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A Survey on Heads up Display Systems

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Abstract: Heads up display (HUD) is an upcoming technology that is still open for interpretation. This technology works around Raspberry Pi, Heads up Display implemented in vehicles, Virtual and Augmented reality, Wearables and smart glasses. An extensive survey has been made in this paper on these topics. This paper describes the computational and hardware functionalities of the Raspberry Pi. It also gives light to the pros and cons with regards to HUD application in vehicles. This paper also reviews the literature on how big a part wearables and smart glasses will play in the future. This also gives an insight on how this technology can be used in cars and cockpits for a better field of view and prevent accidents in future. From this survey carried out, it is prominent that HUD systems have a great potential and thus are here to stay.

Keywords: Heads up display; Raspberry Pi; Virtual reality; Wearable computing; Human assistive technology.

I. INTRODUCTION

A heads up display is a human assistive technology that provides an extended display along with the view of the environment to the user. HUDs have many functions when applied with the current technologies. For most of these applications, monocular or binocular HUDs are the two preferred types that can be implemented. HUD can be made with various processors; Raspberry Pi is one such processor that is easy to use. There are various models in the Raspberry Pi, each having its own pros and cons. Many multifunctional smart displays are available that can be linked to the Raspberry Pi. The Raspberry Pi makes use of various shields for different uses like Global Positioning.

Another important factor that HUD touches upon is augmented and virtual reality. HUD technology is advancing towards establishing collaboration between humans and machines. Augmented machines process the data perceived from the environment and helps to visualize it. This concept has been used in wearable and smart glass products. Wearable computing does not replace reality but rather seamlessly augments it, therefore providing a rapid a progressing technology based on human assistance.

II. RASPBERRY PI

Pritish et al. describe that Raspberry Pi is a customisable computing device. It is mainly popular for being inexpensive and easy to work on. Currently there are two models- A and B. B having a sub model B+. The booting process of Pi is easy. First download NOOBS OS from the raspberry pi website. Load this onto a microSD card and insert it onto the PI. Plug in the keyboard, mouse and monitor. After boot log in using the username: pi and password: raspberry.

Adoption of Pi are various. “PI IN THE SKY” uses the raspberry pi model B has a GPS receiver and radio transmitter [1].

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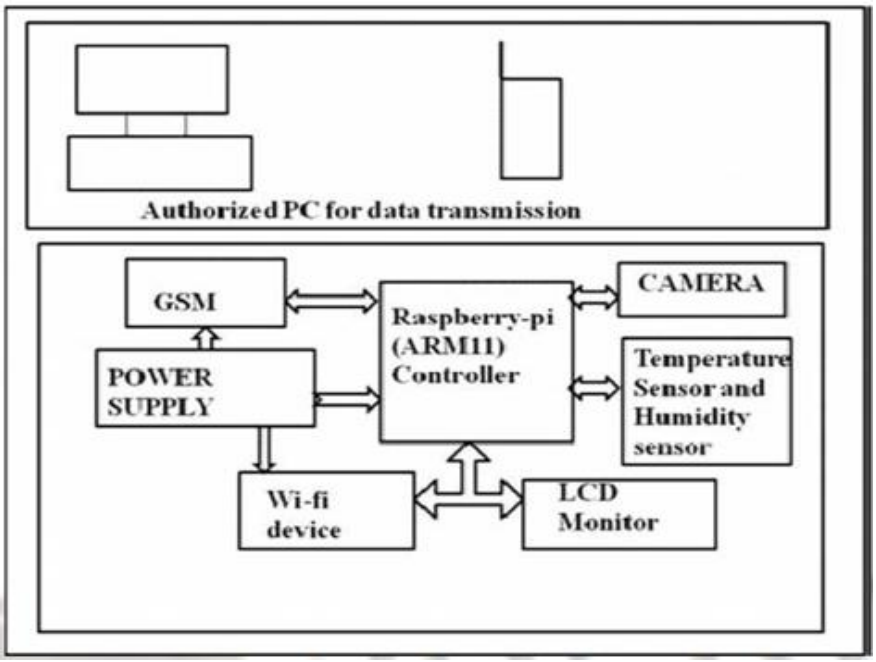
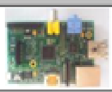
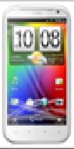


