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Advancement in Vehicle Airbag Deployment System

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Abstract

This paper aims to have a brief study on the safety measures of an airbag. Automobile airbag has gained acceptance as an effective measure to reduce the morbidity and mortality associated with motor vehicle accidents. As more vehicles have become equipped with them, new problems have been encountered that are directly attributable to the deployment of the airbag itself. As increasing variety of associated injuries has been reported, including retinal damage causing blindness, skull damage, neck injuries etc. The artificial outcome from this study is to justify the need of further research in the area of vehicle safety with extensive focus on strengthening airbag related vehicle issues.

Keywords: Airbag, injuries, safety, automobile, weight sensor, accelerometer.

Introduction

Airbag is one of the safety device used in a vehicle. Its function is to cushion persons sitting inside a vehicle during collision and provide protection to their bodies from the interior objects such as steering wheel or windows. Airbag was first introduced in automobiles in 1970s with a limited success. The first airbag was named as Air cushioned Restraint System (ACRS) and launched by General Motors.

WORKING OF A CONVENTIONAL AIRBAG

Airbag must deploy and inflate within a fraction of a second (generally 30-60

milliseconds) from the point of event of collision. It becomes an energy-absorbing buffer between occupants and hard interior surfaces of vehicles. The airbag is linked with an electric cable to a sensor and ECU. Contained in the sensor is a small tube consisting of a ball inside. As the car roles and bumps along the ball inside the tube moves. The movements are converted by the sensor into signals and sends it to the ECU. While the vehicle is driven the sensor sends signals to the ECU that how fast the car is going. This sensor continuously sends signals to the ECU. Only a dangerous crash and deceleration makes the ball hit one side of the tube which sends a danger signal to the ECU which then deploys the airbag. During the crash, the sensors switch on the electric circuit and a pallet of sodium azide (NaN3) ignites. This leads to a rapid reaction, generating enough nitrogen gas to inflate the airbag. This gas fills a nylon bag at a velocity of 240-370 kph (approx.), preventing the contact of occupants with the hard surface and thus reduces the fatalities of severe injuries.

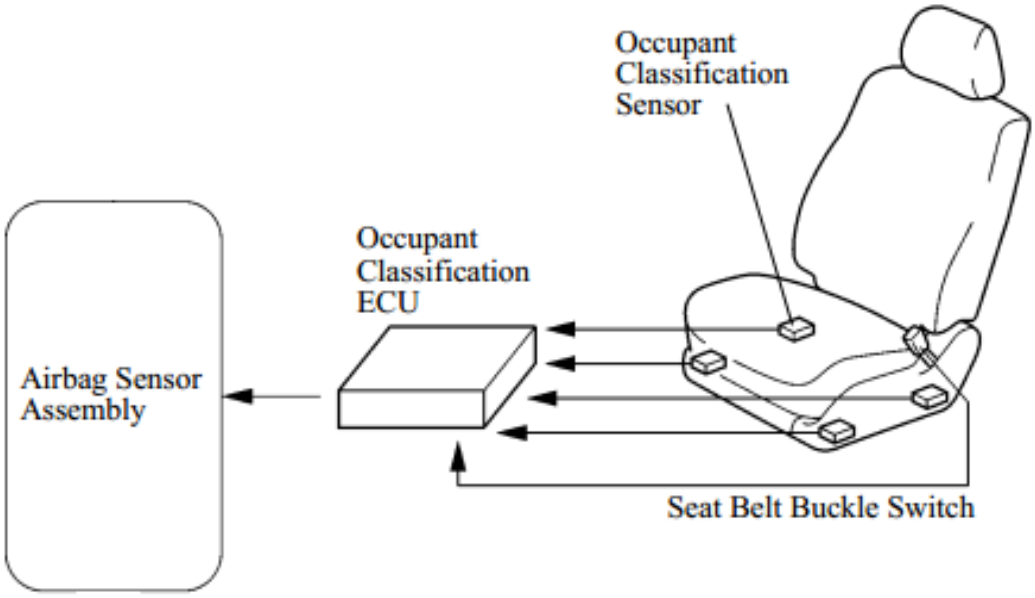

Fig: 2 Schematic representation of an airbag assembly system of a typical car. (Without weight sensor)

It has been observed that even though an airbag has been installed in vehicles for providing safety it has been quite the opposite in certain cases. Hence betterment in an airbag is the need of an hour. A few suggestions are mentioned below.

Infants are the ones who suffer the most during an accident due to deployment of an airbag. Hence it is recommended to have a weight sensor installed in the front passenger seat which calculates the weight and in case of low speed accidents the airbag doesn’t deploy.

