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Unintended Acceleration Prevention System

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Abstract - *There is consistently a danger in two wheelers of being sped up accidentally, after an accident which was caused by the rider. This can be lethal to both rider and pedestrians. Accidental speed increase in two-wheeler is sensible for huge number of instances of harm to client and bikes that results into dangerous wheelies, striking to any object ahead of them. Also, when a rider tries to lift a two-wheeler by the handle after an accident, the motorcycle's accelerator accelerates since it was never shut off during or after the collision, causing the vehicle to move in an unpredicted manner that could cause harm. The system will detect the accidental conditions based on the algorithm and will switch off the ignition using automated kill switch. So that the unintended acceleration can be avoided and excessive harm to vehicle and rider can be prevented.*

Key Words: **Gyroscope, Unintended Acceleration, MPU6050, Lean angle, Kill Switch.**

1.INTRODUCTION

Road accidents is a very common word in our daily life and bike accidents lead to the majority of deaths in India so, due to increase in number of accidents, this is the major thing to work on. In past there were many people who tried to reduce accidents and impact of that accidents but still there is lot of scope in these area for new innovations. In this paper we have proposed a solution which is focused on motorcycle accidents.

In case of new riders who are learning bike most common accidents are due to unknowingly accelerating bike too much after starting the bike which lead to problems like dangerous wheelies, striking to any object ahead of them. After collision riders go in a state of confusion while trying to control bike, they often give throttle input to it, accelerating motorcycle which may cause more damage to rider, bike and surrounding. Sometime after accident when rider go to lift their bike with the help of handle in that case if motorcycle is not turned off, false throttle may lead to unintended motion of vehicle which can cause harm and this one is the most common case which happens with all types of riders. While taking aggressive turns on bike, it inclines at a certain angle which depends upon the speed of vehicle. If the bike is inclined by user beyond its limits, then there are more chances of accident in such cases.

In this paper we have tried to find solutions for all these problems. We are using three axis gyroscope and accelerometer. Our main parameters for accident detection are acceleration and inclination of vehicle with three axes. Electronic control system is used to perform all sensing, performing logic and actuations.

2. LITERATURE REVIEW

[1] In this paper they have determined a two-way detection step to decide if the mishap has happened or not. First is through accelerometer which will recognize any unexpected tilt of the vehicle if there should arise an occurrence of any mishap. The heartbeat sensor will then detect the user's heartbeat rate and determine the severity of the crash or fall. Depending on the changes in the heartbeat, an alert will be provided to the control room and ambulance contacts, along with a map of the location. The android application will send message to the nearest medical help center with the help of GPS which helps in preserving vital time the heartbeat sensor used in this device will sometimes provide false detection for example the heartbeat rises when the motorcycle is going to fall however does not fall as the client some way or another controls the circumstance then for this situation there will false detection.

[2] In this paper they have utilized a vibration sensor along an accelerometer for exact discovery of a mishap. The vibration sensor will identify the signs and send them to the accelerometer, the accelerometer will recognize the signs and send it to the ARM controller. Microcontroller sends message utilizing GSM modem alongside the area of the vehicle. Here they have additionally given a switch which will end the entire interaction in the event of a little mishap, where the person is not hurt and does not need any prompt clinical help. This is a brilliant way to save the emergency rescue team's time.

[3] In this paper they have put a great deal of emphasis in discovering if the mishap has happened. They measured the physical effect on the motorcycle during collisions using a sheet-like flexible piezo film sensor. It is very thin and sheet-like, and it only weights 3 grams. It has a sensitivity of 10mV/g, which is very strong. Which make sure that it will not get damaged during the accidents. They have also used A triple axis accelerometer which measures the deceleration when normally breaking is done is different than the braking done during accidental situations.

