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Integrated Airbag System for Two-Wheelers

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Abstract: In current scenario, the death rate due to road accidents is increasing alarmingly. The airbag system was first introduced in 4-wheeled vehicles. The main objective of using airbags is to ensure maximum safety of the driver, whether it may be four-wheeler or two-wheeler. The severe fatality could be curbed to a great extent using airbags in 2 wheelers up to 25% – 50%. In this paper, we are proposing the idea to implement the airbag safety system in 2-wheeled vehicles.Safety today is a major concern in people & the awareness is also accelerating the sense of responsibility in the rider. If applied practically, surely it would ensure the minimum fatality and ensure a comfortable & safe drive. The concept of working of system, its integrated construction, complete installation and likely problems are discussed. The aim is to reduce the fatality, human injuries and property (vehicle) loss when colliding with an opposing vehicle or object in head to head or side wards collisions by absorbing the kinetic energy of rider and interrupting the instantaneous velocity of vehicle. With the help of electronic sensors& electrical connections,the whole system would workout efficiently. The perfect combination of mechanical & electronics engineering would lead to appropriate installation & functioning of the safety module proposed in two-wheelers.
Keywords: Airbag, Sensor, Crash Angle, Serial Synchronous Controller, Serial Peripheral Interface

I. INTRODUCTION

Over 1,37,000 people were killed in road accidents in 2013 alone, that is more than the no. of people killed in all our wars after independence. Every minute serious accidents occur in country and on average 16 Indians die on road per day. It is a worst situation of road safety in India. The road has become increasingly busy with dramatic increase in traffic accidents. Two-wheelers account for 25% of total road accidents, crash deaths of which 1214 road crashes occur every day in India. 20 Children under the age of 14 die every day due to road crashes in the country, 377 people die every day, that is equivalent to a jumbo jet plane crashing every day. State figures again approve the data. 2 people die every hour in Uttar Pradesh which is identified as a state with max no. of road crash deaths. Again, Tamil Nadu is the state with the max. no. of road crash injuries. 5 lives end on Delhi's road every day.

This situation has to be changed by modifying the bike designs a bit & introducing the compulsory usage of airbags in these. This would again create some awareness in Indian riders that would ensure their safety & minimum figure of road accidental death. The monitoring system could be digitally installed on dashboard using digital metersand the battery power will be consumed for working of the system. In the 2-wheeler, systems installation will be in all four directions forming an elliptical cover to save the rider. There are two cases when system runs by both the angle difference calculation and collision of two bikes or collision of bike with any other object.

II. DESIGN WITH REQUIRED INSTRUMENTS

Following are the instruments used for the 2-wheeler Airbag system –

A. Airbag (leather material with grip technology)

Airbags are stretchable fabrics or other materials that are tightly packed in various locations in bike. These special purpose bags are compressed and adjusted in a very small area. In case of an accident, Airbags are filled up with an air at an instant to provide the cushioning for the rider, so that he/she may not throw around in the event of accidental crash. While this would not ensure the complete safety, it would justify the safety more than 50%. Crucial points are given as follows --

1) Strong leather with grips is used to construct the airbags, especially as the lower surface of the airbags take the friction caused due to the road surface
2) The grip is used to avoid slipping or skidding of the bike on the oily or wet surfaces
3) The shape of the airbag is semi-circular "D" shaped on all four sides of bike

B. Cylinders For Releasing The Air (Opening Of Airbag)

Actual opening of airbag is due to the reaction occurring in between 2 cylinders which are fitted at the bottom of bike. When an external force or collision of objects with bike takes place, then the reaction takes place inside the cylinder. At the cylinder outlet, the pressured exhaust gas (air) is expanded from exit valve. The pressure can be controlled by pressure valve in between airbag and cylinder. This exhaust gas(air) is used to fill the airbag & hence the airbag opens.

The signals from the various sensors are fed into the airbag control unit, which determines the angle of impact, the severity, or force of the crash, along with other important variables. Each restraint device is typically activated with one or more pyrotechnic devices, commonly called an initiator or electric match. The electrical match, which consists of an electrical conductor wrapped in a combustible material, activates with a current pulse between 1 to 3 amperes in less than 2 milliseconds. When the conductor becomes hot enough, it ignites the combustible material, which ignites the gas generator. In a seat belt pre-pensioner, this hot gas is used to drive a piston that pulls the slack out of the seat belt & ensures the rider's safety.

