OPEN ACCESS

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-6 Issue-6, November 2016

Collision Avoidance based on Blind Spot Detection and Automatic Steering Control

Nishad Nazar, K. Govardhan

***Abstract**: there have been constant research and development in the area of automotive electronics focusing on safe driving and driver safety concerns. Thus, automotive industry has developed ADAS (Advanced driver assistance systems) to adapt different technologies for the better HMI to better the driver safety. Blind spots of the automobile have been a major reason for the accidents caused to the vehicle and many sensing technologies have been developed and implemented to prevent the accidents. The automotive industry has always evolved with new development in the sensing and safety technologies for the automobile. Blind spot of an automobile is a critical issue, until now, which cannot be completely eliminated. There have been usage of convex mirror for eliminating blind spots manually by driver assistance, but the current study aims at managing Blind spots automatically. This study works on the Blind Spot monitoring and automatic steering control to steer away the vehicle from the obstacle at the both rear end corners. Autonomous driving concept has seen a tremendous development from almost all the automotive industries till today hence, the concept of monitoring Blind spot and to automatically steer the vehicle to avoid the accident is a great task. The Blind spot is detected using the Ultra sonic sensing technology and set margins using mirrors and the automatic steering control is achieved using the Hall Effect sensing mechanism in the driving shaft. The project uses the Arduino MEGA as the Central Unit for the system.*

***Index Terms**: Blind Spot detection, Ackermann steering, Arduino MEGA etc.*

I. INTRODUCTION

The major focus for any automobile industry has been the safety of the vehicle, hence safety of the driver, this has been the motive of the research and development of the automobile industry continuously over the years. While the focus being safety of the vehicle, it is the prime necessity to monitor the blind spots around the vehicle to keep away from accidents during lane departure or while over taking. There have been many technologies like Lane departure warning, rear assist etc. which assists driver to automate steering and also to monitor blind spots. The automotive technology plays a major role in minimizing the accidents and also to provide better driving ergonomics. The National Highway Authority of India (NHAI) surveys that annual major percentage of total road traffic accidents are the output of the unusual lane departure on the road due to the number of blind spots around the vehicle.

Manuscript published on 30 November 2016.
***Correspondence Author(s)**

Nishad Nazar, Department of Electronics Engineering, Vellore Institute of Technology and University, Vellore (Tamil Nadu)-632014, India.

K. Govardhan, Department of Electronics Engineering, Vellore Institute of Technology and University, Vellore (Tamil Nadu)-632014, India.

Driving under toxicities, inattention, tiredness etc. are among the common causes of careless or abnormal lane switching or departures. The major reason for the cause of most of the careless accidents are due to the lack of proper monitoring of blind spot around the vehicle. Thus, detecting the obstacle by monitoring the blind spot of the vehicle during lane switching/departure is important to reduce the accidents caused. Many car manufacturer have started research and development wing around the world to manufacture vehicles with better driver safety focusing on ADAS. Further developments are also made to make the vehicle to be able to control automatically such critical situations and hence making better Human – Machine Interface. Automobile manufacturers have proposed many safety schemes till date, like, collision forewarning technology or adaptive cruise control technology, lane departure warning system (LDWS), Blind spot information systems, vehicle back assist systems.

Blind spot can be any area around the automobile where the driver cannot observe properly through the mirror, hence this project has chosen to focus on the monitoring of the blind spots surrounding the rear end of the vehicle and to detect the obstacle incoming to the vehicle rear and further developed the algorithm to automatically drive away the car back to the normal steer position by providing partial braking to the individual two front wheels which are driven by the individual motors.

The paper has subdivided into different subsections which explains briefly the importance of Blind spot in section A under I, the proposed system under II, the estimation of the Blind spot of the system under III, experimental results under IV, and conclusion under V.

A. Blind Spot of Automobiles

A blind spot of any vehicle is an area around the vehicle that can’t be directly observed by the driver through mirrors while at the controls, under existing situations. Blind spots exist in a wide types of vehicles: cars, motorboats, sailboats, trucks and aircraft. But certain transportation such as motorcycles, bicycles, and horses have no blind spots at all. Blind spots can be eliminated or alleviated by proper adjustment of mirrors and use of further technical solutions.

