EasyChair Preprint

№ 7309

ARCaddy: Augmented Reality App Suite for Aircraft Maintenance

Sanket Mohanty and C R S Kumar

January 10, 2022

ARCaddy: Augmented Reality App Suite for Aircraft Maintenance

Sanket Mohanty[1], CRS Kumar[1],
[1]Dept of Computer Science and Engineering,
Defence Institute of Advanced Technology(DIAT), Pune 411025, India
sanket_mohanty@diat.ac.in
suthikshnkumar@diat.ac.in

ABSTRACT

Aircraft Maintenance is a complex task requiring highly trained engineers. Facilitating Aircraft maintenance through providing proper tools and equipment is essential in ensuring good maintenance work. While there are a plethora of Augmented Reality applications, the best-suited applications for Aircraft Maintenance are to be selected and evaluated for their usefulness. In this paper, ARCaddy, an AR application suite consisting of a set of openly available AR applications is presented. The ARCaddy is packaged with relevant and tested AR applications. ARCaddy is evaluated for its usefulness by the feedback from the Aircraft Maintenance Engineers. ARCaddy app suite will help maintenance engineers to assist with handy tool kits for various use case in the field of aircraft maintenance.

Keywords
Aircraft Maintenance, Augmented Reality, Apps, Checklists, Computer Graphics, Mixed Reality, Trainer

1. INTRODUCTION

Aircraft Maintenance Engineers require advanced tools and software for efficient maintenance of aircraft. While there are many hardware tools and instruments to facilitate Aircraft Maintenance, the latest software tools can augment the maintenance. Artificial Intelligence(AI) and Augmented Reality(AR) tools and apps play an important role in this scenario.

Augmented Reality(AR) devices such as Hololens, Tablet PCs, Smartphones have found many applications in Maintenance. These AR applications can facilitate various complex maintenance tasks.

The AR superimpose Multimedia content such as Audio/Video/Animation/Text on the real-time environment. There are many useful AR applications that need to be evaluated and validated for the Maintenance Tasks. While these applications are scattered on the internet and are developed by third-party application providers, the ARCaddy is a packaging of selected AR apps that have undergone testing and validation. These AR applications are valuable for Aircraft Maintenance engineers and feedback has been collected and analyzed.

This paper is structured as follows: In the next section, details about the visual inspection of aircraft are presented. In section 3, the Augmented Reality technology is discussed with details about AR devices, applications, etc. The ARCaddy design and implementation details are

presented in Section 4. Results and discussions are articulated in section 5. In section 6, the summary and conclusions are presented.

2. Aircraft Maintenance

Augmented Reality (AR) is a technology that overlaps the information and computer-generated perceptual information sometimes across multiple sensory modalities, including visuals, auditory, haptic &, etc on the real environment to enhance or augment the contextual perception of user's surroundings. AR helps in the creation of intelligent aircraft maintenance systems based on auxiliary operations with overlapping the information on recognized objects in different scenarios.

Aircraft health monitoring recent era requires data collection and diagnostic, supported by technologies like big data, artificial intelligence, mixed reality &, etc. Predictive aircraft maintenance and health monitoring could eliminate unwanted groundings, by making maintenance schedules infrequent intervals, with help of ARCaddy the task gets more user-friendly and more interactive for service engineers. Helps service engineers, pilots for accessing the past records of the aircraft.

Aircraft maintenance checks are cyclic inspections different for both commercial aircraft & military aircraft. Maintenance checks on aircraft are following A & B checks lighter and C & D checks are heavier respectively. Maintenance, Repairs and Overhaul (MRO) with the assistance of ARCaddy reduces a significant amount of time for inspection.