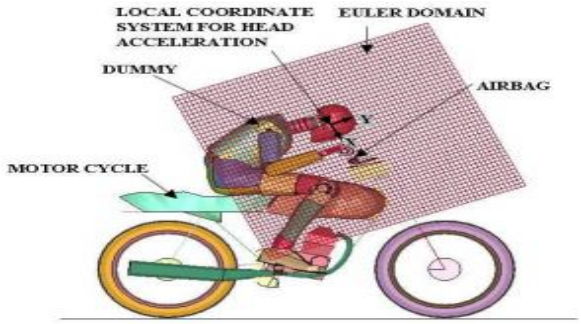

Figure 1: Setup for the Simulations

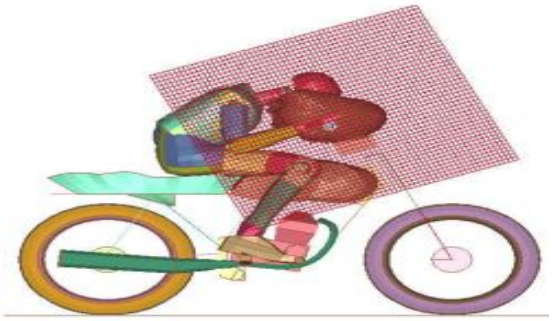

Figure 2: A typical inflated state of the motor cycle and the airbag

C. Sensors (Angle & Crash)

The most crucial parts of the success of the airbag system are the sensors. These small electronic devices are designed to tell when the vehicle is on verge of damaging in an accident. They respond to several different sets of stimuli, including sudden stopping, sudden increase in pressure as pieces of the motorcycle are moved due to the force of the collision, and angle between road surface and tires of motorcycle.Different types of sensor measuring wheel speed, occupied seat status, break pressure, degree of impact and other important status of vehicle are monitored by the airbag control unit located in the front portion of the bike. The sensors relay signals to the airbag control unit, which analyses the data and can ensure safety features like seat belt lock as well as airbag deployment. Two types of airbag sensors used in automobiles are electrical and mechanical. The success of the airbag system relies upon the crash sensors working not only accurately but also extremely quickly, so the most expensive & technologically advanced part of the airbag system.

D. Angle Sensor

The TLE5012B is a 360degree angle sensor that detects the orientation of a magnetic field. This is achieved by measuring sine & cosine angle components with monolithic integrated Giant Magneto Resistance (iGMR) elements. High precision angle values are achieved over temperature and lifetime using internal auto calibration algorithm. Data communications are accomplished with a bi-directional SSC (Serial Synchronous Controller) Interface that is SPI (Serial Peripheral Interface)compatible. The absolute angle value and other values are transmitted via SSC protocol. Also, the sine and cosine raw values can be read out. The raw signals are

digitally processed internally to calculate the angle orientation of the magnetic field. The TLE5012B is a pre-calibrated sensor. The calibration parameters are stored in laser fuses. At start-ups, the values of the fuses are written into flip-flops, where these values can be changed by the application specific parameters.

E. Fitting Cage

This cage is made up of metal strips with two openings for airbag

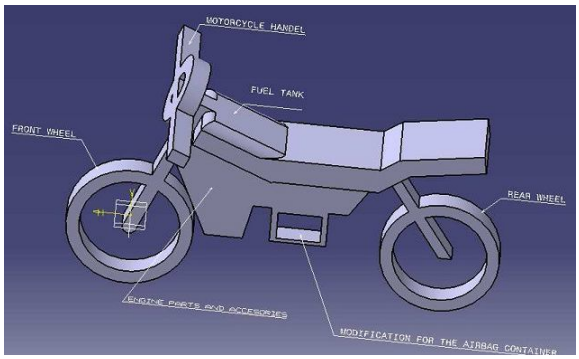

Fig 3. It shows that the modification is required for storage of airbag.

F. Angle Measurement (Angle Indicator)

1) When the proximity sensor is active then it will measure the angle between road surface & the tires of bike

2) This angle is displayed on the angle indicator which is fitted near the speedometer on the handle

3) This indicator will give signal about the degrees in which the bike will turn/tilt

4) When the angle is less than 30 degrees to the right or to the left side, then the airbag will openBike exceeds the angle less than 30 degree in between road surface & tyres by using an angle sensor, hence chemical reaction as described above takes place & airbag opens in right side of the bike.