An example of a blind spot is such that caused by the car's body chassis structure that is the front windscreen pillars – these pillars can mask a distant incoming object such as a motorbike at a junction. Hence the Blind spot of a vehicle can be minimized in these situations by moving the driver’s seat when required to proper position in order to get a better view through the mirror or directly [4].

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

In transportation, driver's visibility is the maximum capable distance to which the driver of an automobile can observe and identify objects around the automobile. In the aspect of vehicle structure, the parts of an automobile that influence and interfere visibility include the dashboard, the windshield, and the pillars. A proper driver visibility is necessary to have a safe drive in the road traffic [2].

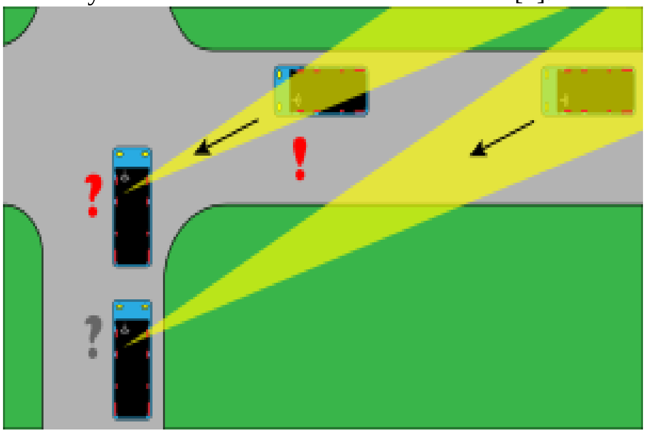


Figure 1. A-Pillar Blind spot of a car

Blind spots may occur in front of the driver when the A-pillar or so called the windshield pillar, interior rear-view mirror and side-view mirror block a driver's vision of the road. There are also other factors, which may reduce the driver's visibility like additional pillars, passengers, headrests etc. that may reduce visibility [7].

II. PROPOSED SYSTEM

Arduino is an open-source platform built on easy-to-use environment for hardware and software. The Arduino project provides the integrated development environment (IDE), which is a cross-platform application written in the Java programming language for performing programming of microcontroller for hardware. It is designed in such a manner to introduce programming to users who are unfamiliar with software development. The Arduino IDE supports the languages like C and C++ using special norms to organize codes.

A. Mechanical design and Ackermann Steering geometry

An automobile system has been chosen with needed necessary design changes to the system structure to place sensors. The system is chosen with the proper Ackerman steering mechanism and further changes are also made to the wheel base to hold motors properly without interfering the Ackermann geometry arrangement.

Fig. 2 depicts the Ackermann steering mechanism for the system. The mechanism consist of the king pin arrangement attached to the tie rod and the axle [5]. The axle and the tie rod are kept parallel to each other. And further it is attached to the driver shaft to the steering wheel.

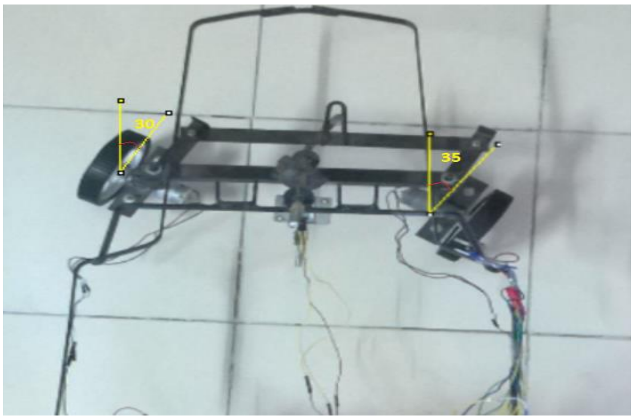


Figure 2. Ackermann steering geometry

Further design changes are made for placing the Hall Effect Sensor fig. 3. The driver shaft is further welded and fitted with a semi metal plate to place the magnets for hall effect sensing. A long thin steel rod is moulded and bended and further spot welded to the tie rod to make a stand for the hall effect sensor. There are two magnets placed with gap of 2.5 cm space in such a way to make the magnetic field proportionally face the hall effect sensor to produce the hall voltage. The hall voltage further senses that the position of steering wheel has changed or the steering has turned and hence the system is further programmed to switch motor speed to steer back to normal position.

