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Development of Android-Based Mobile Application Using Gyroscope Sensor

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ABSTRACT- The idea of this project comes into the picture from various uses of sensors that are present in our surroundings. So, we can actually play with them by using two or more sensor mechanisms that end up as new inventions. Therefore, we are keen to look forward to one of the highly scoped and well-furnished sensors i.e., Gyroscope Sensor with an element of Light Sensor. This sensor is capable of measuring the orientation of the body and the angular velocity of the object. In our android project, we embedded the flashlight feature in the Gyro sensor's angle alteration logic. This mechanism successfully leads to the flashlight of the camera getting ON & OFF when the device is tilted or shifted along the reference angle. This collaboration of sensors plays an important role for a device that does not have that feature.

KEYWORDS- Gyroscope Sensor, Android, Mobile Application, Android Based Mobile Application, Types of Sensors

I. INTRODUCTION

Sensors are devices that are used in smartphones to detect various aspects of the environment. They sense the data for which they are made and work according to that. Gyroscope Sensor- Working, Types & Applications[1]. There are various sensors which are available nowadays in smartphones which are in-built and help in the functioning of the smartphone which can result in a better user experience.

The types of sensors that are present in our surroundings like gadgets, automobiles, or aircraft can be listed as given below:

- **Motion Sensors –** These types of sensors are capable of monitoring device movement or motion sensing like tilting, shaking, or swing etc. The orientation in mobile devices can be identified using an accelerometer. The
- sensors in accelerometer are beneficial in be used to detect earthquakes or in medical devices.
- **Environmental Sensors –** These sensors are capable of detecting humidity and temperature and heat losses in the environment. It plays a major role in monitoring of environmental parameters. These come up with sensors like Gas Sensors, Humidity Sensors, etc.
- **Position Sensors –** These sensors are used for detecting the movement of the object or relative position of the body from the established reference point. The Android smartphone has two sensors that can determine the position of the device which are geomagnetic field sensors with a combination of accelerometer sensors.
- **Ambient Light Sensor –** This sensor controls the brightness level of the screen of smartphones. It can be seen in most of the mobile devices that if we are in daylight, the sensor senses the light and it automatically alters the brightness level to high of the mobile device. If it's dark, then brightness level pulls down to dim so as to protect from highly intensified light rays.
- **Proximity Sensor –** These sensors are present on most mobile devices at the top of the screen. Ifrared light comes into the picture with this sensor. When any physical object comes in contact with light, it detects it and reacts toward it. We can take an example for clarification, when we have a phone call and place our phones on our ears, infrared detects physical objects like our ears. It senses it, then the screen's light automatically goes off. It can prevent battery drainage from screen touching accidently and enhances its life.
- **Accelerometer Sensor –** This basically defines the orientation of the smartphones. We can observe that if we put our phone on auto rotation mode, the orientation of the mobile switches between portrait to landscape mode and all the widgets and apps respond based on their orientation. This is all because of the accelerometer.
- **Gyroscope Sensor –** The handset phones that have the feature of Virtual Reality, it is only possible by the Gyroscope Sensor. Like we have a VR headset and put a phone inside, there is a Gyro sensor responsible. Even 360-degree pictures or videos and AR (Augmented Reality) are possible only because of these sensors. It is used in a very precise manner. It adjusts the content of the phone according to the user.
- **Barometer Sensor –** These sensors are used for detecting altitude (height) data. We can see from a health app on smartphones that use these sensors. Every detail is given by a barometer sensor precisely like climbing up and down stairs and this data is sent to GPS which then is calculated. It is also useful with GPS.
- **Compass Sensor –** This sensor is useful for helping to detect direction as a normal compass does. It's very general and easily available in smartphones.
- **Pedometer Sensor –** It counts our step count which means how many steps we have covered during walking. It is available in high-end devices and some specific devices only.

- **Hall Sensor**-It is used in tablets in comparison to phones. In a flip case cover for a tablet, on opening that cover, the light of the screen will automatically start without touching and the light of the screen gets off while flipping the cover back.
- **IR Blaster –** These sensors can be observed mainly on XIAOMI sets. It's hard to see on other smartphone companies. These sensors can take over control on other electronic devices. For Example, we can control TV, AC, or any other electronic devices from our smartphone if we have IR Blaster.
- Some more sensors still exist in smartphones but they are not so important.

II. GYROSCOPE SENSOR

We are more focused on Gyroscope Sensor due to its extensive features that's why we are discussing this sensor only. The small brief about Gyroscopes can be understood by the following points.