Fig 1 Raspberry Pi adoption

Waqas et.al. In this paper have done a comparative study on raspberry pi with other electronic devices. This is on the grounds of energy consumption, cost and other aspects[2]. This is better presented using a table

Table1 Raspberry Pi Comparison

			Energy Efficiency (kJ/h)	Power (watt)	Cost (US dollar)	Apps	Reading and Web Browsing	Cellular Services	Device for Coding and Programming	Portability	Battery Time
Raspberry Pi (Model B)			8.1	2.25*	35	PI store	Yes	No	Yes	Credit card size	Optional
Smart phone	IPhone		18	5	400	App store	Yes	Yes	No	Pocket size	More than 6 hours
	Android (sensation XL)					Google play store					
Tablet	IPhone		90	2.5	320	App store	Yes	No	No	Book size	More than 8 hours
	Android (Samsung galaxy tab 4)					Google play store					
Laptop (vaio SVF15323CXW)			180	50	728	Window store	Yes	No	Yes	Briefcase size	2-4 hour
Desktop (dell inspire 300)			295.2	82*	599	Window store	Yes	No	Yes	Not portable	No
Smart TV (32LA6210)			795.6	221	408	LG Smart world	Yes	No	No	Not portable	No

Ms. Shraddha et al. explains how Multifunctional Smart display project uses an ARM controller Raspberry Pi and the display via a projector. A Wi-Fi is used for data transmission. The transmitted texts/notifications can be sent using an authorised PC and vice versa such that the receiver will be an authorised PC and the sender/transmitter will be a GSM modem, LCD monitor and a Wi-Fi module[3].

Devi Selvam uses a radio frequency identification card for identification of different objects and uses a global positional system for the time without internet. The raspberry Pi uses GPS system for time as it takes the difference in time as transmitted by different satellites. The satellites transmit even their positions with time hence helping in the tracking process. This is done by loading a PSD software onto the raspberry pi and can be accessed by the SSH connection. This is a graphical display which can be accessed using the XGPS software from the client[4].

Fig 2 GPS with a Raspberry Pi

III. HEADS UP DISPLAYS IN VEHICLES

Karvonen et al. explain the use of ubiquitous computing in-car and views it in user's psychological point of view. New driver tutoring system is used (guidance for safer and economical driving). The system was tested with both expert and novice (both male and female). Quantitative and qualitative testing (Qualitative methods included a thinking-aloud method while driving and an interview post the experiment. Quantitative data was captured by counting the driving errors a participant committed from the video material afterwards) is done to prove how useful it is. Finally the safety issues are discussed. Considering interaction between the user and the device, expectation of the driver, processing capacity of driver, frequency of guidance and results of mental and cognitive load added by the guidance is required make sure that driver is not made to deviate his attention from driving that is, it shouldn't have deteriorating effect on driving performance. All signs and instructions should be provided beforehand in order to prevent confusing and surprising situations. GPS connection, external network should be provided in order to know the signs[5].

Okumura et al. explain that Heads up display is not exactly what we first imagined it to be. The heads up display for cars is projected at a focal point which is much further than first anticipated.

There are two types of HUD in use in the present market. First one being the monocular HUD and the second one being the binocular HUD. Binocular HUD has a parallax hence it is hard to read as well as it takes more time for the user to perceive what is displayed. Monocular on the other hand is more useful as it is easy to read as well has a better flexibility while taking the focus point and the user viewpoint into consideration[6].