Figure 3. Hall effect sensing mechanism

Fig. 4 shows the rear end of the automobile body. The HC-SR04 ultrasonic sensor is placed at both the rear corner ends which covers the 30 degree field view for monitoring the blind spots around the rear end portion.

Figure 4. Rear end with Ultrasonic sensors fixed

The body has a welded motor circuit stand as seen in fig. 6 on the mid of the automobile where the battery and circuit board are placed.

Ackermann steering geometry is a geometrical arrangement of linkage of the system in the steering system of a car or other vehicle constructed to solve the issue of wheels on the inside in the relation of the outside wheel taking turn to trace out circles having different radii.

The intention of Ackermann mechanism is to prevent the need for tyres of wheels to slip the sideways when vehicle follows a curved path.

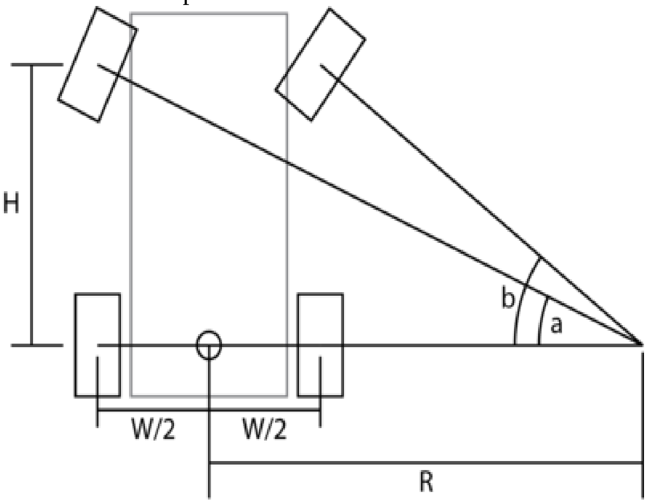


Figure 5. Ackermann steering geometry

Fig. 5 represents that according to the Ackermann steering geometry criteria the inner steering wheel takes greater angle than the outer wheel angle. The system takes a right turn and fulfils the Ackermann steering criteria. The proposed system as seen in fig. 2 fulfills the Ackermann steering criteria by taking the inner wheel a 25 degrees when outer wheel takes a 20 degree turn.

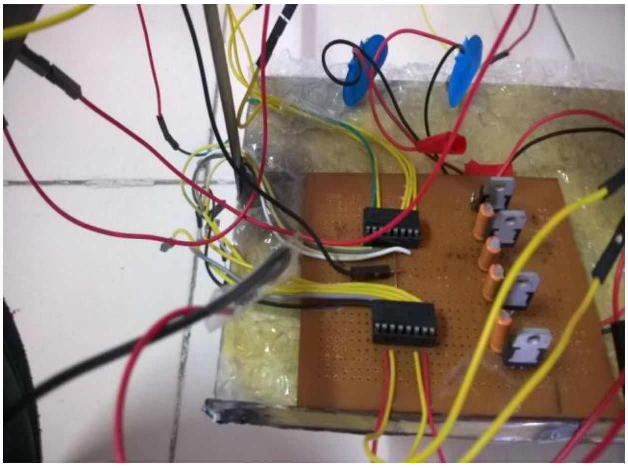


Figure 6. Motor Circuit stand

The fig. 6 depicts the circuit connection of the motor driving circuit. Several inputs and outputs of the sensors are evaluated and the system has suitable adapted the Arduino Mega 2560 as the ECU.

Figure 7. LCD Alert of Obstacle at the rear end

Fig. 7 represents the LCD display alert when obstacles are approaching the Blind spot area which is the rear end of the automobile.