3. Augmented Reality

Augmented Reality (AR) enhances or overlays text/speech/audio/video/animation/graphics on the real-time video through AR devices such as Smart Phones, Tablet PCs, Head Mounted Displays(HMDs), Hololens etc[5]. The AR devices are able to capture real-time images/video/audio through High-resolution cameras, sense position and orientation in 3D through MEMs sensors and GPS. The AR Devices also have high graphics processing capabilities and in real-time recognize the trigger images and overlay programmed graphics and animation. The AR is different from Virtual Reality (VR) where the immersive interactive virtual environments are simulated through VR devices. In Augmented Reality, the user is perceiving the real images and environment, unlike VR where the user is completely blacked out from the real environment into the virtual world.

Hololens 2 by Microsoft is the most exciting AR device development in Augmented Reality[9]. It is a head-mounted display with many interesting features. It has various sensors, Displays, Cameras, processing etc. The following are the detailed specifications of the Hololens 2:

- Display: Uses see-through halographic lenses which use eye based rendering
- Sensors: It uses a variety of sensors such as head tracking, Eye tracking, Depth, Accelerometer, gyroscope, magnetometer and high resolution camera (8MP).
- Audio and Speech: Uses the microphone array and speakers capable of spatial sound.
- Human and Environment Understanding: It uses hand tracking, eye tracking, voice for commands, Iris recognition, Spatial mapping, World scale position tracking and mixed reality capture.
- Computer: It has an onboard computer with an operating system and high-end memory, rechargeable lithium-ion battery backup, and WiFi connectivity.

Sony has also introduced the SmartEyeGlass which is somewhat similar to Hololens. Google has also developed a prototype called google Glass for augmented reality.

3.1 Augmented Reality Applications

AR has many applications for Medical Surgery, Education, Training, Driving, Navigation, Defence, Games etc[3,13]. There are many AR-based games such as PokemonGo which have become popular. AR-based Medical Surgery and Anatomy are becoming commonplace. AR aids for pilots and drivers are built into HMDs. Augmented Reality applications have been attributed with many benefits such as :

- Time savings: AR speeds up the data access and provides helpful hints, directions, checklists, reminders etc.
- Error Reduction: AR can aides the personnel in their tasks and ensure the errors are reduced through remainders, cross-checks etc.
- Mental workload reduction: As the user need not have to memorize many details and volumes of data are made available through AR application.
- Collaboration: Several AR users can communicate and collaborate through networked applications and server.
- Reduction in the cost: AR devices are cost-effective and application development is also standardized. The AR applications can enable a well trained professional to match the expert while performing their tasks.

4. ARCaddy: Implementation

ARCaddy consists of grouping of selected AR applications that are useful for Aircraft Maintenance Engineers. These AR apps have been analyzed in detail and their value for Maintenance engineers is their various tasks is ascertained through active feedback. The applications are packaged and provided as a single file for installation. Thus, while carrying out maintenance tasks, the apps can be selected which are suited for those specific tasks. Here are the list of AR apps (*figure 1. List of Application in ARCaddy*):

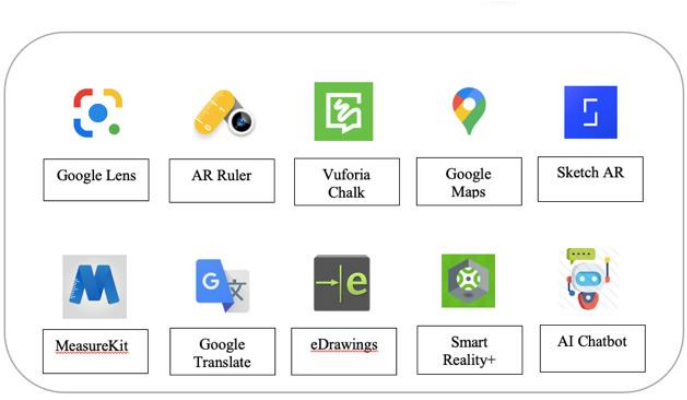

figure 1: ***List of Application in ARCaddy***

- Google Lens

  Google Lens helps in Aircraft maintenance by providing information using image recognition technology, designed to give relevant information related to pointed parts of aircraft using visual analysis based on neural network.