3. METHODOLOGY

The proposed algorithm is designed to three general patterns which leads rider to lose control of bike.
These three patterns are:

3.1) Unintended acceleration in direction of motion of vehicle

Study of various accidental cases was performed and after the analysis it was found that many times in panic, riders throttle up two-wheeler due to which anomalous acceleration takes place. Proposed system has in built 3 axis accelerometer (MPU6050) in it which helps it to detect acceleration. MPU6050 can detect acceleration but a threshold value for comparison is must for logic building in microcontroller. Maximum acceleration for a particular vehicle is limited due to its maximum output power capacity and efficiency of engine.

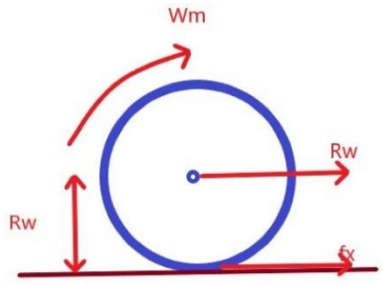


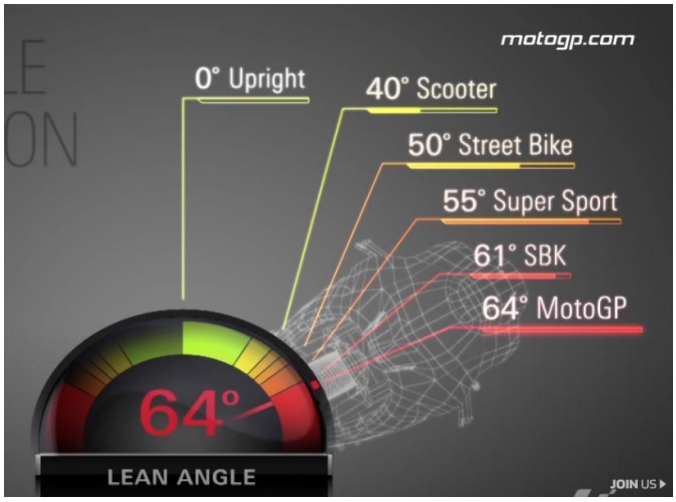
Fig 1: Kinematic Diagram of Wheel

Wm = Angular velocity of wheel
Rw = Radius of wheel
Vx = Velocity of wheel (in direction of wheel)
fx = Traction force
$Pm = Te \times Wm$ .....(Power)
Efficiency of vehicle can be calculated by
$\eta = \frac{fx \times vx}{Pm}$
traction force and acceleration are related as

Therefore, the acceleration is calculated as
fx=m×ax
$$ax = \frac{Pm \times \eta}{m \times vx}$$
Maximum capacity of acceleration for any two-wheeler can be calculated by using above equation but it only tells us about a value. It cannot be used for a viable logic building as a vehicle likely will not exceed the limits of its engine. Time is a perfect solution for this problem by accounting the acceleration w.r.t time we can calculate a threshold value. Hence this threshold value will be provided to the electronic system.

2)Inclination of vehicle wrt ground:

Further study of cases revealed one very common pattern of accidents that the vehicle skids due to improper riding and inclining the vehicle above its limit. Every vehicle has different center of gravity, wheel traction, and power capacity due to which they can incline up to a certain limit at given speed while taking a turn. Many times, rider even loses the control of bike while its stationary. These incidents can affect the engine life adversely. Sometimes the fuel leakage may lead to engine to catch fire. Sometimes throttle input is given by rider while lifting bike to normal position. Tackling these situations can be easily done using a gyroscope which will continuously detect the inclination of vehicle and if the vehicle inclines more than it's limit it will be a valid reason to turn off the engine. Calculations for maximum vehicle inclination for its different types are already performed by Moto GP. Threshold values are referred from Moto GP for reference.