- A gyroscope is a device that takes the reference of the earth's gravity in determining the orientation(see figure 1). It is found inside IMU (Inertial Measurement Unit). It is used to measure the rotation on a particular axis either its x, y or z-axis. This device has a freely rotating disc which is termed as rotor, and is mounted on a spinning axis which is situated at the center of another larger wheel.
- A gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These can measure the tilt and lateral orientation of the object whereas an accelerometer can only measure linear motion.
- Gyroscope sensors are also called Angular **Sensors or Angular Velocity Sensors**. These have installed applications where the orientation of the object is difficult to sense for humans.
- It is measured in degrees per second, and angular velocity can be defined as the change in the rotational angle of the object per unit of time.

Figure 1: Image of the Gyroscope

A. Types of Gyroscope Sensors

The gyroscope sensor can be categorized into four types based on performance and size of the sensor[2].

1)Ring Laser Gyroscope

This gyroscope sensor has a ring laser. It has two counter-propagating resonant modes which are on the same path and these are independent of one another. The rotation of the body can be measured by taking differences between frequencies of these modes.

2)Fiber-optic Gyroscope

The fiber-optic gyroscope sensor follows the Sagnac effect. In this type of gyro sensor, two or more lights pass through the optical fiber's coils which causes interference, in that way it follows the principle of interference of lights. The two beams of light are injected into the optic fiber from two opposite directions, and the phase shift is detected through interferometry.

3)Quantum Gyroscope

This gyroscope is also referred to as a superfluid gyroscope. This type of gyroscope because it uses fluid material to detect the change of orientation in different moving bodies. In this way, mechanical gyroscopes are gradually being replaced.

4)Vibration Gyroscope

This gyroscope sensor is very common to use. The rate of rotation can be calculated from a dynamic body through a vibrating structure. It can have various important characteristics like temperature-frequency coefficient, scale factor, and many more.

III. WORKING PRINCIPLE OF THE GYROSCOPE SENSOR

Angular momentum is the significant part of the Gyro Sensor. It can be measured using Coriolis force or the Coriolis Effect. In this way, preservation of Angular momentum is taken into consideration therefore it follows the principle of conservation of angular momentum. A rotor or a spinning wheel is mounted on a pivot in the sensor. The rotor will rotate on a gimbal which is a particular axis. The two gimbals are mounted on each other which provides three degrees of freedom to rotor. When spinning of the rotor occurs the gyroscope continues to display in the same direction[3].

If we talk about a particular Gyro type like Vibration Gyroscope, we can consider the working principle of this type. It consists of a double-T structure element. It has a drive arm that rotates in a particular direction. These arms are attached to the sensing arms. When the sensor is rotated, the Coriolis Effect or the Coriolis force will affect the drive arms. Due to vibration of the drive arms, the motion in the pair of sensing arms of the gyro takes place which generates a potential difference between angular velocities which is sensed by the device. Then these angular velocities are converted to electrical signals.

IV. APPLICATIONS OF GYROSCOPE SENSOR

The applications of gyroscope sensor can be seen as follows:

- **In sensing of Angular Velocity:** It can be used to sense the rate of change of angular motion in dynamic bodies. Movement of athletics will be the suitable example for this.
- **In sensing of Angles:** The angles between the amount of sensed angular velocity can also be detected using the gyroscope. These are applicable in car navigation and game controllers like AR games.
- **In sensing Control Mechanism:** The gyroscope sensor can be used to detect.

V. GYROSCOPE SENSOR IN MOBILES

The motion games on smartphones like car driving, running games and many others are because of gyroscopes. The best examples are the very popular PUBG, Call of Duty, etc. games which follow the principle of gyroscopic sensors. The 360-degree view in videos are from gyro sensors. It provides an interactive GUI and effective functionality to select options and menus by simply tilting their phones. The image stabilization and GPS-inertial navigation in mobile devices can also be done with the help of this sensor.

A. Gyroscope Sensor in Android Project

In our android project, a gyroscope sensor is used with motion alteration in which the flashlight of the device gets ON & OFF. It measures the rate of rotation in rad/s around a device's x, y, and z-axis.
The sensor's coordinate system is taken the same as the acceleration sensor. The observer would observe positive rotation if it is in a counterclockwise direction or the observer is looking from the positive direction of x, y and z-axis. Rotation is positive in the counterclockwise direction; that is, an observer looking from some positive location on the x, y and z-axis. The output of the gyroscope is integrated over time to calculate a rotation describing the change of angles over the timestamp.
With the mechanism discussed above of the gyro sensor, we embedded the camera service along with the gyro on android devices using gyro Event Listeners.