- AR Ruler

  The application AR ruler helps in Aircraft maintenance with interesting tools for service engineers to measure distance, calculate areas, volumes and angles with overlapping Augmented Reality for better insights.

- Vuforia Chalk

  Vuforia Chalk gives the liberty to service engineers and pilots to securely connect, interact & collaborate with AR-based insights in order to support, assist and get remotely work done.

- Google Maps

  In Aircraft Maintenance applications like Google maps helps service engineers to locate the parts, equipment's, & essentials with the help of tagging, guided navigation assistance and much more.

- SketchAR

  SketchAR is a platform providing aircraft maintenance technicians & pilots to interact with AR-based drawing, write-ups on 3D objects for the checklist, scheduled maintenance assistance.

- Measurekit

  Measurekit is similar to AR Ruler to measure the distance using an AR-based pointer with a marker pin tool, angles & path calculator providing assistance to maintenance technicians.

- Google Translate

  Google translate helps service engineers & pilots to keep the digital copy of discussion about the aircraft maintenance regime throughout the aircraft maintenance schedule and provides a follow-up to predictive maintenance.

- eDrawings

  The application eDrawings is a platform that provides to communicate & interact with 3D designs data to minimize errors to aircraft maintenance professionals with help of Augmented & Virtual Reality. It also provides with interrogation with eDrawings viewer.

- SmartReality+

  SmartReality+ is a platform provides aircraft maintenance technicians with augmented & virtual reality-based models transformed from 2D project designs. A platform to interact with transformed 3D models.

- AI Chatbot

  AI Chatbot is an application that simulates the user conversation with Natural Language Processing (NLP) to provide information regarding the maintenance manuals of aircraft or predictive maintenance schedules to service engineers.

The below figure depicts the basic flow of data of the application in ARCaddy. Different use case in the field of Aircraft Maintenance uses applications accordingly with the flow of information depicted below. ARCaddy provides a single platform for maintenance technicians to interact, collaborate and learn with ease of digitization

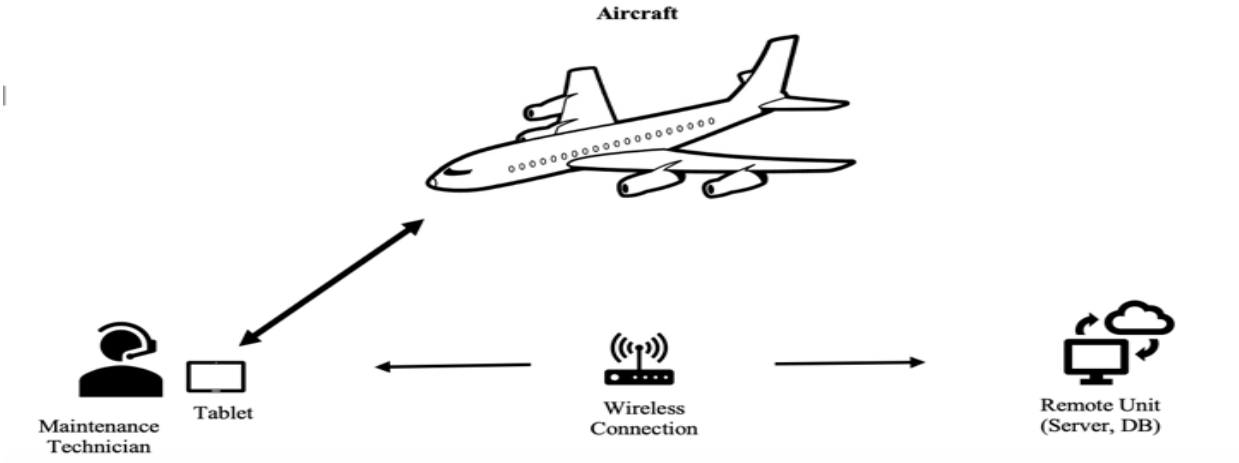

figure 2: ***Data flow of Applications in ARCaddy***

Use case of ARCaddy in the area of aircraft maintenance is providing assistance to maintenance technicians and sets of the tool kit in handled devices for serving the purpose for them to tagging, discussing, measuring and etc with the help of the different applications.

