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APPLICATIONS OF AUGMENTED REALITY FOR INSPECTION AND MAINTENANCE PROCESS IN AUTOMOTIVE INDUSTRY

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ABSTRACT

This paper reviews the applications of Augmented Reality (AR) in automotive industry especially in inspection and maintenance process. AR is now a major part in automotive industry and was amongst the first to use the technology. The need to shorten production time, improve efficiency and save cost allows advance technology being used. Works related to applications of AR for inspection and maintenance of automotive industry are critically reviewed in this paper

Keywords: Augmented Reality, Automotive, Inspection, Maintenance, Process

1.0 INTRODUCTION

World automotive industry saw a record of 88 million autos sales reached in 2016, which is up to 4.8 percent from previous year (Parkin et al.,2017). In 2015, a total number of 91.5 million motor vehicles produced globally, becoming one of the world largest economic contributor (European Automobile Manufacturers Association, 2016). Since the introduction of moving assembly line, automotive industry has become one of biggest market players in developing new advance technologies revolutionary (Gusikhin et al., 2007)

Major transitions are currently happening within the automotive industry and it is important for car makers to keep the momentum moving in supplying demand for customers. Notably, current wave of innovation in automobiles are not so much in speed but in altering basic contours and features of the traditional automobile and trying to reduce production cost.

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Ubiquitous electronics, a variety of digital services, and novel powertrains and connectivity systems are hastening the need for expensive new parts, components, and functions. Technology has always driven the transformation for automotive industry changing. The development of this industry into a digital business creates opportunities for disruption to increase, from external threats or within the automotive industry itself. Automotive companies accepted that digital technologies as part of their core process with technological trends such as 3D printing, mobile advancement, cloud and virtual systems; Internet of Things has expanded traditional barriers of automotive industries. Technology has been able to assimilate with vehicles that can be seen by the consumer that focused more on performance and diagnostic system.

A special consideration must be taken in assembly processing as part of the manufacturing line due to the large involvement of human workers (Faeiza & Mousavi, 2009). Therefore, technologies are need in the automotive to help reduce large numbers of manual process however, it is critical for the industry to consider its approach to the technology in this always connected digital world.

Augmented Reality (AR) is one of the innovative technologies introduced in 1960s when computer graphics pioneer Ivan Sutherland and students at Harvard University and University of Utah used a see-through to present 3D graphics (Van Krevelen & Poelman, 2010). AR can be defined as technologies that project digital materials onto real world objects. This interpretation can cover large spectrum of technologies that range from a pure virtual environment to the real environment (Milgram & Kishino, 1994).

Augmented reality (AR) was one of the biggest trends at the recent Pacific Design & Manufacturing show (Wiltz, 2017). With growing interest in Internet of Things (IoT) applications more and more companies are seeking AR as an enterprise solution to make visual use of the massive amounts of incoming data. Ideally, AR basically combine, or mix, the view of the real environment. It also enables virtual content presented through computer graphics (Olwal, 2009).

Layers of computer generated information are an expansion of physical reality to the real environment (Carmigniani & Furht, 2011). Any form of information can be added whether virtual object or content aligned with is system requirement such as text, sound, video, graphic, GPS data or haptic feedback. The virtual content is aligned and registered with the real object to ensure it achieved the convincing effect. The virtual content should be also presented in the same perspective when a person moves in an environment and it changes their view of real objects.

Ultimately, any AR system should provide better management and ubiquitous access to information. This can be done by using uninterrupted data technique in which the interactive real data is combined with an interactive computer-generated data in the same environment. Real time data and digitally added data can be combine in AR (Siltanen, 2012). AR system process live video image and add to computer generated graphics. In simple term, digital data are augmented with image within the AR system.

2.0 APPLICATION OF AR IN AUTOMOTIVE INDUSTRY

AR is now becoming a tool for designers and engineers in the automotive industries in the need to cater increasing demand in variety of car models and short product life cycle. Virtual and mixed technology are more favored in addition to CAD technology so that the development process can be speed up and optimized (De Sa & Zachmann, 1999). The elevation of AR since the past half-decade not only provides for semi-immersive environment but also has great potential in solving problem before product being manufactured.

