COMPARATIVE INVESTIGATION OF ACTIVE SAFETY AND PASSIVE SAFETY SYSTEMS FOR L CATEGORY VEHICLES.

[1*]Kambala Prasanna Ramesh Kumar Babu, [1]Boddapu Hema Venkata Sai Kumar,

[1]Denis Bragta [1]Abdulla Asif Toukir,

[1]Department of Automobile Engineering, Lovely professional university, Punjab, India.

Abstract: This study has been undertaken to investigate on active and passive safety technology in L category vehicles. Now a days active and passive safety system are playing an important role in two wheelers. Active safety systems like ABS and Electronic Stability control facilities are installing in almost all two wheelers to avoid accidents, skidding of two-wheelers while it is taking turning and much more accident causes.as well as passive safety systems also taking same as belted seat jacket for future two-wheelers to avoid serious injurious for rider. In this paper we compared three two wheelers in Active safety systems for ABS and Electronic Stability control. The efforts are made to highlight the difference between the execution of different active safety system and passive safety system using three vehicles. On the bases of ABS and electronic stability control.

Index Terms **- Active Safety system, Passive Safety system, Two Wheelers, Antilock braking, electronic stability control.**

I. INTRODUCTION

According to World Health Organization 2015, more than 3 lakhs people die in the whole world due to Powered Two Wheelers and it is expected that if no proper safety features added then it will increase.[1]

75% Powered two wheelers among 3 hundred million vehicles, are being used in Asia only (Rogers 2008) [1]

Motorcyclist's fatality rates are 20–40 times higher if compared with per distance travelled by car driver.[1] National Highway and Traffic Safety Administration (NHTSA) of USA has said more than 6 lakhs lives were saved due to implementation of safety technologies from 1960 to 2012 in America [2]

Estimates suggest that 60% of total vehicles are two wheelers in India and 21% of death casualties in 2015 were done by two-wheeler riders.[3]

So, to reduce this increased number of casualties we have to look more on Safeties of PTW.

Active safety system includes the new technologies i.e electric stability control. This active safety system has received more attention w.r.t to the potential benefit These are likely impart to the vehicle driver and passengers. E.g., Antilock braking system, electronic stability control etc.

Passive safety system includes the stability control is used most in two wheelers to avoid the rider from accidents. It's the passive safety system. Preventing when the rider is in heavy speed without any protection and will prevent from serious injuries in the case of any accidents. E.g., Protective helmet, belted seat.

1. Prominent active and passive safety systems used in two wheelers Active safety features

Active safety features

Antilock braking system

ABS is anti-lock braking system to avoid the locking of brakes. The ABS technology avoids skidding while the rider applies breaks. Experiments have shown that ABS reduce stopping distances of motorcycle which gives better braking stability from falling to the ground (Gail et al. 2009; Teoh 2011; Lich et al. 2015) [4-5]

Passive safety features

Belted seat:

Powered two wheelers offers a solution to decrease the traffic congestion and promote personally. the concept of new passive safety system based upon belted seat known as belted safety jacket.[6]

PTWs ingrained instability and the truancy of passive safety system protective devices and structures conduct a relief for road defense. Two- wheeler Riders are having more risk than four-wheeler drivers per K.M drive in terms of fatalities and crucial damages compared with four-wheel occupants [6]. The novelists clarify that to decrease the damage evidence of the driver, in a large scope of accident ranging, it was fundamental to avert clash of every part of the body i.e., especially body and head in opposition to the vehicle, but also to decline the rider. accordingly, the airbag was made little, and it was placed closer to the rider than the foregoing versions.[7]

Anti-locking braking system (ABS): Anti-lock braking system (ABS) is works on sensor basis which is located at the wheel disc and the sensor is connect to ABS unit at under the seat detects the speed from the speed sensor. When the rider applies a break the speed sensor detects, and the ABS is works accordingly to avoid skidding.

[4-5]

Electronic Stability Control: Electronic stability control (ESC) is helps to grows a vehicle stability by adjudicate and shorten the loss of drift.[8]

Belted seat:

In this occurrence, the critical problem is: 'how is it achievable to slash the rider's damage during major accidents?' [3]. Examples of painful problems may be: "a rider unsafe hits against the opposite vehicle" or "a rider is emitted from the Powered two-wheeler vehicle (PTW)". About potential/partial solutions, "Personal Protective Equipment

(PPE)" is maybe the clear. In this earliest step, problems and potential solutions complicated are those emerged from the examination of the state of the art and the foregoing understanding of passive safety technologies. [9-11] Based on this statistics,

foregoing explanation to the problem were noted and a general outlook on potential drawbacks appeared through the use of these apparatus and systems was created. As well, the assessment of all technical explanations found in the state of the art led to the definition of three familiar macro-functions able to answer the problem.

cover the rider.

slow-down the rider.

control of the rider displacement [12-15]

In this exertion we have taken three vehicles and we compare these three vehicles based on execution of these ABS system electronic stability control and belted seat. In this one vehicle will execute the ABS mechanism in some different way and the other vehicle will be execute in different way and same as in electronic stability control and belted seat. The efforts are made to highlight the difference between the execution of different active safety system and passive safety system using three vehicles. (Pulser 150, unicorn, Xtreame 160R, 390 Duke, R15, Gixxer) On the bases of ABS and electronic stability control belted seat and (another technology name) to highlight the difference in the working mechanism of the systems in different vehicles.