B. Circuit diagram and Block Diagram of the system

This part of the section represents the circuit pin connection of the entire system and the block diagram of the system. The system uses the ultrasonic sensor HC-SR 04 and the Hall Effect sensor A3144 series.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

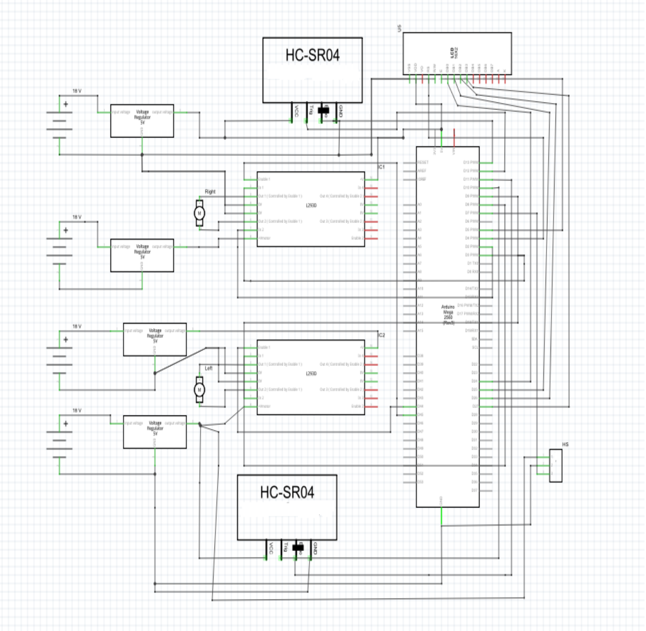


Figure 8. Circuit connection

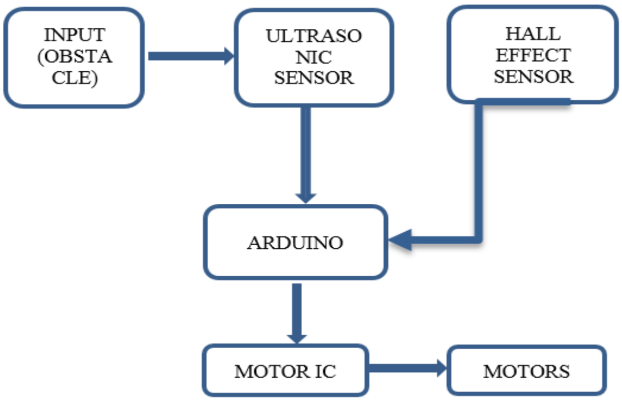


Figure 9. Block diagram of the system

C. Criteria setting of motor during the dynamic

During the dynamic motion of the system, it has to perform the Blind spot detection of obstacle using the ultrasonic sensor which is set with a predefined distance for the system, which covers the 30 degree field of view to the rear end corners. And, when the obstacle is detected, then the motor speed is alternated which is controlled by the L293D motor driving circuit to switch the direction of the dynamics of the system to move away from the system.

The table I represents the two motors and their different speed set to the individual motors while the obstacle is detected on either of the ultrasonic sensors fixed on the Blind spot area.

Table I. Criteria setting of the DC motor

Right US	Left US	Right Motor (RPM)	Left Motor (RPM)
None	None	500	500
Detected	None	500	160
None	Detected	160	500
Detected	Detected	500	500

III. ESTIMATE BLIND SPOT OF THE SYSTEM

The prime objective of the project being to estimate the blind spots of the vehicle in the rear end, adaption of the normal mirror method is used here. Use of side mirrors and rear mirrors are made to estimate the blind spot on the rear corners. The frame selected for the automobile being 90 cm in length and 28 cm in length of the rear end portion of the automobile. According to the ratio of body measurements in relation to the mirror criteria, it is decided to place a mirror of 6cm length and 4.5 cm height which covers the rear portion, while monitored by the driver itself.

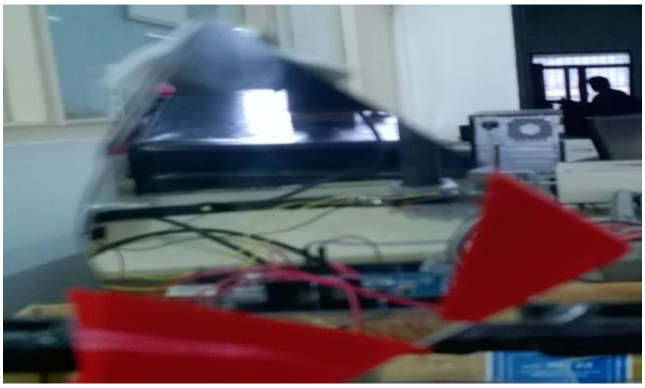


Figure 10. View from the rear mirror

The fig. 10 shows the rear mirror fitted to the automobile and the image of the rear end of the system and it is clearly visible that the corner right and left ends aren't visible, hence it is estimated as the probable blind spot area of the automobile, that is the area where the driver cannot observe properly even throught the use mirror [9]. Therefore, the ultrasonic sensors are fitted on both right and left corner of the rear portion of the automobile, hence ultrasonic sensors has to be placed on the right position to detect the obstacle on this blind spot, further to detect and steer away from the obstacle.

