Gyro-Stabilized Camera Control in drones for Military Applications

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Abstract. The usage of drones or unmanned aerial vehicle in military applications is increasing. The input or the control of drones is becoming a challenging task for the developers. One of the input recognition methods is the gesture recognition. Pilot’s head movement using a gyroscope is used to control the angle of an on-board FPV (First Person Video) Camera. MPU 6050 Sensor collects the displaced values from three axis and sent it as an input for the processor which reads the possible values. The values are then compared and processed and given to the output. The output is controlled by servomotor which actuates mechanical moves based on MPU sensor. This whole setup can be connected through wireless RC (Radio Controller) transmitter and receiver. This motion controlled mechanical arms can be used for various applications like FPV (First Person View) in drone enabled surveillances, Military, Search and Rescue etc.

1. Introduction
As we know many recognition methods are used for human computer interaction. Vision recognition, Speech recognition, gesture recognition, Movement recognition are the commonly used recognition methods used in latest technology. These recognition methods have grown to a tremendous level due to rapid development of hardware and software. This gesture recognition has got a good attention recently. There are two types of gestures. In static gestures the posture of the body or hand denotes a sign whereas the dynamic gestures the movement of the body or hand conveys some message. The main advantages of the gesture recognition are accurate, high stability and time saving. Gesture recognition are commonly used in mobile phones unlocking, Domestic and Industrial automation, Automobiles, Security services, Transportation services and Robots design.

2. Drones
A Drone is commonly an Air supervisor without a human on board. It is commonly called as an unmanned aerial vehicle. It look like an aircraft. The unmanned Aerial Vehicle system will have a ground based controller, a communication protocol and a UAV. The unmanned aerial vehicle can be operated in various angle of degrees by using a remote control. Either a human or computer programming can be used for operating the remote. A human can do manually whereas the automatic operation can be achieved by programming. When the missions are secret and dangerous, using a UAV will be best method when comparing to manned aircraft. The drones are not only used only for defense applications, it can be also used in surveillance, Agricultural (Spraying pesticides from air), Photography, transportation to human non access areas, forest fire controlling and domestic gaming purposes. UAVs work on the battery power and depending on the work the battery power can be increased. The battery selection is an important criterion because
the UAV’s have to carry the battery with them. Heavy batteries will decrease the UAV’s efficiency. UAVs operated using remote control is often called as Remotely Piloted vehicles (RPV). UAVs has major role in Target and decoy, combat, logistics, research and development, Civil, agriculture and aerial photography. The major components of the drone are Body platform, Battery, Computing components, Sensors, Actuators, software and a hardware software interface board. The use of drones is keep on increasing to reduce the risks to the humans.

3. Gyro-Stabilized Camera
A small shake or error in the image will be very large after amplification. Digital stabilization is possible after the image is taken but for large amplification images, digital stabilization is not practically possible. This can be overcome by the Gyro-stabilized camera systems which uses either Fiber optic gyroscope or MEMS (Micro Electro Mechanical systems to track any movement in the camera base.[10] If the gyroscope detects any movement, it gives an input to the processor and the camera will be tilted in the counter opposite direction to avoid the fall. The main applications of these gyroscope stabilized camera are mobile phones to play games, marine, vehicle and mast tower. The recent advancement provides a maximum zoom ability of the camera and the sensitivity is increased to improve accuracy.

4. Literature Survey
A various control algorithms are available for the stabilization of the drones. The commonly used algorithms are PID, Linear Quadratic Regulator (LQR), Sliding mode, Back stepping, Feedback linearization, Adaptive, Robust, Optimal, L1, H∞, Fuzzy logic and Artificial neutral networks. Each algorithm has its own advantages and disadvantages. After the comparison of many algorithms, the author confirmed PID control algorithm as the best one in terms of accuracy and analysis. [1] The usage of unmanned aerial vehicle is common in military applications. When the history is analyzed, the role of UAV in the military applications is more. The author studied the history of drones and presented a detailed report on the usage. [2] The main applications of MPU6050 sensor is the detection of signals from the gestures. The angles of the drones are calculated and the position is balanced. The response from the sensor is fed to the processor for further calculations and analysis. [3] Kui Liu in “Dual-sensor approaches for Real time robust hand gesture recognition” proposed two effective methods. In the first method, Images from a left and right stereo cameras setup are merged to form a pair. The second method actively uses the Kinect depth camera and a inertial sensor to find the acceleration and angular velocity within the framework of a hidden Markov model [4].

5. Problem Identification

5.1. Existing Model
For running drones and to control the cameras fixed Joystick and the potentiometers are needed. These potentiometers controls camera only when the measurement is fed into it manually. The other existing model involves a handheld device either wired or wireless called Teach Pendant. The existing systems is not providing an accurate results.[7]

5.2. Problem Identification
In existing model for controlling the drone and the camera attached to it, two persons are needed. Since it is controlled using joystick and potentiometers it is not time efficient and accuracy is the major disadvantage. For turning the camera to a particular angle, the angle’s information should be fed to the potentiometer independently. As the observation from the later, this increases the complexity and reduces the efficiency of the system.