II. Active Safety System:

i. Anti-Braking System (ABS):

ABS works to prevent a two wheeler's wheel to avoid locking of brakes. Anti-lock braking system (ABS) is works on sensor basis which is located at the wheel disc and the sensor is connect to ABS unit at under the seat detects the speed from the speed sensor. When the rider applies a break the speed sensor detects, and the ABS is works accordingly to avoid skidding [16-17]

Anti-lock braking system is installed in many two-wheeler vehicles now a days because the ABS antilocking functions helps to avoid skidding and major injuries as compare to Disc brakes and Drum brakes it works as when the rider applies a brake the ABS technology goes through anti-locking of wheels to avoid skidding. ABS have been installed to reduce the braking distance. Motorcycles with Anti-locking braking system (ABS) technology have been manifested to be involved to avoiding crashes on the road. [18-21]

Most of the motorcycle measurers manufacturers are now offering to install ABS in all motorcycles. If you are planning to buy a motorcycle to our suggestion is to a motorcycle which having ABS technology, it is recommended to buy you an ABS technology motorcycle. Two-wheeler ABS technology involves the less crashes on road; however, ABS may be not appropriate the of-road riding conditions. [23-24]

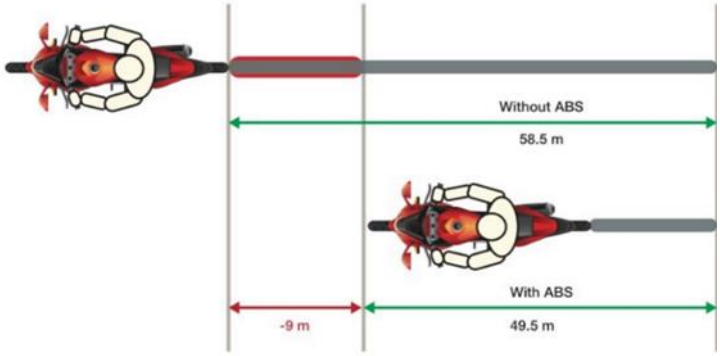

Fig 1: The Braking distance of bike with ABS and without ABS

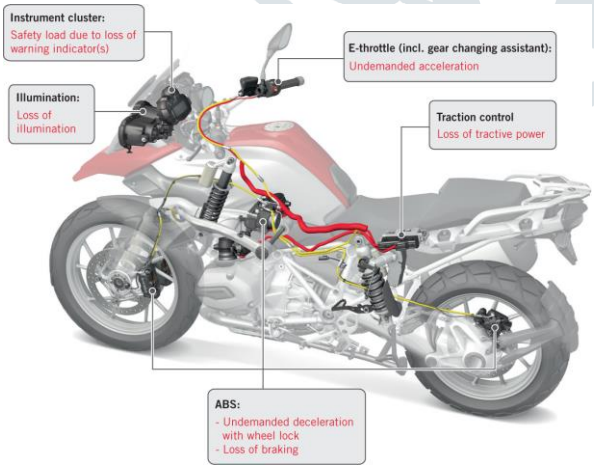

Fig 2. Motorcycle ABS technology is almost similar to 4-wheelers.

Fig 3. ABS Unit.

Benefits for ABS in Motorcycle.

The of the advantages of ABS on on-road motorcycle were commissioned by the commonwealth and Victorian governments released in 2015. [24-25]

1. ABS reduces the Death rate and severe injury from motorcycle crashes by 31%.
2. there are only around 20% of new motorcycles come with ABS technology.

Comparison of three vehicles.

	VEHICLE 1	VEHICLE 2	VEHICLE 3
MODEL	Pulser 150 (BS6) 	Unicorn (BS6) 	Xtreme 160R (BS6) 
MANUFACTURER	BAJAJ	HONDA	HERO
PRINCIPLE	In Addition of ABS the new Bajaj pulser 150 will future revised powering it will be 149cc engine.	The unicorn is powered two-wheeler with 162.7cc BS6 engine develops a power of 12.73bhp and torque of 14 Nm	The hero Xtreme 160R is 100 Million edition draws powered two-wheeler from a BS6 compliant 163cc air cooled single cylinder engine matted to 5 speed gearbox
SENSORS	ABS Sensor (Front wheel) Speed sensor (wheel) Fuel indicator sensor (under seat) Temperature sensor (in crankcase)	ABS sensor (Front wheel) RPM sensor (under tank) Fuel indicator (under seat)	Manifold Air sensor (between air filter & engine) Bank angle sensor (under seat) Engine oil temperature sensor (near intake manifold) Stand sensor (near side stand)
ACTUATORS	Electric, Hydraulic, Pneumatic	Electric, Hydraulic, Pneumatic	Electric, Hydraulic, Pneumatic
APPLICATIONS	Engine Description – 4 stroke BS6 engine Displacement – 149CC Maximum power – 14bhp @8500 rpm Minimum power – 13.4Nm @6500rpm No of cylinders – 1 ABS – single channel	Engine Description - 4 stroke BS6 engine Displacement – 162.7cc Maximum power – 12.91PS @7500rpm Maximum Torque -14Nm @5500rpm No of cylinders – 1 ABS – single channel	Engine Description – 4 stroke 2 volve BS6 engine Displacement – 163cc Maximum power – 11.2KW @8500rpm Maximum Torque – 14Nm @5500rpm No of cylinder – 1 ABS – single channel
GENERATION EVOLVED	Pulser 150 is born in November 2001 it was manufactured by Bajaj to become key player in Automobile industry with 4 stroke and 2 volved cooled engine.	Generation evolved in unicorn with lot of changes as 1. Bigger engine, 2. Fuel injection 3. Ground clearance 4. Seat 5. Engine kill switch 6. Weight	Xtreme 160R is listed to produce 15.2 PS of peak power and 14Nm of max torque from the new 163cc engine These are fine figures and are third best in the list of premium 150cc motorcycles – and higher than Gixxers and FZs