Case Study

According to an interesting fact carried out by Akademie is Germany's leading organization for international media developmentDeutsche Welle in 2013, road accidents have reached an entire new level. Talking about India, the country has overtaken all other countries and has the worst traffic rate worldwide. Around the globe 40 people under the age of 40 die due to road accidents every hour. According to the WHO, this is one of the most important death cause for 5 to 29 year olds. In India the death toll raised to 18 per hour in 2013 as opposed to 13 in the 2012.

Table 1: Total number of accidents in each state of India during the years 2008-2011. (Courtesy: data.gov.in)

Total Number of Fatal Vehicle Accidents in States/UT's. Year: 2008-2011

Sl. No.	States/UTs	2008	2009	2010	2011 (P)
1	2	3	4	5	6
1	Andhra Pradesh	12,233	12,676	13,932	13,783
2	Arunachal Pradesh	90	114	108	96
3	Assam	1,641	1,735	1,924	2,015
4	Bihar	3,514	4,038	4,513	4,676
5	Chhattisgarh	2,600	2,566	2,668	2,659
6	Goa	294	298	307	314
7	Gujarat	6,132	6,112	6,648	7,045
8	Haryana	4,071	4,227	4,168	4,255
9	Himachal Pradesh	568	760	766	735
10	Jammu & Kashmir	694	773	814	846
11	Jharkhand	1,829	2,042	2,256	2,279
12	Karnataka	7,848	7,717	8,354	8,091
13	Kerala	3,632	3,556	3,646	3,896
14	Madhya Pradesh	5,861	6,415	7,044	6,992
15	Maharashtra	10,789	10,143	11,188	11,557
16	Manipur	109	99	121	142
17	Meghalaya	103	124	131	147
18	Mizoram	53	51	63	59
19	Nagaland	57	33	24	24
20	Odisha	2,838	3,043	3,388	3,220
21	Punjab	2,840	3,216	3,282	4,483
22	Rajasthan	7,241	8,010	8,143	8,354
23	Sikkim	32	55	32	48
24	Tamil Nadu	11,813	12,727	14,241	14,359
25	Tripura	190	216	224	229
26	Uttarakhand	717	676	740	726
27	Uttar Pradesh	11,652	12,679	13,282	13,004
28	West Bengal	4,671	4,135	4,975	5,107
29	Andaman & Nicobar Islands	22	31	25	17
30	Chandigarh	144	164	132	129
31	Dadra & Nagar Haveli	62	43	61	61
32	Daman & Diu	29	32	30	33
33	Delhi	2,015	2,272	2,104	2,007
34	Lakshadweep	0	1	0	0
35	Puducherry	207	214	224	230
Total		**106,591**	**110,993**	**119,558**	**121,618**

Table 1 represents the total number of vehicle accidents from 2008 to 2011. Hitherto from 2008 it is seen that the number of accidents have increased in total and a prudent measure is required.