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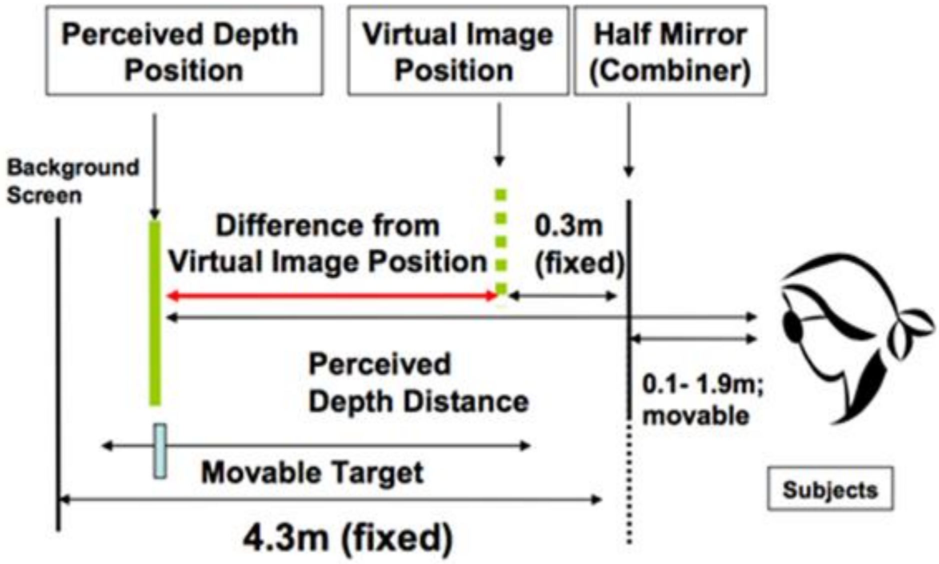

Fig 3 HUD visual offset

Charissis et al. observed after constant evaluation with the HUD display that the use of virtual reality would be a better option as to the previously stated Heads up Display system. This was done to evaluate if it would be feasible for the user to have further information other than the regular Head down Dashboard display or not. The heads up display works well under low visibility conditions and it might not be very useful to the user under good visibility. Thus the idea of Heads up display was dropped and virtual reality was favoured.

This data suggests that virtual reality would be a viable option compared to Heads up Display systems. Virtual reality today is at a boom with areas such as military, gaming and research. But as of today all virtual reality sets are bulky and not very portable[7].

Veer Deepinder Kaur et al. based this paper on the analysis of performance parameters and also the differences between head-up displays (HUDs) and helmet mounted displays (HMDs) used for aviation applications. There are various parameters on which their utility and application potential have been compared. Field of view (FOV), display symbology, luminance contrast, human aspects, size, weight, construction and mounting/wearing mechanism are some of the parameters discussed.

This gives meticulous details on the parameters that can be considered and how the components can be used.

Parameters on which their utility and application potential have been compared are

- Field of view (FOV)
- Display symbology-symbols used to display certain parameters
- Luminance contrast
- Human aspects, size, weight, construction and mounting/wearing mechanism[8].

IV. VIRTUAL REALITY AND AUGMENTED REALITY

Tunali et al. explain the effects of head mounted display (HMD) and stereo 3D displays on target selection tasks in virtual environments. By preparing two different experiment sets, relative performances of monoscopic regular monitor and stereoscopic head mounted display in selecting targets were compared. Results of these experiments suggested that a system which utilizes head mounted display [HMDs] can provide better performance, compared to the standard desktop monoscopic system[9].

Komura et al. in this paper provides an insight into recent advances in the field of virtual reality which were discussed in ACM Symposium on Virtual Reality Software and Technology (VRST) 2014, Edinburgh, November 2014. This paper also discusses the pros and cons of Stereoscopic Head Mounted Display (ex: OCULUS RIFT) as a product to a customer.