ii. Electronic Stability Control:

Electronic stability control (ESC) is helps to grows a vehicle stability by adjudicate and shorten the loss of drift. Some electronic stability control system also reduce engine power control is regained. [25-26]

Braking is correspondingly applied to wheels step by step, the exterior front wheel to be a counter overdrive, or the interior back wheel to be a counter understeer. [27-29]

Electronic stability control is works on the computer assistance, which is also known as electronic control unit [30]. The electronic stability control monitors the vehicle direction and steering of the vehicle. While it came to action when the rider loss the control of steering i.e when the vehicle skids on a slippery road electronic stability control system makes controlled drafting [31-33]. The electronic stability control sensor finds the direction of skid and engages the individual wheel braking to create the torque about the vehicle axis and oppose the skidding. Moreover, it can also bring down the engine power to slow down the vehicle to more convenient speed. [33-35]

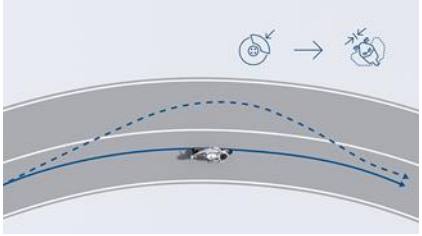

Fig 4. Motorcycle stability during turning

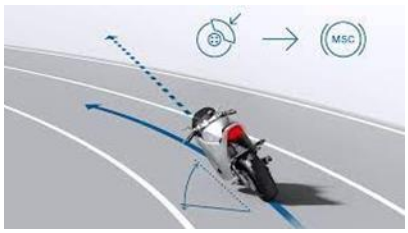

Fig 5. Motorcycle stability

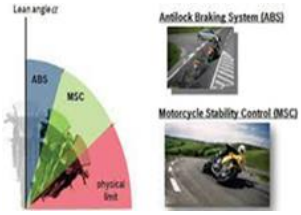

Fig 6. Electronic stability

Electronic stability control is works on the computer assistance, which is also known as electronic control unit [30]. The electronic stability control monitors the vehicle direction and steering of the vehicle. While it came to action when the rider loss the control of steering i.e when the vehicle skids on a slippery road electronic stability control system makes controlled drafting [31-33]. The electronic stability control sensor finds the direction of skid and engages the individual wheel braking to create the torque about the

vehicle axis and oppose the skidding. Moreover, it can also bring down the engine power to slow down the vehicle to more convenient speed. [33-35]

Comparison of three vehicles.

	VEHICLE 1	VEHICLE 3	VEHICLE 3
MODEL	390 Duke 	R15 	Gixxer 
MANUFACTURER	BAJAJ AUTO & KTM	Yamaha	Suzuki
PRINCIPLE	The KTM duke 390 is folded with lot of futures this duke is based on Flagship model duke 1290 with 373.2cc engine	The Yamaha YZF-R15 is a single cylinder sport bike made by Yamaha Motor Company since 2008. In September 2011.	Suzuki upgraded the Gixxer, and SF Models The facelift model has a brand-new fairing, a new digital instrument cluster and BS6 compliant engine.
ELECTRONIC STABILITY CONTROL (ESC)	Control unit is connected with wheel speed sensor and back angle sensor at under the seat.	Stability Control unit is connected with wheel speed sensor and back angle sensor at under the seat.	Stability Control unit is connected with wheel speed sensor and back angle sensor at under the seat.
SENSORS	Wheel speed sensor (at back wheel) Back angle sensor (under seat end) ABS Sensor (at front wheel Disc & Back wheel Disc	Temperature sensor Fuel indicator sensor (under set near to tank) Side stand sensor	Speed sensor Fuel indicator sensor (under seat) ABS sensor (at front wheel disk)
ACTUATORS	Electric, Hydraulic, Pneumatic	Electric, Hydraulic, Pneumatic	Electric, Hydraulic, Pneumatic
APPLICATIONS	Engine Description - 4 Valve, Liquid Cooled BS6 Engine Displacement – 373.2cc Maximum power – 43.5Ps @9000rpm Maximum torque – 37Nm @7000rpm No of cylinders – 1 ABS – Double channel	Engine Description - 4 Valve, Liquid Cooled BS6 Engine Displacement – 155cc Maximum power – 18.6 Ps @10000rpm Maximum torque – 14.1Nm @8500rpm No of cylinders – 1 ABS – Double Channel	Engine Description – 4 stroke, Air cooled BS6 engine Displacement – 155cc Maximum power – 13.6 PS @8000rpm Maximum torque – 13.8Nm @6000rpm No of Cylinders – 1 ABS – Single channel
GENERATION EVOLVED	From 2017- Present The new KTM 390 Duke state of the art with twin overhead camshaft once again underlines KTM'S development strength.	From 2008 – present Yamaha R15 was made to race. The dimensions made it possible. And on the top of that, Yamaha R15 was aerodynamically designed.	First generation – 1984 Second Generation – 1988 Third Generation – 1992 Fourth Generation – 1994 Fifth Generation – 1966 Sixth Generation – 2001 GSX – R1000 -2001 GSX – R1000R – 2017 GSX-R125: 2017–present GSX-R150: 2017–present GSX-R600: 1992–present GSX-R750: 1985–present