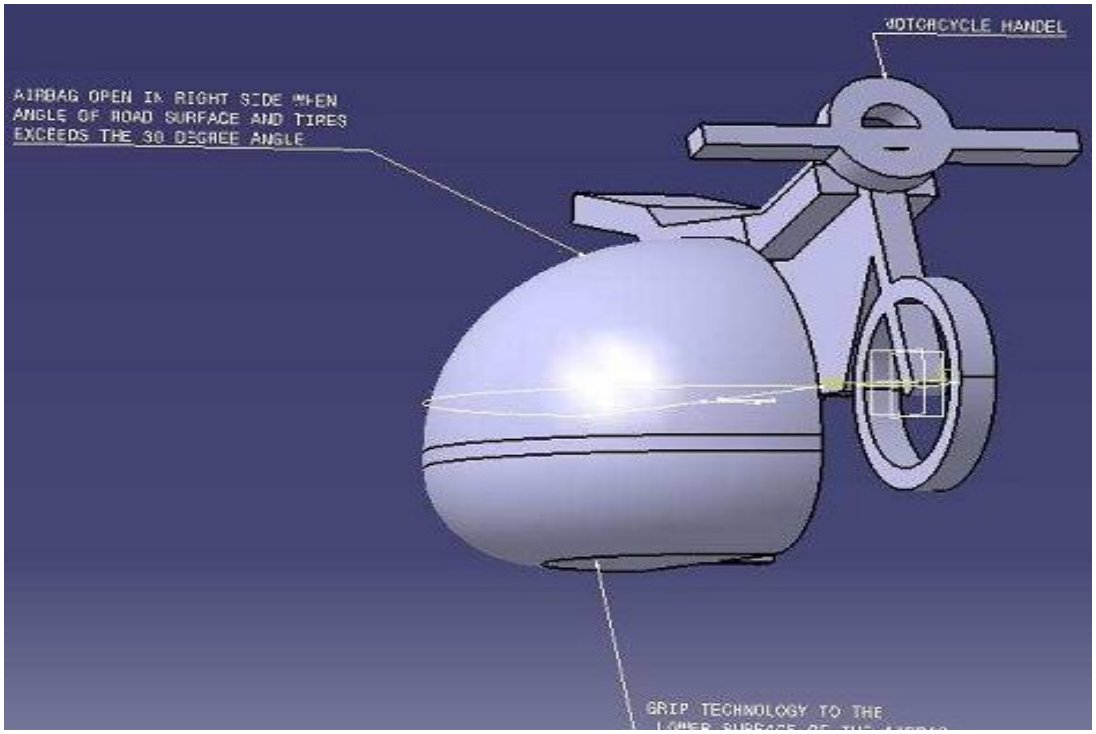

Fig 4. It shows that the airbag contains grips to the lower surface of it.

G. Inflator

Once the control unit determines there is an accident, it will send signal to the inflator system. The inflator sets of a chemical charge, producing an explosion of nitrogen gas, filing up the air bag. As the airbag fills up, it bursts through the panelling that

contains it and in order to protect you. This all happens in an instant, usually within 25 or 50 milliseconds. That translates to almost 200 miles per hour. The airbag then will deflate itself on its own once it deploys.