Maintenance technicians can measure the parts of an aircraft, tools required using the Measurekit application. The technician can also discuss, tag required information for other colleagues or own reference using an application like Vuforia Chalk, AR Ruler, Google Maps, Google Lens, etc.

ARCaddy Apps suite will serve the purpose for technicians and engineers to have immersive experience while working and cutting down the work time span by a large margin.

5. Summary and Conclusion

According to the point of view of aircraft predictive maintenance plan, this paper discusses about the structure of the AR smart support framework. Framework advancement and application prerequisites, information module arrangement and the executive's capacities, and ARCaddy fix framework with diverse applications and use cases for the service engineers. Additionally, the product capacity of the framework is examined. The outcomes show that AR innovation can be applied to aircraft maintenance support manual. AR shrewd support framework can significantly further develop work effectiveness. ARCaddy app suite would help in field of aircraft maintenance to provide an immersive experience to the user and cut down work time.

6. REFERENCES

1. J.Vora et al., Using Virtual Reality for Aircraft Inspection Training: Presence and Comparison Training, *Applied Ergonomics (Elsevier)*, 2002, 33, 559-570. DOI: 10.1016/s0003-6870(02)00039-x

2. F.De Crescenzio et al., Augmented Reality for Aircraft Maintenance Training and Operations Support, *IEEE Computer Graphics and Applications,* 2011, 31(1), 96-101. DOI: 10.1109/MCG.2011.4
3. Schmalstieg, Hollerer, Augmented Reality: Principles & Practice, Pearson Education India, 2016.
4. H Timothee, Fundamentals of Aircraft Maintenance Management, Notion Press, 2016.
5. E Pangilinan, S Lukas, V Mohan, Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing, O'Reily Publishers, 2019.
6. Jesse Glover, Linowes, Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications, Packt Publishing, 2019.
7. Kroes, Watkins and Delp, Aircraft Maintenance and Repair, Sixth Edition, McGraw Hill International, 1993.
8. K Latorella, P Prabhu, A Review of Human Error in Aviation Maintenance and Inspection, *International Journal of Industrial Ergonomics (Elsevier)*, 2000, 26, 133-161. **DOI:** 10.1016/S0169-8141(99)00063-3
9. Hoover, Melynda, An evaluation of the Microsoft HoloLens for a manufacturing-guided assembly task., Graduate Theses and Dissertations. MS Thesis, Iowa State University, 2018.
10. Sei Wei Yong, Aun Naa Sung, A Mobile Application of Augmented Reality for Aircraft Maintenance of Fan Cowl Door Opening, *International Journal of Computer Network and Information Security(IJCNIS)*, 2019, 11(6), 38-44. DOI: 10.5815/ijcnis.2019.06.05
11. M.Sirakaya and E.K. Cakmak, Effects of Augmented Reality on Student Achievement and Self Efficacy in Vocational Education and Training, *International Journal for Research in Vocational Education and Training (IJRVET)* 2018, 5(1), 1-18, DOI: 10.13152/IJRVET.5.1.1
12. T. R. Herbert, Impact of Using Augmented Reality for Aircraft Maintenance, MS Thesis, Air Force Institute of Technology, 2019. DOI: AFIT-ENY-MS-19-M-121.
13. S. Lavelle, Virtual Reality, Cambridge University Press, 2019.
14. Prathapa A.P., Automated Visual Inspection of Military Aircraft Fuselage with Machine Learning Techniques, MTech Dissertation(supervision by Prof CRS Kumar), Dept of Computer Science and Engineering, DIAT, 2020.