III. Passive safety system

i. Belted seat

The common theme of the investigation was to develop a safety technologies installable on all Powered Two Wheelers, the difference in the device layout will be compulsory to switch to the frame of different models [36-37]. Belted seat jacket is more important component for future generation two wheelers. For this source, the assessment of the equipment awarding with different geometrical framework is crucial. The belted seat jacket is helps to avoid higher injuries for rider when the rider hits any opposite vehicle A full factorial Design of Experiment (DOE) was taken since no details about factorial interaction was available. Five factors and two levels were advised. [37-38].

Three out of five factors are linked to geometrical dimensions of the device:[39]

- Lengthwise slip-ring position
- perpendicular slip-ring position
- Belt's jacket is perpendicular link position: The resting variables are binary and represent other option for system layout.
- Pretensioner presence
- Vest-belts link position

The mechanism and algorithm used are different compared to the Alpinestars and Dainese. This system is much focusing on street motorcyclists and not for the racetrack [40]. Basically, for the hardware design concept, the canister that contains high pressure CO2 fluid is used to inflate the airbag in within 0.05 to 0.1 seconds [6 & 41]. Solenoid valve with pressure rating of 60 bar was

used to control the air flow. The most important part for an airbag deployment system is gyro sensor. MPU-6050 is used to calculate the gyro and accelerometer data thus can help to improve the system by combining the algorithm. The performance of an airbag inflation system is depending fully on the algorithms in aspects of efficiency, safety, and reliability. [5 -6]

Fig 7. Belted seat installation in motorcycle

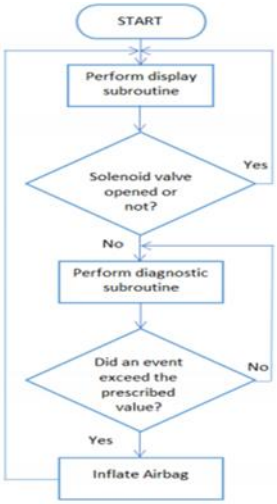

Fig 8: Flowchart for airbag deployment in real-time system

The carbon dioxide (CO2) is stored in the cylinder at ambient temperature and at very high temperature, so it is at liquid state. When the inflation is triggered and the percussor is removed the cylinder is put in communication with the airbag chamber, so CO2 suddenly evaporates and flows through the percussor hole in the chamber which is at almost ambient pressure. This sudden pressure reduction leads to a great temperature decrease, the cold CO2 in the chamber is after quickly warmed again trough the contact with the chamber tissue and the ambient, so pressure in the airbag continues to rise even when all gas in the cylinder already flew in the chamber. Given the cumulative mass of CO2 [6 & 41], several simulations, acting on the mass flow and gas temperature, were performed to adjust inflation parameters and achieve a good match with experimental inflation data, both on pressure and on time, obtained from three pressure sensors disposed on the device during an inflation. Back impact sequence with and without airbag at different speeds from equivalent height 2m, the airbag triggered at 1m above ground. [41-43]

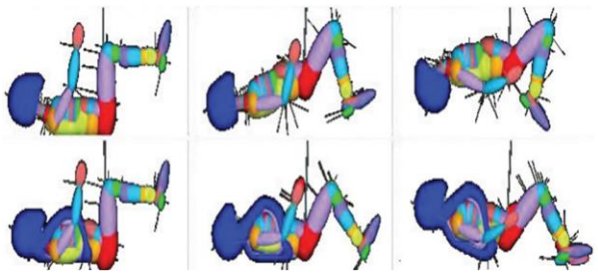

Fig 9. Belted seat jacket working process.

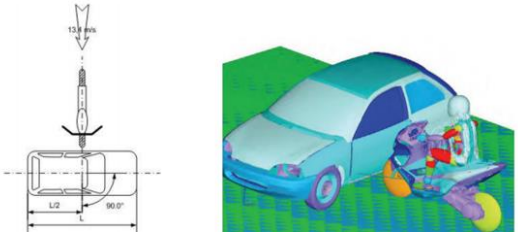

Fig10. Belted seat jacket opens when the bike meat anything.