III. SYSTEM COMPONENTS: DESCRIPTION

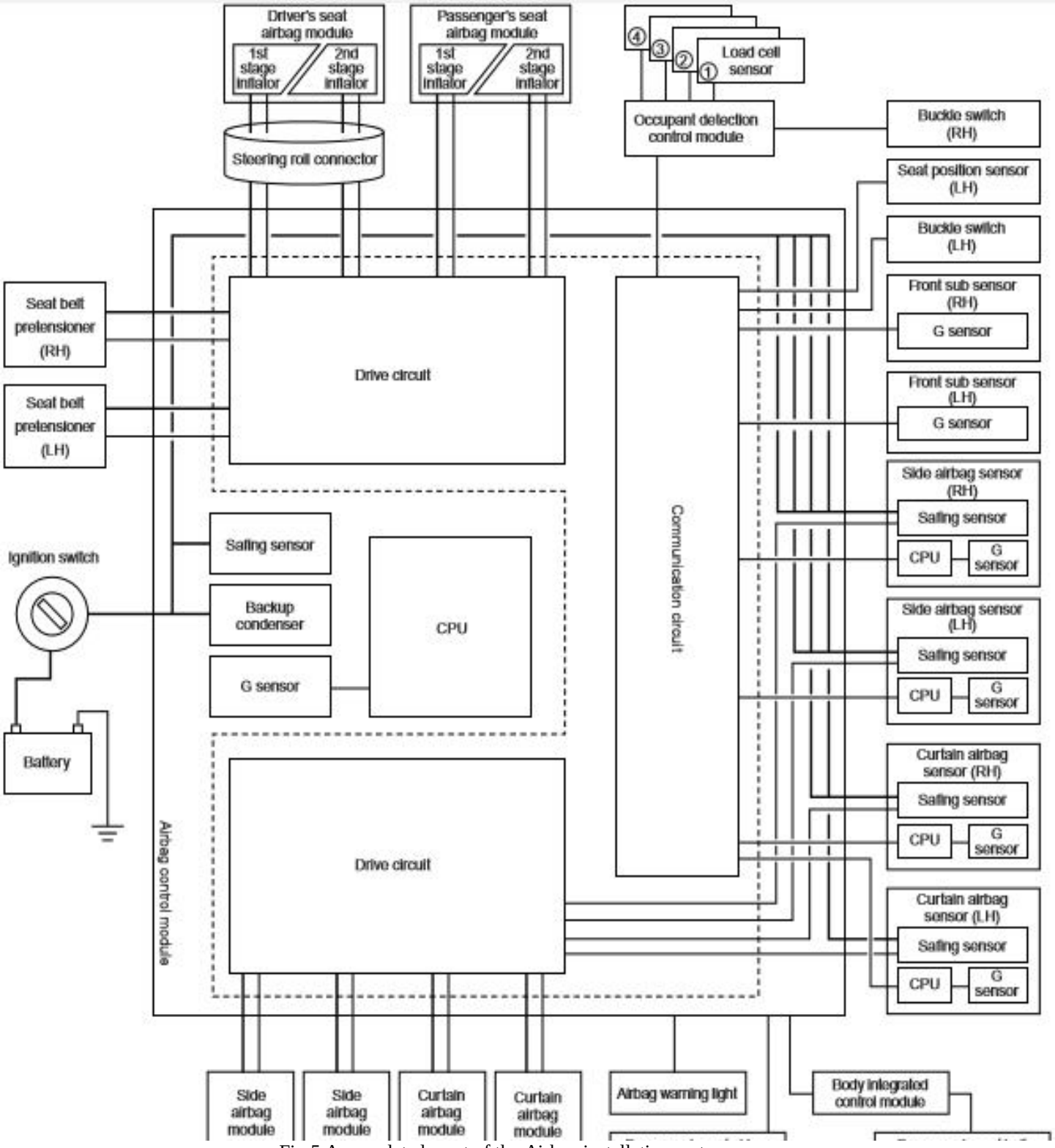

Fig 5.A complete layout of the Airbag installation system.

Table 1. Major functions of the important parts of the Integrated Airbag System

S. No.	Name	Major Function	Location
1.	Airbag Control Module	• Senses impact & judges its magnitude by means of a safety sensor & G sensor built inside • Serves as supplementary power supply if the battery voltage is lowered for any reason • Directs airbags to inflate • Performs self-diagnosis of the whole airbag system	Inside center console
2.	Driver's Seat Airbag Module	Protects the driver's head & upper body to minimize injury in case of frontal collision	Inside the pad at the center of steering
3.	Driver's Seat Side Airbag Module	Protects the drivers upper body to minimize the injury in case of side collision	Inside the driver's seat backrest
4.	Curtain Airbag Module	Deploys together with the side airbag to protect the driver's head & minimize injury in case of side collision	Inside at left & right sides
5.	Steering Roll Connector	Provides electrical connection between the vehicle side airbag harness & steering wheel	Between the combination switch & steering wheel
6.	Front Sub Sensor	Detects the impact in case of a frontal collision & outputs a deceleration signal to the control module	Left & Right front side
7.	Side airbag sensor	• Senses impact & judges its magnitude in case of side collision by means of safety sensor & G sensor built inside • Performs self-diagnosis of the airbag system	Inside part of left & right side
8.	Curtain airbag sensor	• Senses impact & judges its magnitude in case of side collision by means of safety sensor & G sensor built inside • Performs self-diagnosis of the airbag system	In front of rear wheel arch
9.	Airbag warning light	• Indicates whether the system is normal or abnormal • Displays diagnostics trouble codes	Inside the combination meter
10.	Occupant detection control module	Performs self-diagnosis of the occupant detection system	Beneath the driver's seat cushion
11.	Loadcell sensor	Detects the load on the seat applied by the passenger	On the passenger's seat slide rail
12.	Passenger's seat airbag ON/OFF indicator	Indicates whether the deployment of the passenger's seat airbag is allowed or not, based on the decision of the occupant detection system	Center of the instrument panel at the clock area

IV. TECHNICAL FEATURES

A. Giant Magneto Resistance (GMR) based
B. principle.
C. Integrated magnetic field sensing for angle measurement
D. Full calibrated $0 – 360^0$ angle measurements with revolution counter & angle speed measurement.