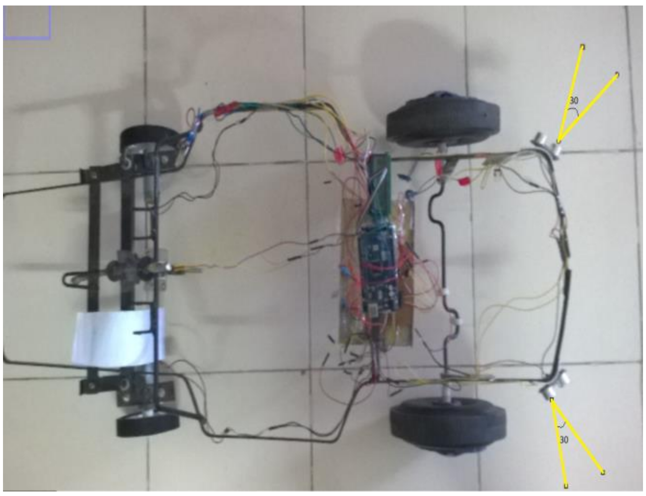


Figure 11. Field view of the ultrasonic sensor

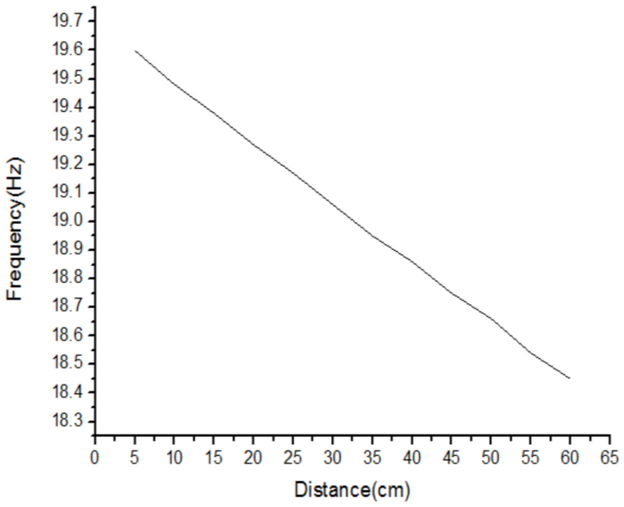
Above image depicts the field view of the HC-SR 04 sensors which covers the rear end of the vehicle. Both the sensors are placed carefully after studying the blind spot of this system.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The sensor covers the 30 degree of the corner right and left portion of the system, where it can detect the incoming obstacle to the sensor.

IV. EXPERIMENTAL RESULTS

The automobile has undergone several demonstration using different motor RPM setting and has set different range for Ultrasonic sensors, and observation were made based on distance verses frequency characteristics of the sensor and also the distance verses voltage of the signal received is also plotted. And after the observation, for convenience, the experimental process was carried out with 20 cm range to the Ultrasonic sensors and has kept two magnets within 2cm distance for the calibration of Hall Effect sensing.



Graph 1. Distance verses Frequency of HC SR04

Above characteristic graph 1 plots the nature of the Ultrasonic sensor, and it has seen that the frequency of the signal received at the receiver side is reduced according to increasing distance from the obstacle to the sensor.

Figure 11. Right turn during motion

During the dynamic motion of the automobile, an obstacle was setup at a range of 15cm to the left corner sensor, hence the automobile make a turn of 25 degrees as Inner steering angle and 20 degrees as the outer steering angle, also achieving the Ackermann steering criteria. Two magnets are placed at degrees 20 and 40 each for experiment. After the experimentation, the steering ratio was found out as 10:5 that is when the steering wheel makes an angle of 10 degrees, the wheel makes a turn of 5 degrees. Now, after the obstacle has been detected at the left sensor, the automobile makes a right turn to avoid the obstacle. Thus, making a steering ratio of 20:10, and hence the magnet phases proportional to the Hall Effect sensor to produce the hall voltage that senses the steering wheel has turned and further the ECU sends signal to change the motor speed to individual wheel, by taking a opposite turn to return to normal steering wheel position.