IV. Patents

Sr. No	Patent	Link
1	EP1531101B1 Antilock brake controlling method (Shinji Goto, Keishin Tanaka, Makoto Toda, Hiroyuki Yoshida) 1.The antilock braking system of a vehicle includes with plurality of wheels. 2. In traveling the antilock system works as the rotational speed of wheel A and the rotational speed of wheel B will be detected and ABS will be inhibited where the rotational speed of wheel A is less than the B.	https://patents.google.com/patent/EP1531101B1/en?oq=EP1531101B1
2	US7841674B2 ABS control system for off-road driving conditions (Hermann J. Goebels, Andreas Ziegler) 1. More than one signals come from plurality sensor by said electronic control device to determine the speed of a wheel. 2. a unit named the processing unit that calculates the reference speed wheel slip sensed and then ABS controlled the wheel	https://patents.google.com/patent/US7841674B2/en?q=Antilock+braking+system&oq=Antilock+braking+system
3	JPH06191386A Anti-lock brake control method and anti-lock brake control device (Yoshiyuki Yasui) 1. An ABS system for a vehicle/motorcycle having at least one wheel and the speed of one wheel will be detected. 2. illustration of the related ABS is the system that controlling to prevent the locking of wheels during apply of brakes.	https://patents.google.com/patent/JPH06191386A/en?q=Antilock+brake+controlling+method&oq=Antilock+brake+controlling+method+
4	US20010053953A1 Antilock braking control method and system (Shao-Wei Gong, Kwun-Lon Ting) 1. measuring of a wheel radius in the x direction in response to cyclically controlling of a breaking torque. 2. measuring of a wheel angular velocity predefined relationship to the wheel radius plane to identify the wheel motion.	https://patents.google.com/patent/US20010053953A1/en?q=Antilock+brake+controlling+method&oq=Antilock+brake+controlling+method+
5	US5445443A Motorcycle ABS using horizontal and vertical acceleration sensors (Berthold Hauser, Heinz F. Ohm, Georg Roll) 1. An Intelligence circuit coupled to the wheel sensor to receive the sensor output signal. 2. a pressure modulator coupled to the intelligence circuit which adject the braking pressure at the two wheels	https://patents.google.com/patent/US5445443A/en
6	US6622077B2 Anti-lock braking system and method (Gerhard Ruhnau, Gerald Stanusch) 1.an antilock braking system for wheeled vehicle having at least two axles. 2. in break units equipped with the antilock braking system braking pressure modulators.	https://patents.google.com/patent/US6622077B2/en
7	US5277482A Antilock braking system (Claus Beyer, Peter Dominke) 1. antilock braking system for preventing the locking of wheels of a vehicle during a rider applies a break. 2. the ABS is in switched off mode when the vehicle is not braked	https://patents.google.com/patent/US5277482
8	US4694938A A braking device for motorcycles (Tsutomu Hayashi, Takeshi Kawaguchi, Tetsuo Tsuchida) 1. a break is actuated on the basis of hydraulic system pressure from a master cylinder.	https://patents.google.com/patent/US4694938

	2. antilock control unit controlling a break hydraulic pressure.	
9	GB2143917A Motorcycle anti-lock brake systems (Tsutomu Hayashi, Masaie Kato, Mitsuru Saito) 1. a motorcycle having a antilock braking system having a front road wheel and a rare road wheel. 2. the back master cylinder having a secondary brake chamber controlling the brake torque.	https://patents.google.com/patent/GB2143917A/en
10	US8573709B2 Braking control apparatus for electric vehicle (Keisuke Suzuki, Jun Kubo) 1. in a breaking control of a electronic vehicle a target breaking controls the command calculation section calculates target breaking torque.	https://patents.google.com/patent/US8573709B2/en?q=Antilock+breaking&oq=Antilock+breaking
11	US6892395B2 Safety garment having safety harness (James R. Schweer) 1. A safety garment for industrial purposes or hunting including a safety jacket, coat, and vest are included. 2. The safety garment of belted seat, further comprising leg loops for selective attachment to said waist belt.	https://patents.google.com/patent/US6892395B2/en?oq=US6892395B2
12	US3533107A Safety garment for cyclist (Anthony Raneri, Americo Frank Garbarino) 1. the safety garment of the belted seat when the driver or rider meat an accident its automatically the jacket will be open	https://patents.google.com/patent/US3533107A/en?oq=US3533107A
13	US4177877A Safety vest (Albert A. Gallinati) 1. a safety garment having its inner and outer shell 2. The invention according to safety vest and said garment having a lining and said strap assembly being held captive between the shell and the lining	https://patents.google.com/patent/US4177877A/en?oq=US4177877A
14	US5738046A Safety jacket and harness system (Tommie Ann Williams, David A. Williams) 1. The present invention relates to a safety jacket and harness system and more particularly pertains to providing a safety system for the user of a tree stand and the system has a jacket coupled	https://patents.google.com/patent/US5738046A/en?oq=US5738046A
15	US5970517A Safety harness with integral support line (Omar P. Jordan.) 1.a harness having an integral support line. 2. the support line having first and second end that extend from the harness body	https://patents.google.com/patent/US5970517A/en?oq=US5970517A+
16	US6101631A Built-in full-body harness system for hunters (Ferguson, Jr.Vernon) 1. The presenting of invention relates to the field body harnesses in general to a full-body harness that is built into an article of camouflage clothing.	https://patents.google.com/patent/US6101631A/en?oq=US6101631A
17	US20030146044A1 Sefety harness with support strap (Omar Jordan) 1. the support harness with the help of support strap for the use of rescue person.	https://patents.google.com/patent/US20030146044A1/en?oq=US20030146044A1
18	US20060124389A1 Fall-arresting safety harness with an improved buckle (John Wydner) 1. To present the invention relates to the field of safety equipment. More particularly, the present invention relates of safety hunting harnesses in general. Most particularly, the present invention relates to a improved buckle for an adjustable with a fall arresting safety harness.	https://patents.google.com/patent/US20060124389A1/en?oq=US20060124389A1