E. Two separates highly accurate single bit SD-ADC.
F. 15-bit representation of absolute angle value on the output (resolution of 0.001^0)
G. 16-bit representation of sine/cosine values on the interface
H. Supports SIL with diagnostics functions & status information.
I. Interfaces: SSC, PWM, Incremental Interface (IIF), Hall Switch Mode (HSM), Short PWM Code (SPC)
J. Max 1^0 angle error over lifetime & temperature with activated auto calibration.
K. Bi-directional SSC interface up to 8 Mbit/s
L. 0.25 micrometre CMOS Technology
M. Automotive qualified: - -40℃ to 150℃ (Junction Temperature)

V. AIRBAG SECURITY SYSTEM FOR HUMAN BODY

The provision of airbags on motorcycles is more complex than installation in cars, because the dynamics of a motorcycle crash are more difficult to predict. Bike dynamics leads to act with very short reaction time & fast inflation but only if the motorcycle is involved in the accident. Especially the rider must remain on the motorcycle during the accident and the impact dynamics must lead him to hit exactly the part of his vehicle protected by airbags.Hand/Leg Cracks or Fractures, Head Injury, Bleeding from body parts, getting thrown from bikeOne can get protection from the above mentioned bodily arms as described, the airbag system opens from the bottom to the left or right side of bike, hence we can avoid hand/leg cracks & fractures. The diameter of the airbag when opened is more than height of the bike and that of the rider, hence head injury is avoided. As the material used in the airbag construction is light weight and strong leather, the chances of bike skidding or slipping is diminished and external injuries like scratches are avoided. The chances of rider being thrown from the bike are avoided as the leather belts are provided on both sides of the bike to secure the legs of the rider. The material used for constructing these belts is similar to those used for constructing the seat belts in the cars.When an object collides with the bike, at an instant the airbag opens in both directions to protect the rider.

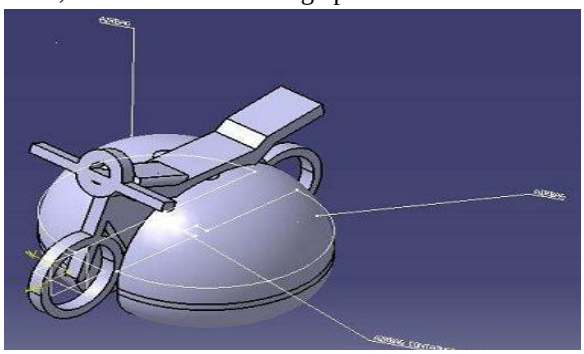

Fig 6. Airbag opens in both directions when an object collides with the bike.

VI. PROBLEM

Skidding (defined as an out-of-control sliding motion as would result from applying the brakes too hard in a car or bike) is one of the major causes of accidents in two-wheelers. The rider is not protected during skidding as it's a sudden action. The causes of skidding include sharp turns on road, unbanked turns, obstacle such as pebbles of various kinds & sizes, water, oil spills etc., sudden increase in side traffic and pedestrians or pets crossing the road. Almost of all these causes are beyond rider's control, so many a times skidding is inevitable. In a skidding accident, the body parts that are most vulnerable to getting hurt are the legs, the feet and the knees, also hand & head is in danger zone. Apart from the impact, the rider and pillion rider also get dragged along with the two-wheeler vehicle on the road till the vehicle and rider loses their momentum completely to come to halt... The chances of getting leg trapped and dragged is also very high in case of such an accident. This can cause severe injury to the rider. Therefore, there is an essential need to protect riders when two-wheeler vehicles skid.