In today's world, we are experiencing the rapid advancement in handheld devices such as smartphones and tablet computers and this help to accelerate AR adoption. These devices are developed with better features such as higher resolutions display, power processors and high quality cameras, an array of sensors, GPS and compass capabilities making them suitable platform for AR system. With AR being mobile, car manufacturer is focusing into self-experience features and learn enhancement for user's safety and driving experience using handheld devices with high tech features.

In 2012, Pioneer Corporation launches a navigation system that uses AR Heads Up Display (HUD) in place of driver's visor in which the system overlays video with smart devices function such as GPS tracker, graphic display, object orientation and (Alabaster, 2013). Hyundai Motor Company has developed an AR manual application for users using their smartphones or tablets in which they can access how to information regarding their car. (Samuely, 2015). The guide proved consumer an easy option to access important vehicle information without the need of manual instruction to find desired information.

Fig.1. Hyundai AR Manual Application

Automotive industry amongst other industry has also begun using AR as a new marketing strategy for their product (Smith, 2009). Volkswagen was the first to introduced AR marketing campaign by AR using tracker technology in 2008. Volkswagen also created an AR campaign for Golf model where people can see an augmented reality version of Golf via their website in 2010. At Geneva Auto show in 2012, Volvo gave user the opportunity to see the inside of Volvo V40, a newly launched model. Using tablet, the app used 2d marker to emulate 3d images augmented reality experience.

In 2015, Ferrari Showroom App used 3d tracking technology to recognize real world cars and layering information such as shapes, colors, and video so that customer can build their custom specification for their supercars without dealer need to order the accessories first. It can be seen that big market players are using AR as one of their marketing tools. AR helps to make the buying experience easier for the customer. There are potential where AR could replace real showrooms to the extent that customer can purchase cars from their own home using virtual reality headset or smartphone.

Fig.2. Ferrari 3D Application

Konica Minolta had started a research with Ishikawa Watanabe Laboratory, University of Tokyo in April 2016 to develop a technology for quickly projecting a 3D virtual image hence creating 3D AR Head Unit Display (HUD) which was exhibited for reference is one of the research outputs (Minolta, 2017). The automotive HUD technology is designed to present information directly in the driver's field of view ahead. Most of the current HUDs present information on the windshield. Conventionally, car navigation systems and instrument clusters are used to present information to the driver. HUDs have been actively developed to enable the driver to obtain information while looking ahead, thereby increasing driving safety.

3.0 AR IN AUTOMOTIVE INSPECTION

Information acquisition is most time consuming and are exposed to errors in which traditional manual method are commonly used (Chung, 2002). In 1993, a system was designed for five different inspection systems for automotive electronics company which is human inspection, computer-search human-decision, human-computer decision-sharing and automated inspection (Hou, Lin, & G, 1993). The result of the study showed that the two hybrid inspection systems influenced by human decision have a better performance than the automated inspection. In this section we will review important literature that related toward AR in automotive inspection that influence scholarly and commercial works of AR.

In real workshop, technician today have to go through a lot of data and information in diagnostic and vehicle repair. However, the data is not accessible at the most convenient place, which is at the vehicle itself. Technician must search for information in database and manually check whether he can assess the problem and repair the fault. This is especially important for electronic system for luxury or high tech cars therefore vehicle inspection takes more time than maintenance. Spatial Augmented Reality (SAR) and HMD can be combined to display information to operators and can be personalized towards individuals (Zhou et al., 2012).

Spot Welding is a critical process in car manufacturing as it makes car safer and reduce in rattles and road noises. Sheet metal parts are joint together using spot weld technique that make joined part stronger and uniform in appearance. In spot welding inspection process, SAR creates a new alternative in designing an inspection system that AR can aid to support inspectors and improve efficacy. Portable laser projector based SAR specifically allows visual data being projected on arbitrary surface and within physical work cell, user can get real data information. In 2017, A projector based SAR was developed aimed to improve the precision and accuracy of manual spot weld placements with aid of visual cues in an industrial quality setting to highlight spot weld locations on vehicle panels for manual welding operators (Doshi et al.,2016). Results show that there are gains to be made towards accuracy and precision using the SAR projection system compared to current spot-welding practices.