[4]

Fig 2: Maximum Inclination for Different Vehicle

3)Angular acceleration wrt axis perpendicular to the ground:

Several times it is observed that two wheeler's perform wheelies accidently due to unusual throttle input. The gyroscope in MPU6050 is capable to calculate angle of inclination in three axes but it cannot be accounted because, at an inclined road it might detect false inclination. The proposed system accounts the angular acceleration in Z direction. Instantaneous values of angular acceleration are calculated by program fed up in system, it is calculated using equation α = az×l where l is length of wheelbase. Threshold value for angular acceleration is calculated by using following method:

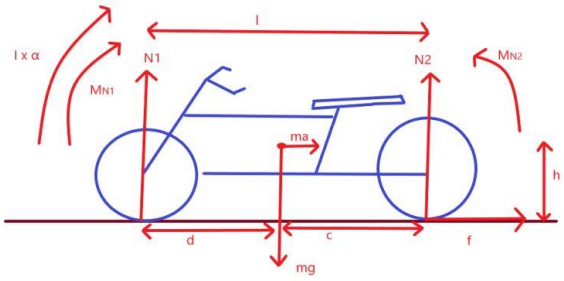


Fig 3: FBD of Bike

Assuming vehicle moving with zero acceleration
∑F=N1+N2-mg
Also, as there is no wheelie or stop-pie the summation of moments wrt C.G should be zero.
∑Mo=-MN1+MN2
∑Mo=-N1×b+N2×c
Now, for accelerating condition angular acceleration of front wheel can be calculated by
∑Mo=-N1×l+N2×l-fh= I×α
Values for N1 and N2 for a wheelie condition can be calculated by:

$$N1 = \frac{c \times mg}{l} - \frac{h \times ma}{l}$$

$$N2 = \left(1 - \frac{c}{l}\right) \times mg + \frac{h \times ma}{l}$$

Moment of inertia of bike for wheelie condition is approximately calculated as exact calculations for MI of a two-wheeler are very complicated. The MI of two-wheeler can be calculated by:

$$\frac{11 \times m}{6} \times [(l^2 - 2 \times r^2) + (l^2 + r^2)]$$

Here, l = wheelbase length
r = Wheel radius
The system calculates the angular acceleration wrt Z axis and if it exceeds the threshold value and the angle detected by gyroscope wrt Z axis also exceeds 60° then the system cuts off the power.
For implementation of this system, we are using MPU6050 module to know the orientation and acceleration of two-wheeler. Then we are using Arduino Uno as a microcontroller which will receive data of orientation and acceleration of two-wheeler from MPU6050 module and control the switching of relay. Finally, kill switch is controlled by relay.