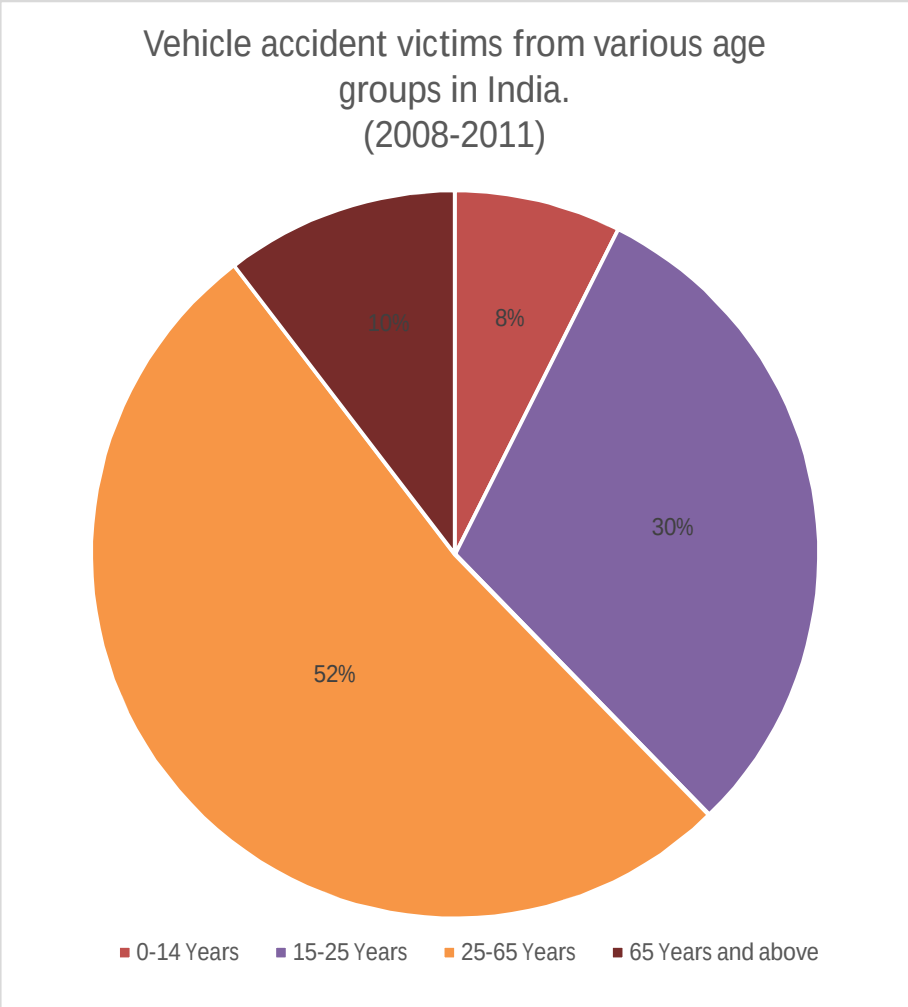

Fig. 1: Vehicle accident victims from various age groups between the years 2008 to 2011 in India. (Courtesy: data.gov.in)

Figure 1 belabors the age group of victims who have suffered in a vehicle crash. The majority of victims belong to the age group of 25-65 years.

Table 2: Total number of deaths or injuries in each state of India during the years 2011. (Courtesy: data.gov.in)

Total Number of Accidents, Number of Persons Killed and Number of Persons Injured in Vehicle Accidents in Urban & Rural Areas: 2011

Sl. No.	States/UTs	Urban			Rural			Total		
		Total	Killed	Injured	Total	Killed	Injured	Total	Killed	Injured
1	2	3	4	5	6	7	8	9	10	11
1	Andhra Pradesh	19,081	5,429	21,387	25,084	9,736	34,196	44,165	15,165	55,583
2	Arunachal Pradesh	140	66	240	123	60	198	263	126	438
3	Assam	3,951	1,406	3,686	2,618	936	2,819	6,569	2,342	6,505
4	Bihar	4,746	2,238	3,176	5,927	2,852	3,907	10,673	5,090	7,083
5	Chhattisgarh	6,402	1,153	5,656	7,706	1,830	8,273	14,108	2,983	13,929
6	Goa	1,906	151	884	2,654	182	1,434	4,560	333	2,318
7	Gujarat	10,797	1,890	9,877	19,408	6,118	19,867	30,205	8,008	29,744
8	Haryana	3,907	1,644	2,561	7,221	3,118	7,166	11,128	4,762	9,727
9	Himachal Pradesh	1,153	254	2,047	1,946	818	3,415	3,099	1,072	5,462
10	Jammu & Kashmir	2,738	427	3,334	3,917	689	6,678	6,655	1,116	10,012
11	Jharkhand	2,378	1,044	1,987	3,073	1,528	2,824	5,451	2,572	4,811
12	Karnataka	18,159	2,929	19,610	26,572	6,042	39,981	44,731	8,971	59,591
13	Kerala	13,765	1,720	16,241	21,451	2,425	25,138	35,216	4,145	41,379
14	Madhya Pradesh	25,937	2,842	26,045	23,469	5,027	29,500	49,406	7,869	55,545
15	Maharashtra	39,676	3,998	17,262	28,762	9,059	28,366	68,438	13,057	45,628
16	Manipur	245	56	343	447	102	775	692	158	1,118
17	Meghalaya	305	78	266	294	134	325	599	212	591
18	Mizoram	39	23	43	58	58	172	97	81	215
19	Nagaland	39	25	107	0	0	0	39	25	107
20	Odisha	4,550	1,788	5,316	4,848	2,014	5,932	9,398	3,802	11,248
21	Punjab	2,255	1,592	1,372	4,258	3,339	2,709	6,513	4,931	4,081
22	Rajasthan	8,923	2,943	10,525	14,322	6,289	18,141	23,245	9,232	28,666
23	Sikkim	127	33	101	279	73	220	406	106	321
24	Tamil Nadu	28,387	6,222	29,129	37,486	9,200	45,116	65,873	15,422	74,245
25	Tripura	292	91	284	542	154	746	834	245	1,030
26	Uttarakhand	729	449	775	779	488	937	1,508	937	1,712
27	Uttar Pradesh	13,801	6,647	8,959	15,484	14,865	6,554	29,285	21,512	15,513
28	West Bengal	8,550	2,748	7,929	6,395	2,916	7,033	14,945	5,664	14,962
29	Andaman & Nicobar Islands	53	4	58	181	13	240	234	17	298
30	Chandigarh	367	102	330	70	34	40	437	136	370
31	Dadra & Nagar Haveli	15	7	14	88	56	196	103	63	210
32	Daman & Diu	13	6	7	37	27	30	50	33	37
33	Delhi	7,281	2,065	7,226	0	0	0	7,281	2,065	7,226
34	Lakshadweep	0	0	0	0	0	0	0	0	0
35	Puducherry	748	127	767	732	106	922	1,480	233	1,689
Total		**231,455**	**52,197**	**207,544**	**266,231**	**90,288**	**303,850**	**497,686**	**142,485**	**511,394**