19	US20030015905A1 Seat harness with a non-openable closed belt (Jacques Sappei, Marc Menetrier) 1. The safety of the harness according to the invention is then enhanced since it can't be opened. In addition, the harness may be donned more easily as its components are always correctly positioned and identifiable	https://patents.google.com/patent/US20030015905A1/en?oq=US20030015905A1
20	DE102013009379A1 Protection system for fall-prone persons (Anmelder Gleich) 1. this conventional airbag designs are not up to the ingenious constructions, as they evolution, as in the hedgehog, has brought to their protection.	https://patents.google.com/patent/DE102013009379A1/en?oq=DE102013009379A1
21	WO2007024591A1 Vehicle stability control system (Michael Kroehnert, Siegfried Jauch, Flavio Nardi, Andris Samsons, Vaughan Scott 1. A yaw rated sensor make a important role in vehicle to control a stability while a vehicle in turning position. 2. A torque request sensor configured to generate an output indicative of a torque request by a rider of the vehicle	https://patents.google.com/patent/WO2007024591A1/en
22	US8170767B2 Vehicle stability control system and method (Joseph Carr Meyers, Daniel Domek Eisele, Todd Allen Brown, Li Xu, Albert Chenouda Salib. 1. by applying a break vehicle the pressure under the wheel at outside corner of a vehicle when a vehicle is oversteering. 2. By applying a break vehicle the pressure under the wheel at inside corner of a vehicle when a vehicle is understeering	https://patents.google.com/patent/US8170767B2/en
23	US9043111B2 Three-wheel vehicle electronic stability system and control strategy therefor (Mario Dagenais, Daniel Mercier) 1. the set of front wheels are being associated to the frame via a front suspension. 2. engine supported by a frame and operated to associated to last one of the wheels to provide power to the vehicle.	https://patents.google.com/patent/US9043111
24	US5445443A Motorcycle ABS using horizontal and vertical acceleration sensors (Berthold Hauser, Heinz F. Ohm, Georg Roll) 1. a circuit connected to the wheel sensor to receive the sensor output signal and detects outbreaking states from sensor outputs. 2. a pressure modulator is connected to the circuit which adjusts the brake pressure at two wheels to response the control signal.	https://patents.google.com/patent/US5445443
25	WO2013130656A1 Gyroscope stabilization in two-wheeled vehicles (Daniel Kee Young Kim, Brandon BASSO) 1. a control moment of gyroscope includes a flywheel a flywheel motor to drive the fly wheel. 2. position and the velocity sensor to determine the position and the velocity of a vehicle	https://patents.google.com/patent/WO2013130656A1
26	EP2944526B1 Stability control system, saddled vehicle having stability control system, method, and computer program (Goh Takahashi, Yoshitomi Nakagawa) 1. a stability control for changing brake force or a driving force of a motorcycle having a first wheel and second wheel to the stability control system. 2. a vehicle speed sensor arranged to acquire a motorcycle speed	https://patents.google.com/patent/EP2944526B1/en?q=stability+control+of+motorcycle&oq=stability+control+of+motorcycle

27	US9409573B2 Vehicle speed determination system, stability control system, and saddled vehicle having the same (Yoshimichi Seki) 1. a wheel is sensor is directly arranged to wheel of vehicle at in front wheel. 2. the difference in the vehicle speed between a front-wheel tangential and the rare-wheel tangential point due to difference between a locus of a point.	https://patents.google.com/patent/US9409573B2/en?q=stability+control+of+motorcycle
28	EP2699462B1 Dynamic stability control using gnss and ins (Ute Marita Meissner, Rolf Meissner) 1. the driving dynamics of a vehicle are controlled by a brake and engine intervention. 2. the control of driving dynamics performed by a way of braking.	https://patents.google.com/patent/EP2699462B1/en?oq=EP2699462B1
29	US9718465B2 Bicycle stability control methods and systems (Jamel Seagraves, Darioush Aghai-yazdi) 1. detecting by a stability control of a bicycle an impending occurrence of an event related to the bicycle based at least in a part one or more parameters	https://patents.google.com/patent/US9718465B2/en?q=stability+control+bikes&oq=stability+control+in+bikes
30	US8342546B2 Two-wheeled in-line vehicle with torque generator (Robert H. Bryant) 1. a first wheel pivotable about a shaft to define said steering axis to steer said two-wheeler vehicle by tilting said frame about said longitudinal center line.	https://patents.google.com/patent/US8342546B2/en?q=stability+control+bikes&oq=stability+control+in+bikes

V. Conclusion:

Based on the analysis and the literature summarized the following conclusions can be made:

1.Anti-lock Braking system (ABS) is a in active safety system, and it is very important to this generation bikes to avoid accidents. It is the system acts as anti-locking of brakes while a rider applying brake. It helps to avoid skidding of wheels.