V. CONCLUSION

The automobile system has been developed to monitor the Blind Spot around the rear end of the vehicle using the ultrasonic sensors. A normal mirror which is suitable to the automobile measurements are used, and blind spot area is estimated and ultrasonic sensor is fixed to monitor the area. System uses the HC-SR04 ultrasonic sensors for the blind spot monitoring and detecting of the obstacle or the incoming system. Further, LCD display alert has also been provided for the indication of incoming obstacle. The sensors are programmed with a predefined distance of 20 cm for the detection range with a field view of 30 degrees. Therefore, when there is an incoming vehicle on either rear corner end, the ultrasonic sensor detects the incoming vehicle and the vehicle steers away from the obstacle using the DC motors which are controlled with different speed processed by Arduino Mega 2560. After steering away the vehicle direction, if the vehicle covers the steering ratio of 2:1, that is if the steering wheel is turned 20 degrees then the wheel turns 10 degrees, while the hall Effect sensor faces proportional to the magnet placed, to produce a hall voltage, and hence the voltage is used as a data to further process the motors to steer back the vehicle to the normal steering position.

REFERENCES

1. Muhammad Zahir Hassan and Haziq Irfan Zainal Ariffin, "Development of Vehicle Blind Spot System for Passenger Car", Applied Mechanics and Materials, Vol (393), 2013
2. Akhil Samnotra, Dr. Mahesh Kolte, "Collision Avoider using Lane Departure Warning", International Journal of Scientific and Research Publications, Vol (4), February 2014
3. Shunji Miyahara, "Blind Spot Monitoring by a single camera", SAE International, January 2009.
4. Yasuhisa Hayakawa and Osamu Fukatu, "All Round Blind Spot Detection by Lens condition adaptation based on Rearview Camera Images", SAE International in October 2013
5. Y. K. Wang and S. H. Chen, "A Robust Vehicle Detection Approach," IEEE International Conference on Advanced Video and Signal-based Surveillance, 2005, pp. 117-122.
6. Z. Sun, G. Bebis and R. Miller, "On-Road Vehicle Detection Using Optical Sensor: A Review," IEEE Transactions on Intelligent Transportation Systems, 2004, pp. 585-590.
7. Techmer, "Real-time motion analysis for monitoring the rear and lateral road," in Proceedings of the IEEE Intelligent Vehicles Symposium, pp. 704–709, June 2004.
8. M. Ruder, W. Enkelmann, and R. Garnitz, "Highway lane change assistant," in Proceedings of the IEEE Intelligent Vehicles Symposium, vol. 1, pp. 240–244,

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

9. J. C. McCall and M. M. Trivedi, "Video-based lane estimation and tracking for driver assistance: survey, system, and evaluation," IEEE Transactions on Intelligent Transportation Systems, vol. 7, no. 1, pp. 20–37, 2006.
10. Diarmaid O Cualain and Martin Glavin "Lane Departure and Obstacle Detection Algorithm for Use in an Automotive Environment" Journal of Intelligent and Fuzzy Systems, vol.2, no.3, May 2012.
11. Bhupendra Pratap Singh1 , Brijesh Kumar Yadav2 , Lal Bahadur Singh3 , Badri Vishal4 , Raj Kumar Yadav5 Mr.Ram Pratap Yadav6 , Mr.Rahul Srivastav7, "Advanced Four Wheel Steering System" ,IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 3, Issue 2, April-May, 2015
12. Sharul Agrawal, Mr. Ravi Prakash, Prof. Zunnun Narmawala, "Implementation of WSN which can simultaneously monitor Temperature conditions and control robot for positional accuracy", Green Computing Communication and Electrical Engineering (ICGCCEE), March 2014
13. Aidan Lalor , "Vehicle Handling Characteristics and Development of a Formula Student Car", Swansea Metropolitan University, 2012

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)