Physical discomfort which is caused by simulator sickness or motion sickness and the depth of focus blur effects have been studied to be rectified. This will help in the adoption of augmented and virtual reality technology to achieve a comfortable user friendly product[10].

Vinton G. Cerf has briefed about how Douglas Engelbart became open to a huge partnership potential between machines and humans which led to invention of N-line system (NLS) which dealt with human computer interactions. Then the author speaks about how this amazing partnership can strengthened even more with the current technology which has enabled the machines to listen, view and manipulate the environment. This provides the machines with the ability to perceive some data as input and visualize the multidimensional data. Further it speaks about how Google Glass offers such an ability in a user friendly hands free mode. The device is described as a platform for development of various applications and functions achievable through creativity[11].

Charissis V et al. in this paper explains that a variety of instrument displays on the dashboard of a driver often hinder his response time especially under adverse weather conditions. Under such circumstances this paper illustrates the use of a full windshield Heads Up display with a collision detection system. This display only provides the required information to the driver and does not confuse him with a crowded set of information available on regular Head down Display that is rather useless to him.

Continuous information relay for the driver in terms of data/diagrams always helps him in judging situations in a better way with a lesser reaction time. The fact that general displays have a lot of unrequired set of information must be dealt with and the user must be given an option to use the information that he wants on his display and not information that he has no use for[12].

Barniv et al. explain about virtual environment (VE) applications, where virtual objects are presented in a see-through head-mounted display, virtual images must be continuously stabilized in space with respect to the user’s head motion. Time delays in head-motion compensation cause the virtual objects to “swim” around instead of being stable in space that can results in misalignment errors when overlaying virtual and real objects. Visual update delays are a very critical technical hinderance for implementing head-mounted displays in applications such as battlefield simulation/training, tele robotics, and telemedicine. Head motion is currently measurable by a head-mounted 6–degrees-of-freedom inertial measurement unit[13].

V. WEARABLES AND SMART GLASSES

Firouzian et al. say Wearable technology has gained a lot of interest nowadays as it’s a user centered assistive technology. This paper explains how a remote controllable Head Mounted Display with an indicator based smartglass will help in navigational guidance of senior citizens by remote caretakers. Light emitting diode indicators were implanted on a glass frame which provides simple visual cues by blinking in different patterns and combinations as navigational commands. A location aware system based on GPS and geographical information system can be integrated to the system for efficient usage.

This paper also gives an overview of basic requirements for wearable technology:

1) Wearability-The product should be light and comfortable and should not affect the skin.

2) Maintainability- It should consist of a rechargeable battery and should be software upgradable.

3) Functionality- The quality and service provided by the product should satisfy the customer[14].

Roggen et al presented at the International Symposium on Wearable Computers, the best symposium to get an idea of what are all the significant milestones achieved with respect to how the wearables are influencing the community and where the future of wearable technology is heading. Even though eyewear computer existed from a long time, they became widespread in the year this conference was held. Thad Starner (Georgia Tech and Technical Lead on Google’s Glass) delivered the closing keynote to a packed ISWC which covered almost 2 decades of research on eye wear computers. He also verified that the wearable computing was not replacing reality but it was seamlessly augmenting the reality. So from this paper on ISWC we can infer that the wearables are here to stay and eyewear computing will be the next big trend in the future of rapidly progressing technology based on human assistance upon interfacing[15].

Kalinauckas in this paper describes the basic problems of a Google Glass. The most important problem is that of price. The device was found to be very costly and hence accessible to only fervent technology supporters. It doesn't have a very good battery life and reduces if camera is used. It had problems with image, design and explorer's hostility. Personalization and customizability options are very limited. Basically the glass didn't do anything unique compared to a smart phone which makes a customer feel that it's not worth investing for a Google Glass[16].