- First, the CAMERA SERVICE is enabled by System Service to allow the camera to flashlight on a particular event.
- Then, the Package Manager checks the device if it has a CAMERA FLASH feature or not. If it has the feature, flash control will enable the feature for the app, or if it does not, then it will throw the error message of not having it.
- When it is all acknowledged successfully, we register gyro Event Listener to Sensor Manager for Gyro Sensor.
- Now we use the raw data sent by the sensor. It means it consists of three float values specifying the angular velocity of the device along the x, y & z axis. The unit of the velocity is taken into rad/sec.
- In the case of anti-clockwise along any axis, the value will be positive and for clockwise, the case will be vice-versa. But in this case, we are more focused on rotation along the z-axis and avoiding the orientation of the device.
- Therefore, we take an array of values of the sensor Event object. If the value is more than 0.5, we consider that the rotation will be anti-clockwise so we set the background color of the app page to blue and yellow for preceding the negative value of 0.5.
- The fragment of the source code is mentioned below to understand the logic building[4]:

```
gyroEventListener= new SensorEventListener() {
@RequiresApi(api = Build.VERSION_CODES.M)
@Override
public void onSensorChanged(SensorEvent event) {
if (event.values[2] >0.5f) {
getWindow().getDecorView().setBackgroundColor(Col
or.BLUE);
try {
cameraManager.setTorchMode("0", true);
        } catch (CameraAccessException e) {
e.printStackTrace();
        }

   }else if(event.values[2] < -0.5f)
   {
try {
cameraManager.setTorchMode("0", false);
      } catch (CameraAccessException e) {
e.printStackTrace();
      }
getWindow().getDecorView().setBackgroundColor(Col
or.YELLOW);
     }
   }
```

For user experience, we manage to change the window background color of the activity so the observer can detect the motion change along the z-axis with the flashlight switching between ON & OFF(see figure 2 and figure 3).

VI. RESULT & DISCUSSION

The outcome will be like this as given figure 2 and figure 3:

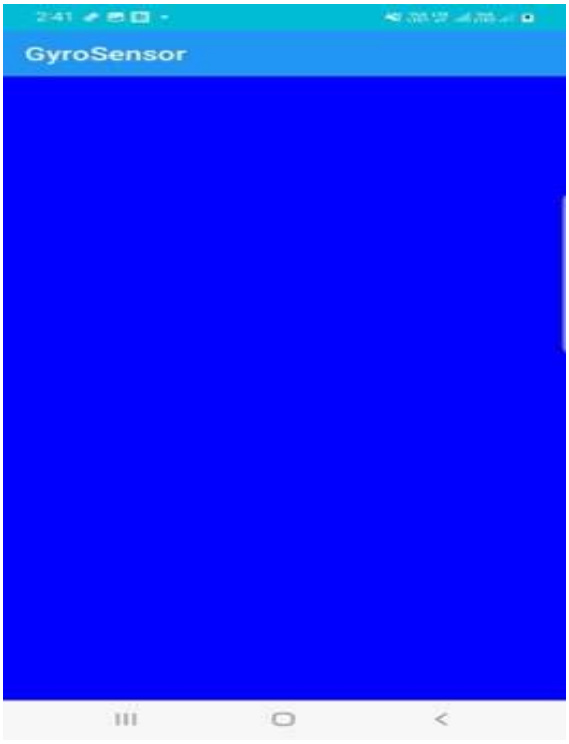

Figure 2: When a flash is OFF

These screenshots are for understanding that flash switching will come into context as motion changes counterclockwise and clockwise rotation.
This is the working flow of the gyro Sensor embedded with the camera flash feature in android devices.

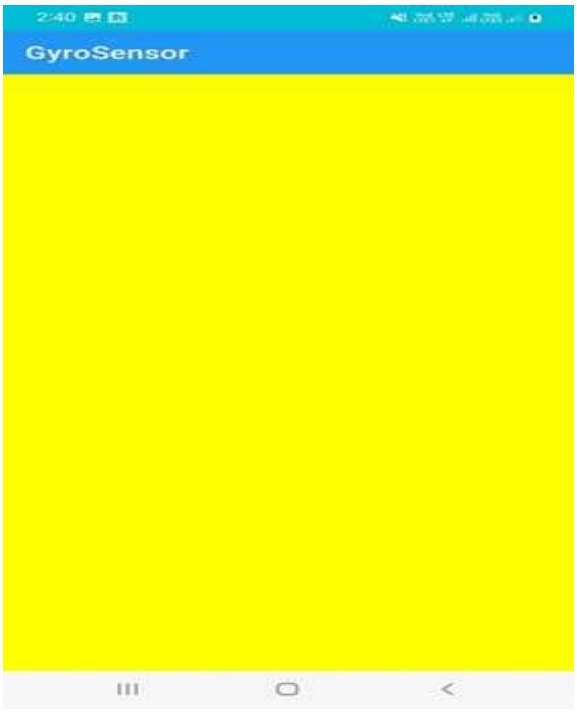

Figure 3: When a flash is ON

vibrations generated by the external factors. It is used in camera-shake control and vehicle control and in finding course direction for ballistic missiles is a suitable example for navigation through gyroscope.

VII. CONCLUSION

So, we successfully developed the Mobile app having a Gyroscope sensor incorporating an element of Light Sensor. This app inherits the property of both sensors that amplifies the features present in the devices. It would be interesting to play with other sensors like here and great outcomes will come into context in the future.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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