In this Paper [6], two axes gimbal system was proposed and formulated utilizing Newton's second law. The construction of the stabilization loop was introduced and the concepts of cross-coupling and dynamic unbalance were accomplished. The equations for the gimbals' motion were derived and introduced in two formulations according to the dynamic mass unbalance.

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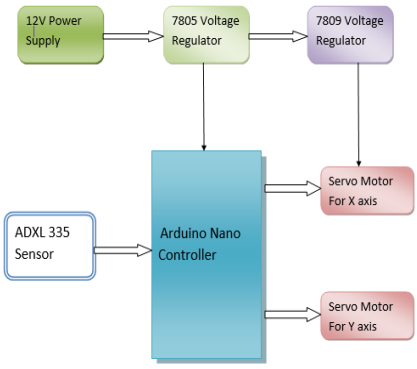

Figure 2. : Block Diagram

III. HARDWARE DESCRIPTION

A. Arduino Nano

The camera gimbal frame consist of Arduino Nano microcontroller is based on Atmega328p. ATmega328P Microcontroller is from 8-bit AVR family. It's Operating voltage is 5V and Input voltage (Vin) is 7V to 12V. It is same as Arduino Uno but only difference is that the Arduino nano is smaller in size that of Arduino UNO.

B. ADXL 335 Sensor

The ADXL335 sensor gives complete 3-axis acceleration measurement. The output signals of this module are analog voltages that are proportional to the acceleration. It contains a polysilicon surface-micro machined sensor and signal conditioning circuitry. ADXL335 accelerometer provides analog voltage at the output X, Y, Z pins, which is proportional to the acceleration in respective directions that is X, Y, Z.

C. Servo Motors

Two servo motor is an actuator that allows for accurate control of angular and linear position. It consists of a suitable motor coupled to a sensor for the feedback. It rotates in angles.

IV. SOFTWARE DESCRIPTION

ARDUINO

The Arduino Integrated Development Environment (IDE) is an application used in Windows, MacOS, Linux that is related to C++. It is used to write programs to boards which are Arduino compatible. It is the place where a coder can type up you his code before uploading it to the board he want.. Essentially, the IDE translates and compiles your sketches into code that Arduino can understand. Arduino is a great tool for developing interactive objects, taking inputs from a variety of sensors and motors and other outputs. Arduino projects can be used for stand-alone projects

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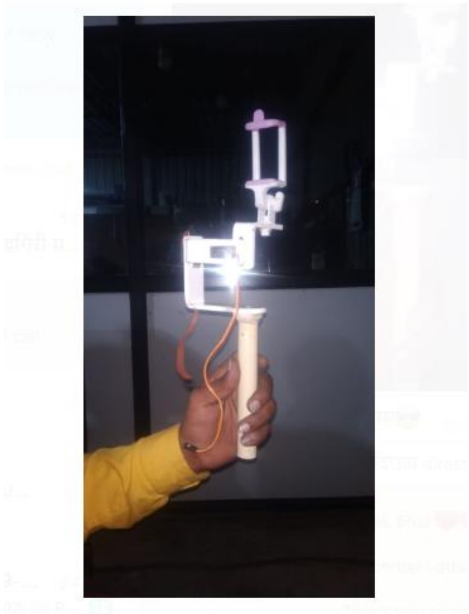
V.IMPLEMENTATION DESIGN

In this project, to start with ,only two servo motors are used and have implemented two axes correctly, a gimbal is supposed to have three axes, which are yaw, pitch and roll. But in this paper successfully implementation of yaw and pitch into the gimbal frame is discussed.
The algorithm of the code is given below
1. Start
2. Initialize ADXL335
3. Rotate both servo motors on its default position i.e 90°
4. Measure ADXL335 Results & save in temp. variable
5. If Result is greater than or equal to temp. variable then Rotate servo motor clockwise
6. Else Rotate servo motor anticlockwise
7. Stop



VI.CONCLUSION

The basic elements of the gimbal system are introduced in this paper. A simple Two axis gimble is developed with the help of Arduino, Servo motors are used in the system as motion providers. Step motor or servo motor may be preferred instead of brushless servo motor for more cost cut. The error signal is detected by using the IMU sensor received from the sensor. This system can be further developed to Three axis Gimble with BLDC motors for more accuracy.

VII. FUTURE SCOPE

Three axis gimble can be developed for three axes yaw ,pitch and Roll.This work can be further improved for industrial and profession use, use of brushless DC motors can be done for smoother movement of the gimbal arms. For profession use, more heavy quality Motors can be used for better quality camera to fit in the gimbal. Also a joystick can be added to the gimbal to have the freedom of positioning the camera. In the future, gimbals can be attached to drones for Ariel shoots, police surveillance, and military surveillance. This will provide more smoother and stable videos.

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