VI. OTHER APPLICATIONS OF HUD

Anhong et al. conducted experiments which exposes numerous errors which occur during parts picking for distribution. These errors can be minimised with the help of a Heads up Display like a google glass. It further explains how opaque glass improves selection efficiency over the transparent glass. Workload is reduced and the process becomes faster with a Heads up Display and is much more efficient than the currently used pick by paper list method, pick by light method and the cast mounted display (CMD). Here the HUD is worn by a picker to view the pick charts of all shelving units and then a succeeding pick chart is displayed by HUD as soon as picker drops item in the order bin. Test results of experiments explained in this paper clearly evaluated HUDs to be virtually error free and approximately 30 percent faster than paper lists and overtakes pick by light method giving a better average pick time.

Transparent Display v/s Opaque Display: HUDs with transparent display were tested against the ones with opaque display. The transparent display causes too much of visual interference during any task because the user is more focused on the environment he is working in while glancing at the transparent display. The average number of errors from test cases is reduced and average time taken to compete a task is lower when an opaque display is used instead of a transparent display[17].

Orlosky et al. in these papers presents a solution to indoor navigation for evacuation and emergency support during dangerous situations with the help of a Head up Display. The system which has to be implemented for a navigation has to be robust, light and efficient. This challenge is answered by combining a magnetic location tracker and Optical Character Recognition (OCR) to achieve Indoor Localization. Then the instructions for navigation are directly displayed to rescuer's immediate field of view with the help of a Head mounted display. The rescuer can navigate using their hands only for the purpose of rescue and support without needing to use it on the navigation system. There is no need for an extra hand held device. The combination of hardware with optical character recognition for indoor localization will give an upper hand over all other systems in terms of both simplicity and robustness increasing the efficiency of the rescue mission[18].

Reising in this paper explains how a Head up Displays started playing important roles in Unusual Attitude Recovery. It also speaks about overcoming the deficiencies of then HUD abilities in planes to the 3 important or key queries questioned in order to recover from an unusual attitude: 1) Is the movement of the plane upwards or downwards?, 2)Is the plane inverted?, 3)Where is the horizon?.

Here the Symbology should not be mistaken for other vital aviation related information such as attitude, air speed, compass reading etc. The study in this paper is based on experiences of 16 pilots from US Air Force who have used HUDs. They were all introduced in a Dynamic cockpit which contained 8 angled bar HUD combinations which were tested on their efficiencies in providing aircraft attitude information to the pilot. The HUDs consisted of pitch bars bent pointing in direction of true horizon. The results showed that inclusion of multicolour coding and fixed point of rotation for dynamic pitch ladder symbology provides a better unusual attitude recovery[19].

Ercoline in this paper mainly concentrates on the use of HUD systems in aircrafts. Given that HUDs have been in use in some form or another even from when the Wright brothers invented the aircraft. The author suggests there are multiple good uses of this feature, yet there are always bad and some ugly effects. Spatial disorientation, rapid symbology movement of the display hinders the use of HUDs to most of the pilots today. Also the author suggests that a standardization of the way information is relayed is highly required for the future market of HUD systems or else the pilots may have to use a different UI for every aircraft they fly.

There are some hindrances as of now in the market eventually the problems can be refined and HUDs become a very important factor in the area of flying[20].

Plessey in this paper describes the Role of Head-up-display in Computer-Assisted Instruction to reduce fatigue. The head-up display (HUD) creates a new form of presenting information by enabling a user to simultaneously view a real scene and superimposed information without large movements of the head or eye scans (Newman, 1995; Weintraub & Ensing, 1992). This paper provides a detailed information of heads-up-display. HUD is categorized into three kinds - head-mounted or ground-referenced, optical see through or video see-through, and single-sided or two-sided types[21].

VII. CONCLUSIONS

Based on the literature survey, Heads-up Display is human assistive technology that can help human's better analysis their environment around them. When used as a head mounted display it enables a hands-free approach to use this technology making it more effective to use. This combined with customizability will definitely be a product that can be used in various genre of activities.