2.Electronic stability control is also a active safety system technology it works to take a proper turning with certain angle to avoid skidding of wheels. The electronic stability control unit is a type of sensor which is connected to Abs and speed sensor.

3.Belted seat Jacket is a future passive safety system technology. It helps to not get major injuries for rider when the bike met an accident. At starting the rider needs to wear a belt which is included in bike when the rider met anything the belted seat jacket is automatically covers the whole body to avoid injuries.

References:

[1] Giovanni Savino, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will & Julie Brown, “Active safety systems for powered two-wheelers: A systematic review”, 2020, Page No 1 [2] Giovanni Savino, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will & Julie Brown, “Active safety systems for powered two-wheelers: A systematic review”, 2020, Page No 2

[3] Mr. Nidal Ahmed Aftab Ahmed Pawne, Mr. Gaurav Mohan Deo, Mr. Armash Qutbuddin Farid, Mr. Irfaan Ahmed Mohmed Yusuf Nishandar, “Auxiliary safety systems for two wheelers”, 2017 IJNRD | Volume 2, 104

[4] Giovanni Savino, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will & Julie Brown, “Active safety systems for powered two-wheelers: A systematic review”, 2020, Page No 3

[5] Savino, Giovanni, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will, and Julie Brown. "Active safety systems for powered two-wheelers: A systematic review." Traffic injury prevention 21, no. 1 (2020): 78-86.

[6] Grassi, A., D. Barbani, N. Baldanzini, R. Barbieri, and M. Pierini. "Belted safety jacket: a new concept in powered two-wheeler passive safety." Procedia Structural Integrity 8 (2018): 573-593.

[7] Abidin, Zulkifli Zainal, and Fakhruddin Razali. "Development of Airbag Suit System for Motorcyclist." (2014).

[8] Savino, Giovanni, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will, and Julie Brown. "Active safety systems for powered two-wheelers: A systematic review." Traffic injury prevention 21, no. 1 (2020): 78-86

[9] Reimer, Suzanne, and Philip Pinch. "Sites of qualification: the motorcycle rider airbag and the production of safety." Journal of Cultural Economy 14, no. 1 (2021): 26-40

[10] Grassi, A., D. Barbani, N. Baldanzini, R. Barbieri, and M. Pierini. "Belted safety jacket: a new concept in powered two-wheeler passive safety." Procedia Structural Integrity 8 (2018): 573-593.

[11] Andrew P., William S., Rouse B., 1999. Handbook of Systems Engineering and Management. W. S. I. S. Engineering, John Wiley & Sons

[12] Ankarath, S., Giannoudis, P.V., Barlow, I., Bellamy, M.C., Matthews, S.J., Smith, R.M., 2002. Injury patterns associated with mortality following motorcycle crashes. Injury, Volume 33, pp. 473-477.

[13] Horsch, John D., John W. Melvin, David C. Viano, and Harold J. Mertz. "Thoracic injury assessment of belt restraint systems based on Hybrid III chest compression." SAE transactions (1991): 1875-1898.

[14] Backaitis, S.H. and St-Laurent, A., 1986. Chest deflection characteristics of volunteers and Hybrid III dummies. SAE Technical Paper.

[15] Barbani, Daniele, Niccolò Baldanzini, and Marco Pierini. "Development and validation of an FE model for motorcycle–car crash test simulations." International journal of crashworthiness 19, no. 3 (2014): 244-263.

[16] Mladenović, Dušan, Mladen Marina, and Dragan Sekulić. "Motorcycle safety features, contemporary elements of active and passive safety." In Proceedings of the Second International Conference Transport for today's society. 2018.

[17] Mehta, Vatsal, R. Ujwal, Rakshith Narun, Savan Vachhani, and Babu Rao Ponangi. "Passive Safety System for Two-and Four-Wheeled Vehicles." In International Conference on Communication, Computing and Electronics Systems, pp. 173-184. Springer, Singapore, 2020.

[18] ELAIYARAJA, Mr K., KRAJ KUMAR, and M. SHEIK MOHAMED. "SMART HUMAN TWO WHEELER SAFETY SYSTEM." (2017).

[19] Giovanni Savino, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will & Julie Brown, "Active safety systems for powered two-wheelers: A systematic review", 2020, Page No 3

[20] Jitesh, Sahil. "Antilock braking system (ABS)." International Journal of Mechanical Engineering and Robotics Research 3, no. 4 (2014): 253.