VII. CONCLUSION

Today, we need safety audits and accountability periodically. We can't keep calling areas accident-prone zones for years and doing nothing about it on our part. We need to seriously and sincerely look at road safety and perfect road planning. In the next 5-10 years with the way traffic is increasing alarmingly in Delhi-NCR, we have to handle this in a more innovative way. Therefore, the goal is

to ensuring the total safety to the motorcycle rider by implanting the airbags in all four directions of the motorcycle as mention in this paper. Fatality rate can be reduced to up to 50%. Not only human fatality & death rates can be minimized but also the safety of motorcycle can be optimised to a great extent. To achieve the objective small changes in the design of the vehicle has to be made. The going on experimental research on the subject by our team will again ensure the complete feasibility of the system.

VIII. ACKNOWLEDGEMENT

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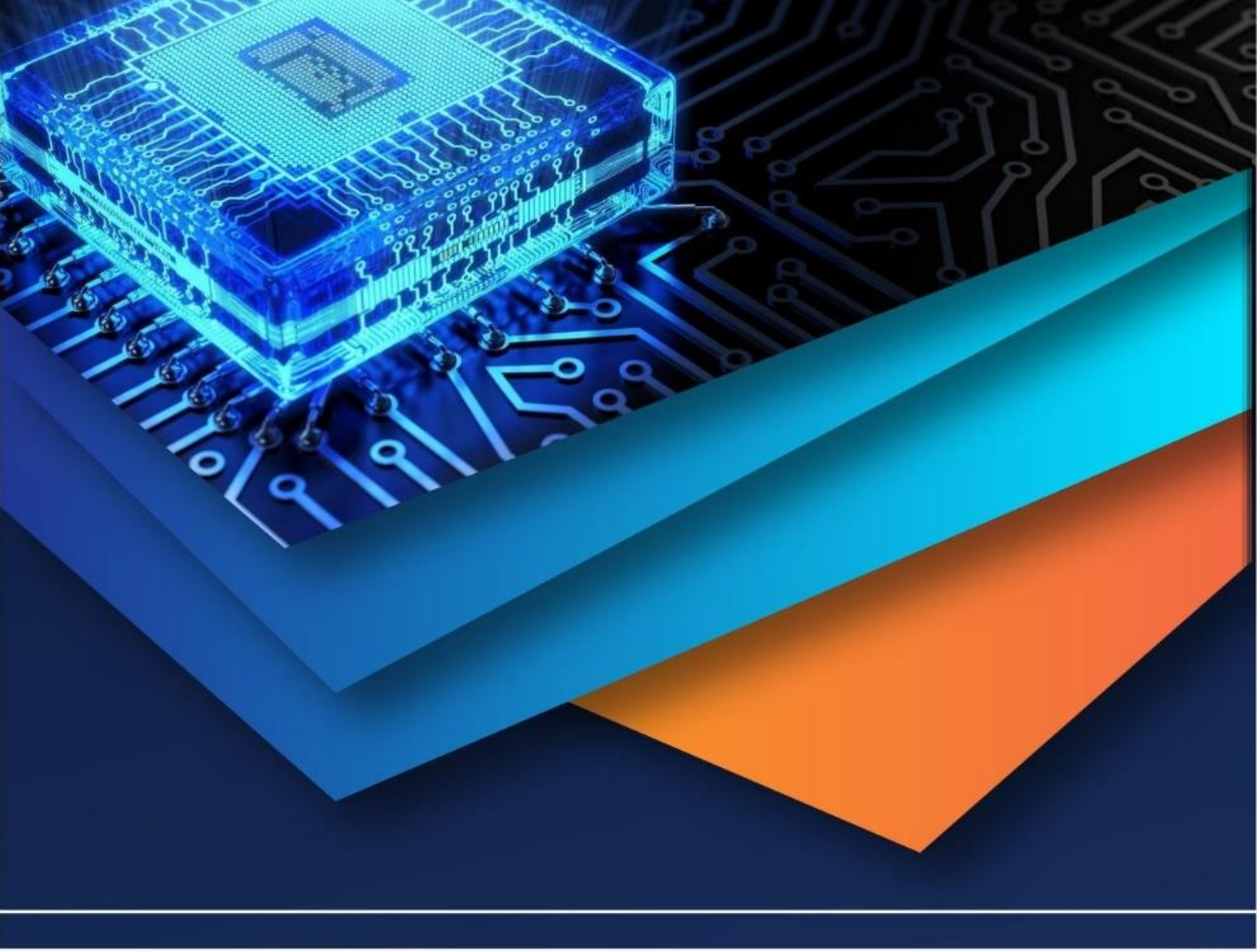

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