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REFERENCES

[1] Pritish Sachdeva and Shrutik Katchii." A Review Paper on Raspberry Pi" Accepted 01 Nov 2014, Available online 05 Nov 2014, Volume 4, Number 6. Dec 2014. P-ISSN 2347 – 5161. International Journal of Current Engineering and Technology.

[2] Waqas Anwaar, Munam Ali Shah Department of Computer Science COMSATS Institute of Information technology. "Energy Efficient Computing: A Comparison of Raspberry PI with Modern Devices"International Journal of Computer and Information Technology (ISSN: 2279 – 0764) Volume 04 – Issue 02, March 2015.

[3] Ms.Shraddha J Tupe, Ms A. R. Salunke Jawaharlal Nehru Engineering College, Aurangabad. International Journal of Advance Foundation and Research in Computer "Multi-Functional Smart Display using Raspberry Pi"(IJAFRC) Volume 2, Special Issue (NCRTIT 2015), January 2015. ISSN 2348 – 4853.

[4] Devi Selvam. International Journal of Innovations in Engineering and Technology (IJIET) 2013." System Design of Raspberry Pi for Radio Frequency Identification and GPS." Volume 3. Issue 2. ISSN: 2319 – 1058.

[5] Karvonen, H.; Kujala, T.; Saariluoma, P. Intelligent Transportation Systems Conference, 2006." In Car Ubiquitous Computing Driver Tutoring Messages Presented on a Head Up Display" ITSC '06. IEEE, Toronto. Date of Conference: 1720 Sept. 2006. Pages: 560 - 565, DOI: 10.1109/ITSC.2006.1706800. IEEE Conference Publication.

[6] Okumura H; Sasaki T; Hotta A; Moriya A; Okada N; Nagahara O; ." Hyperrealistic Heads-Up-Display for Automotive Application" IEEE International Conference on Consumer Electronics (ICCE). 2011. Pages: 875 - 876, DOI: 10.1109/ICCE.2011.5722913. IEEE international conference.

[7] Charissis. V and Naef M. Intelligent Vehicles Symposium, 2007 IEEE." Evaluation of Prototype Automotive Head-Up Display Interface: Testing Driver's Focusing Ability through a VR Simulation" Pages: 1 - 6, DOI: 10.1109/CEWIT.2014.7021141. IEEE Conference Publications.

[8] Veer Deepinder Kaur, Student, M.E (Electronics & Communication Engineering), University Institute of Engineering & Technology (UIET), Panjab University, Chandigarh, India Surender Singh Saini, CSIR-Central Scientific Instruments Organisation, Chandigarh Arvind Kumar, Head of department (ECE), University Institute of Engineering & Technology (UIET), Punjab University. "Analysis of performance of Head-up Display and Head Mounted Display for Aviation Application"International Journal of IT, Engineering and Applied Sciences Research (IJIEASR). Year: April 4th, 2006.

[9] Tunali M.F. and Gokturk M. Signal Processing and Communications Applications Conference (SIU), 2015." Effects of HMD on 2D Object Interaction in 3D Virtual Environments." Pages: 1825 - 1828, DOI: 10.1109/SIU.2015.7 130210. IEEE Conference Publications.

[10] Komura, Taku; Lau, Rynson W.H.; Lin, Ming C.; Majumder, Aditi; Manocha, Dinesh; Xu, Wei Wei. Computer Graphics and Applications, IEEE. Year: 2015," Virtual Reality Software and Technology" Volume: 35, Issue: 5. Pages: 20 - 21, DOI: 10.1109/MCG.2015.102. IEEE Journals & Magazines.

[11] Cerf, Vinton G. Internet Computing, IEEE Year: 2013," Augmented Intelligence" Volume: 17, Issue: 5. Pages: 96 - 96, DOI: 10.1109/MIC.2013.90. IEEE Journals & Magazine. Publisher: IEEE.