The facts in Table 2 shows the number of victims injured and killed in rural and urban regions inthe year 2011. It depicts from the Table 1 that there has been an increase in the accidents which lead to injuries and deaths showed in table 2.

Table 3: Average weight of children (both boys and girls) below the age of 13. (Courtesy: buzzle.com)

Age (Yrs.)	Boys	Girls
1	22.0 lbs (9.97 Kg)	21.76 lbs (9.87 Kg)
2	28.4 lbs (12.88 Kg)	28.4 lbs (12.88 Kg)
3	33.0 lbs (14.97 Kg)	30.8 lbs (13.97 Kg)
4	35-37 lbs (15.87-16.78 Kg)	35.2 lbs (15.97 Kg)
5	41.8 lbs (18.97 Kg)	39.6 lbs (17.97 Kg)
6	46.2 lbs (20.95 Kg)	46.2 lbs (20.95 Kg)
7	50.6 lbs (22.95 Kg)	50.6 lbs (22.95 Kg)
8	57.2 lbs (25.95 Kg)	57.2 lbs (25.95 Kg)
9	61.6 lbs (27.95 Kg)	63.8 lbs (28.93 Kg)
10	70.4 lbs (31.93 Kg)	70.4 lbs (31.93 Kg)
11	77.0 lbs (34.92 Kg)	79.2 lbs (35.92 Kg)
12-13	85-100 lbs (38.55-45.35 Kg)	95-105 lbs (43.10-47.62 Kg)

Table 3 portrays the average weight of children below the age of 13 years. The maximum weight is approximately 48 kg. The least weight is roughly around 10 kg.

Proposed CONCEPT

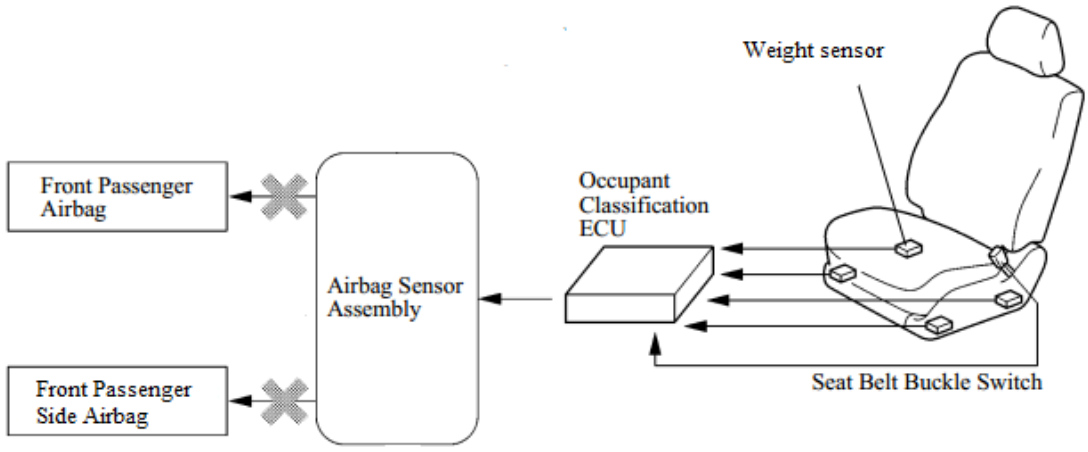

Fig: 3Schematic representation of an airbag assembly system of a typical car. (With weight sensor)

Working of the conventional airbags without the weight sensor had no provision to detect whether an infant or an adult is sitting in the passenger seat at

This is really important to understand as it has been observed that most of the time an infants are the one who suffer the most injuries due to deployment of an airbag at set velocity. Hence, to overcome this problem, authors are recommending to install a weight sensor in the front passenger seat.

A weight sensor is a typical sensor which calculates the weight of the person sitting on a passenger seat. This information is used in deployment of the airbags at the time of crash, keeping the velocity of deployment of the airbags according to the person's weight.