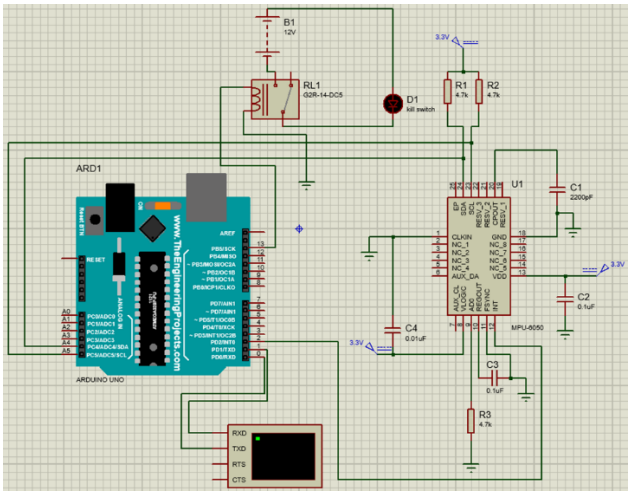


Fig 4: Circuit Diagram

Components Used:
MPU-6050 IC, 5V Relay, Arduino Uno, Resistors, Capacitors, 12V DC Power Supply, Connecting Wires, etc.
IC MPU-6050 pin connections:
1.Connect a 0.01uf non-polarized capacitor between pins 1 and 8. Connect capacitor terminal connected to pin 1 to ground and its other terminal to 3.3V.
2.Connect a 4.7k ohm resistor to pin 9 and connect the other end of resistor to ground.
3.Connect a 0.1uf non-polarized capacitor between pins 10 and 11 and connect capacitor terminal connected to pin 11 to ground.
4.Connect a 0.1uf non-polarized capacitor to pin 13. Connect capacitor terminal connected to pin 13 to 3.3V and its other terminal to ground.
5.Connect a 2200pf non-polarized capacitor between pins 18 and 20 and connect capacitor terminal connected to pin 18 to ground.
6.Connect 4.7k ohm resistor each to pins 23 and 24 and connect opposite terminals of resistors to 3.3V.
Main Circuit Connections:
1.Connect 3.3V terminal of Arduino Uno to IC MPU-6050 pins which required 3.3V supply as written in IC MPU-6050 pin connections section.

2.Connect ground terminal of Arduino Uno to IC MPU-6050 pins which required ground connections as written in IC MPU-6050 pin connections section.
3.Connect pin 12(INT) of IC MPU-6050 to pin 2 of Arduino Uno.
4.Connect pin 23(SCL) of IC MPU-6050 to pin A5(SCL) of Arduino Uno.
5.Connect pin 24(SDA) of IC MPU-6050 to pin A4(SDA) of Arduino Uno.
6.Connect one coil terminal of 5V relay to pin 13 of Arduino Uno and other coil terminal to ground.
7.Connect positive terminal of 12V battery to one side of kill switch and its negative terminal to N.O. of relay.
8.Connect common terminal of relay to remaining terminal of kill switch.

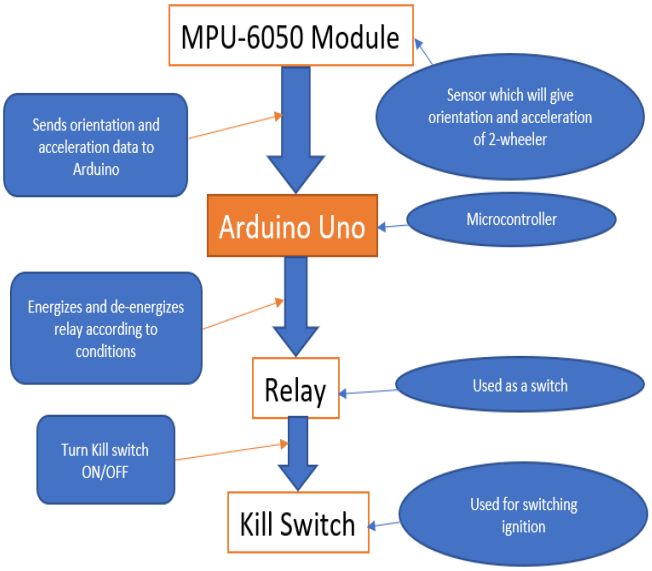


Fig 5: Workflow

When this circuit is implemented on the two-wheeler, MPU-6050 IC gives acceleration and orientation values for various conditions. These values are transmitted continuously to Arduino Uno through serial data bus accomplished by SDA and SCL terminals. Then by checking for cases written in code, it energizes and de-energizes the 5V relay. If relay is energized, kill switch is turned ON and if relay is de-energized, kill switch is turned OFF.

4. CONCLUSION

When any unintended cases of vehicle motion like unintended acceleration in direction of motion of vehicle, unintended inclination of vehicle with respect to ground, unintended angular acceleration that leads to unintended motion. In either of three cases the power from engine to wheel is killed by stopping the engine itself using kill switch. Actuation to kill switch is through relay on command from microcontroller. Decisions of microcontroller are based on inputs from MPU-6050 module and algorithm. Gyroscope module gives us inclination of vehicle in all three axis and respective acceleration that we need in our algorithm. So, in this way accidental damage of two wheeled vehicles can be reduced by using this system.

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