[12] Charissis V. Emerging Technologies for a Smarter World (CEWIT), 2014 11th International Conference & Expo. 29-30 October 2014." Enhancing Human Responses through Augmented Reality Head-Up Display in Vehicular Environment." Pages: 1 to 6, DOI: 10.1109/CEWIT.2014.7021141. IEEE Conference Publications.

[13] Barniv, Y.; Aguilar, M.; Hasanbelliu, E. Biomedical Engineering," Using EMG to anticipate head motion for virtual environment applications." IEEE Transactions. Year: 2005, Volume: 52, Issue: 6. IEEE Journals & Magazines.

[14] Firouzian, A.; Asghar, Z.; Tervonen, J.; Pulli, P.; Yamamoto, G." Conceptual design and implementation of Indicator-based Smart Glasses: A navigational device for remote assistance of senior citizens suffering from memory loss" Medical Information and Communication Technology (ISMICT), 2015 9th International Symposium. March 2015. Pages: 153 - 156, DOI: 10.1109/ISMICT.2015.7107518. IEEE Conference Publications.

[15] Roggen, Daniel; Perez, Daniel Gatica; Fukumoto, Masaaki; Van Laerhoven, Kristof." Wearables Are Here to Stay." Pervasive Computing, IEEE. Year: 2014, Volume: 13, Issue: 1 .Pages: 14 - 18, DOI: 10.1109/MPRV.2014.11. IEEE Journals & Magazines.

[16] Kalinauckas, A. "7 Problems with: Google glass" Engineering & Technology, Year: 2015, Volume: 10, Issue: 2, Pages: 16 - 17, DOI: 10.1049/et.2015.0218, IET Journals & Magazines.

[17] Anhong Guo; Xiaolong Wu; Zhengyang Shen; Starner, T.; Baumann, H.; Gilliland, S. " Order Picking with Head-Up Displays" Published in: Computer, Year: 2015, Volume: 48, Issue: 6. Pages: 16 - 24, DOI: 10.1109/ MC.2015. 166. IEEE Journals & Magazine. ISSN: 0018-9162. INSPEC Accession Number: 15201043. Date of Publication: June 2015. Date of Current Version: 11 June 2015. Publisher: IEEE.

[18] Orlosky, J.; Toyama, T.; Sonntag, D.; Sarkany, A.; Lorincz, A." On-body multi-input indoor localization for dynamic emergency scenarios: Fusion of magnetic tracking and optical character recognition with mixed-reality display." Published in: Pervasive Computing and Communications Workshops, 2014 IEEE International Conference on Year: 2014. Pages: 320 - 325, DOI: 10.1109/PerComW.2014.6815225. IEEE Conference Publications. Date of Conference: 24-28 March 2014. Page(s): 320 – 325. INSPEC Accession Number: 14300956. Conference Location: Budapest. Publisher: IEEE.

[19] Reising, J.; Zenyuh, J.; Barthelemy, K. "Head-up display symbology for unusual attitude recovery". Published in: Aerospace and Electronics Conference, 1988. NAECON 1988. Proceedings of the IEEE 1988 National Year: 1988. Pages: 926 - 930 vol.3, DOI: 10.1109/NAECON.1988.195120. IEEE Conference Publications. Date of Conference: 23-27 May 1988. Page(s): 926 - 930 Volume.3. Meeting Date: 23 May 1988-27 May 1988. INSPEC Accession Number: 3239884. Conference Location: Dayton, OH. Publisher: IEEE.

[20] Ercoline W. "The Good, the Bad, and the Ugly of Head-Up Displays"Engineering in Medicine and Biology Magazine, IEEE. Year: 2000, Volume: 19, Issue: 2. Pages: 66 - 70, DOI: 10.1109/51.827408. IEEE Journals & Magazines.

[21] Plessey." New head up display." Electronics and Power. Year: 1975, Volume: 21, Issue: 10. Page: 610, DOI: 10.1049/ep.1975.0625. IET Journals & Magazine.