Say for a case of low speed accident, which may cause no injuries, the airbag shouldn't deploy.

The system working is almost like a typical airbag system with a few modification made in it.

Take an example from Table 3, the highest weight of a child is 48 kg. When the weight is below or equal to 48 kg the weight sensor sends a signal to the ECU and the ball inside the tube should not hit the end of the tube. Which in return should not send danger signals the ECU to deploy the airbag. These type of sensors are used along with the usual airbag sensors. On the other hand if the speed of the car is high and there is a chance of a fatal injury then the airbag should inflate with minimum time.

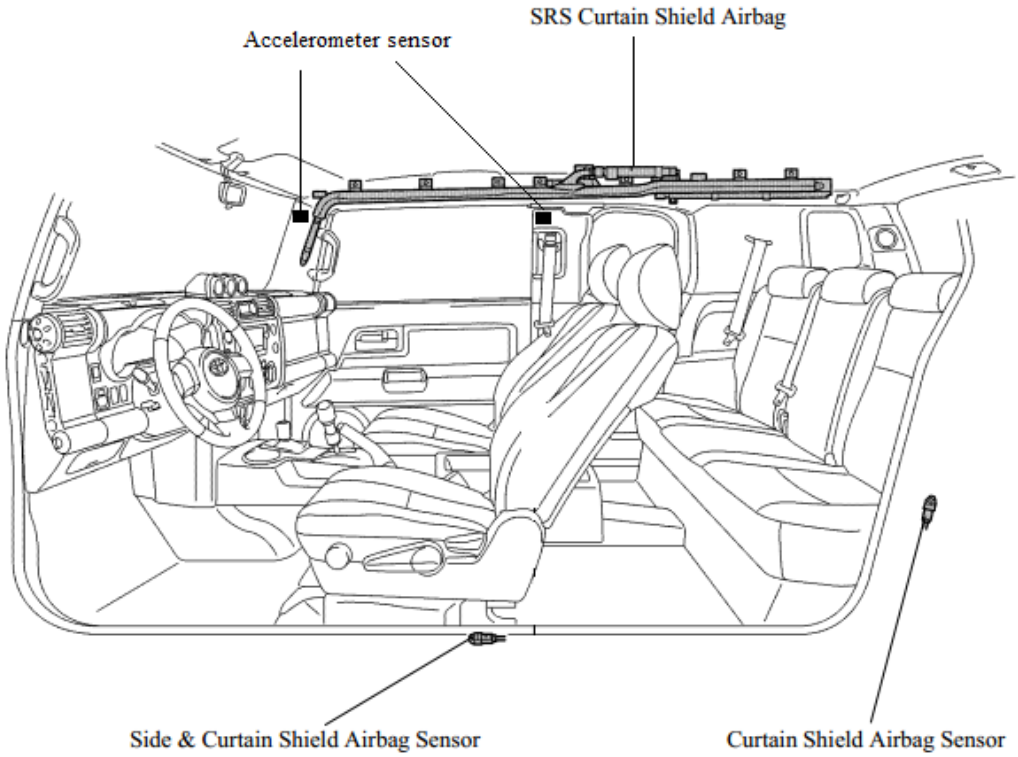

Fig: 4Schematic representation of an airbag assembly system of a typical car. (With accelerometer sensor)

The other sensor mentioned above is the accelerometer sensor that were not implemented in the previous vehicles. These sensors are used to calculate the speed of the human body. With these sensors installed in the vehicle the forward speed of the passenger can be calculated during a crash. A predetermined momentum of the head can be set. If, during a crash the momentum of the persons head exceeds the set value, then the airbag should deploy. For example, if the car is speed is 80kmph which is high enough to cause an injury in a situation of a crash then the forward momentum of the person's body should be calculated and the sensor should send its signal to the ECU to deploy the airbag.

As mentioned earlier in case of the weight sensor it should be opposite in this case. Here if the momentum matches or exceeds the predetermined value of the person's momentum the accelerometer sensor should send signal and the ball should strike the end of the tube and send signals to the ECU which is turn should deploys the airbag.

CONCLUSION

Serious injuries in infants may result from airbag deployment. It is recommended that

infants and children should travel in the rear seat of automobile to minimize risk of injuries. Further research on modifying airbag design and deployment is important to minimize the risk for infant's injury. Not only infants are the victims of the high speed crashes. It has been seen in figure 1 of the case study that the people who are victims of accidents are in the range of 25-65 age group. Hence accelerometer sensor are a vital key to avoid these fatal accidents and to reduce the deaths caused.