6. Proposed Methodology
The proposed methodology and the block diagram is given in figure 1. Here the gestures are sensed by the sensor and it is fed to the Arduino Nano. The processor will give commands according to the gestures signal received to the drones. Here the drones and the cameras are completely controlled by the processor. The drone flies according to the PWM signals received.
The conventional transmitter and receiver is communicated via Arduino. The wearable is packed with two sensors (Accelerometer and gyro sensor) commonly known as MPMU 6050 sensors (gyroscope). Gyroscope is used for measuring or maintaining orientation and angular velocity of the camera. The other concept deals with the hand gesture which helps to turn the camera to the desired direction. In the below block diagram, the Gyroscopic sensor can be attached to our wrist or head and then it can be used to operate a drone in real time. At first the drone is made to move and the camera starts recording. When the hand is moved to an angle, the sensor collects the displaced values from the three axes (X, Y and Z) and the collected value is fed to the Arduino Nano.

![Figure 1: Schematic block of proposed system](image)

After the samples are processed in Arduino, it is fed to the transmitter. Since it is wireless communication the transmitter transmits the signal (i.e. Movement of the hand) to the receiver end. Once the receiver end receives the drone changes its direction according to the angle the hand is moved. Gun is attached to the drone and hence their movement is simultaneous since a gun cannot be used in the prototype instead of the gun laser light is used. The drone and the gun can be controlled by the same person. And the gun can be triggered in need. The sensor (gyroscopic) can be attached to our hand and then it is used to operate the drone in real time. When the hand is moved to a particular angle, the equivalent displaced places say (X, Y, and Z) is given to the sensor. The sensor calculates the angle from these displaced values and it is fed back to the transmitter which is used to operate the drone. When the sensor is moved, the camera and the gun present in the drone will also move to the direction. The videos can be recorded using the camera via an application called Plug and Play.

The respective angle of movement can also be calculated and a precise rotation of the drone can be done by programming. The working module can be made automatic by defining the angle of displacement of the drones. Making automatic by writing codes will give a precise and accurate working model. Getting angles of displacement can be done by using codes in Arduino. getAngleX, getAngleY, getAngleZ are the program snippets for finding the angle of displacement. The values corresponding to the angle of deflection is listed in Table 1.

| angleX  | angleY  | angleZ  |
|--------|--------|--------|
| -18.17 | -21.29 | 1.64   |
| -18.17 | -21.27 | 1.63   |
| -18.16 | -21.30 | 1.63   |
| -18.15 | -21.32 | 1.64   |
| -18.16 | -21.28 | 1.65   |
| -18.17 | -21.27 | 1.65   |
7. Interference and Analysis

7.1. Normal Operating mode

Figure 2 shows the working of the model in normal operating mode.

- Step 1: When the sensor is placed still and when the transmitter is made ON
- Step 2: When the camera is placed in the normal position
- Step 3: The camera takes a photo of the normal position in an application called Plug and Play

![Figure 2: Normal Operating mode](image)

7.2. When the sensor is moved upwards

Figure 3 shows the working of the model when the sensor is moved upwards.

- Step 1: The sensor is rotated upwards.
- Step 2: The camera is also rotated to the position the sensor rotates.
- Step 3: The camera captures the rotated view.

![Figure 3: Sensor moved upwards](image)

7.3. When the sensor is moved downwards

Figure 4 shows the working of the model when the sensor is moved downwards.

- Step 1: The sensor is rotated downwards
- Step 2: The camera is also turned to the position the sensor rotates.
- Step 3: The camera captures the rotated view.
Figure 4: Sensor moved downwards

The Laser beam and the Camera will turn accordingly to the respective direction by the sensor values and the snapshot taken from the camera can be monitored. There are many applications available in website for connecting the camera using Wi-Fi to the device and it can record for further purpose. The Wi-Fi can be password protected for enhanced security.

8. Drawbacks

The new form of recognition like Gesture interfaces provides a lot of advantages. These Gesture based interfaces provide the user with a new form of interaction. This kind of input also gives new issues that are not relevant to the traditional input. Correctly recognizing the gestures, the developer needs a system. Learning and remembering are accurately not possible. Designing a system that recognizes accurately and quickly the gestures is difficult task. The other difficult task for the developer is to provide a manual for quick and easy learning of these gestures. And the sensor senses the hand movement and moves the particular object respectively. But the disadvantage is whenever a hand is moved unintentionally the particular object also starts to move.

9. Conclusion and Future scope

The challenges in the usage of unmanned aerial vehicle in military applications have been studied and a fair solution is proposed. Two major disadvantages like the accurate positioning and the real time streaming of the place are discussed in this paper. With the help of the sensors and the real time camera, the solutions for the disadvantages are provided. The usage of very low cost processor in the system made this work, a reliable and a cheap control mechanism is designed for the applications. The outcome of the idea is to provide accurate positioning in unmanned vehicles. It helps in the usage of unmanned aerial vehicles in military can save lives. It is also specifically designed to provide visual picture in places where human interaction is less possible.

By placing the fire extinguisher below the drones instead of gun, it can be used to let go of fire in places where the human interaction is not at all possible.

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