Fig.3. SAR prototype at GM HVO

Re'Flekt collaborated with Bosch and developed a live-diagnosis AR application called "Bosch Flex-Inspect", and was presented at the 2014 NADA Auto Show in New Orleans (Re-Flekt, 2014). This application were directly linked to Bosch-developed cloud-based diagnosis system called "Flex-Inspect" which was inspired from a real working situation. The app enabled existing data from car system sensor such as battery voltage and tire air pressure analyzed and presented in layers' image on the tablet. For automotive inspection, there are limited literatures that reviews on AR for inspection since most AR app are still under development and not commercially used due to high cost for commercial implementation.

4.0 AR IN AUTOMOTIVE MAINTENANCE

AR has become a trend in consumer market since it can create interaction with users, however for industry sector especially automotive maintenance, AR represent high expectation and user demand due to failing cost and requirement (Olieveira, Farinha, Singh, & Galar, 2013). AR application development in automotive maintenance and repairing process uses various overlay method with mobile hardware. One of AR advantage in maintenance is the capacity to superimpose information and invisible effects on real time environment such as procedures or instruction for equipment.

Maintenance and repair operations are potential areas that can be use as subject matter for application of AR. These activities are mostly done manually by skilled operators following rigorous procedure in documenting and carrying out maintenance works in relatively static and predictable environment. Manual process means that operator needs to physically navigate tasks in maintenance and this can be extremely time consuming. Even the most trained maintenance personnel still need to follow manuals and with restricted space,

Amongst the early works of AR maintenance were the ARVIKA project which was relevant maintenance and industrial AR (Friedrich, 2002). Leading industry players from automotive and aerospace joined the project which uses head mounted displays, user interface and markers to solve maintenance problem. Another significant project was A mobile marker less AR system for maintenance and repair in 2006 (Platonov, Heibel, Meier, & Grollmann, 2006). This particular project uses marker less CAD based tracking system which can work with different illumination conditions and are able to automatically recover from often tracking failures.

Augmented Reality for Maintenance and Repair (ARMAR) develop by US Air force in 2007 (Henderson & Feiner, 2007). The project explores the capability of the prototype to overlay real time computer graphics registered to an equipment and help to increase productivity of maintenance personnel. From the project, it was determined that AR are able to aid in job process and support training for users as well.

BMW developed BMW Augmented Reality techniques using special data goggles and wireless access to support maintenance work for complex technical innovations and vehicles service (Dini & Dalle Mura, 2015). The vehicle model, a BMW 7-series engine was use as test subject for the system. The marker less CAD-based tracking system was overcome different illumination conditions. During tracking stage, illumination will influence the guidance system but the AR based system was able to automatically recover from tracking failures.

Application of AR not only limited for car manufacturer but also for customer. Customer can do self-vehicle maintenance at their own home with mobile AR application. Audi has partner with Metaio and created AR mobile application that can recognize and exemplify over 300 elements of Audi A3 model so that user can understand more about the vehicle (McCarthy, 2013). Hyundai has produce Hyundai Virtual Guide using AR system (Turpen, 2015). The application was able to identify over 45 features of 2015 Sonata and user can see insight use, maintenance and repair procedure when relevant parts of the car viewed to IOS mobile devices camera.

5.0 CONCLUSION

AR technology has been proven to be popular amongst automotive manufacturer which add another dimension to automotive industry. Furthermore, overlaying contextual information into real work environment is able to increase labor and productivity. Adoption of AR can speed up problem solving and influence data quality. A holistic approach is necessary towards human interaction, financial and technological aspects in adopting AR in automotive industry. In conclusion, AR application will benefit the automotive industry and more work should be done to incorporate AR in many aspects of process in automotive industry.

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