[21] Roll, Georg, Oliver Hoffmann, and J. Konig. "Effectiveness evaluation of antilock brake systems (ABS) for motorcycles in real-world accident scenarios." In ESV Conference. 2009

[22] Mohan, S. "Design And Development Of An Improved Anti-Lock Braking System For Two-Wheelers." PhD diss., 2011

[23] Savino, Giovanni, Roberto Lot, Matteo Massaro, Matteo Rizzi, Ioannis Symeonidis, Sebastian Will, and Julie Brown. "Active safety systems for powered two-wheelers: A systematic review." Traffic injury prevention 21, no. 1 (2020): 78-86.

[24] Bhasin, Kartik. "A Review Paper on Anti-Lock Braking System (ABS) and its Future Scope

[25] Sarkar, Subhasis, Deep Mistry, Suraj Raval, Harsh Vadhnere, and Nimit Suryawala. "A Review Paper on Pneumatic Controlled ABS." (2020).

[26] De Filippi, Pierpaolo, Mara Tanelli, Matteo Corno, Sergio M. Savaresi, and Mario D. Santucci. "Electronic stability control for powered two-wheelers." IEEE transactions on control systems technology 22, no. 1 (2013): 265-272.

[27] De Filippi, Pierpaolo, Mara Tanelli, Matteo Corno, Sergio M. Savaresi, and Mario D. Santucci. "Electronic stability control for powered two-wheelers." IEEE transactions on control systems technology 22, no. 1 (2013): 265-272.

[28] Zhao, Yu, and Chengning Zhang. "Electronic stability control for improving stability for an eight in-wheel motor-independent drive electric vehicle." Shock and Vibration 2019 (2019).

[29] Seiniger, Patrick, Kai Schröter, and Jost Gail. "Perspectives for motorcycle stability control systems." Accident Analysis & Prevention 44, no. 1 (2012): 74-81.

[30] Schroeter, K., P. Seiniger, and J. Gail. "Perspectives for motorcycle stability control systems." In International Conference on Safety and Mobility of Vulnerable Road Users, 2010, Jerusalem, Israel. 2010.

[31] Lich, Thomas, Wilko Gordon Block, S. N. Prashanth, and Brad Heiler. "Motorcycle stability control-the next generation of motorcycle safety and riding dynamics." SAE International journal of engines 9, no. 1 (2016): 491-498.

[32] Cardinale, Pascal, Camillo D'Angelo, and Massimo Conti. "Traction control system for motorcycles." EURASIP Journal on Embedded Systems 2009 (2008): 1-10.

[33] De Filippi, Pierpaolo, Mara Tanelli, Matteo Corno, Sergio M. Savaresi, and Mario D. Santucci. "Electronic stability control for powered two-wheelers." IEEE transactions on control systems technology 22, no. 1 (2013): 265-272.

[34] Lich, Thomas, Wilko Gordon Block, S. N. Prashanth, and Brad Heiler. "Motorcycle stability control-the next generation of motorcycle safety and riding dynamics." SAE International journal of engines 9, no. 1 (2016): 491-498.

[35] Cherta Ballester, Oscar, Maxime Llari, Valentin Honoré, Catherine Masson, and Pierre-Jean Arnoux. "An evaluation methodology for motorcyclists' wearable airbag protectors based on finite element simulations." International journal of crashworthiness 26, no. 1 (2021): 99-108.

[36] DIN EN 1621-1, 2013. European Commitee for Standartization - Motorcyclists' protective clothing against mechanical impact - Part 1: Motorcyclists' limb joint impact protectors - Requirements and test methods

[37] Grassi, A., D. Barbani, N. Baldanzini, R. Barbieri, and M. Pierini. "Belted safety jacket: a new concept in powered two-wheeler passive safety." Procedia Structural Integrity 8 (2018): 573-593.

[38] Otte, D. and Middelhauve, V., 1987. Quantification of protective effects of special synthetic protectors in clothing for motorcyclists. Interntional IRCOBI conference on the, 1987.

[39] He Huan, Chen Zhe, He Cheng, Ni Lei, Chen Guoping, "A hierarchical updating method for finite element model of airbag buffer system under landing impact", Chinese Journal of Aeronautics, (2015), 28(6): 1629–1639.

[40] Berg, F.A. & Rücker, P. 2007. Motorcycle airbags - an option to improve the secondary safety for powered two-wheeler riders. 21st International JUMV Automotive Conference Science & Motor Vehicles, Beograd, Paper No. NMV0708

[41] Zeeshan Ahmad, "The unassuming danger of car airbags: Injuries secondary to airbag deployment", Injury Extra 42 (2011) 69–70.

[42] Alena Høye, "Are airbags a dangerous safety measure? A meta-analysis of the effects of frontal airbags on driver fatalities" Accident Analysis and Prevention 42 (2010) 2030–2040

[43] Kwanghyun Cho, Seibum B. Choi , Sungdon Wee, Kyungjae Shin "Design of an Airbag Deployment Algorithm Using a Radar Sensor" 6th IFAC Symposium Advances in Automotive Control Munich, Germany, July 12-14, 2010