Exploring Mixed Reality in General Aviation to Support Pilot Workload

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Figure 1: This mockup image shows how mixed reality could potentially be used to display relevant information about surrounding points of interest (e.g., other traffic, airports) to pilots using a head-mounted display.

ABSTRACT

Pilots in non-commercial aviation have minimal access to digital support tools. Equipping aircraft with modern technologies introduces high costs and is labor intensive. Hence, wearable or mobile support, such as common 2D maps displayed on standard tablets, is often the only digital information source used by pilots. Yet, they fail to adequately capture the 3D airspace and its surroundings, challenging the pilot's workload. This work explores how mixed reality can support pilots by projecting supportive elements into their fields of view. Considering the design of a preliminary mixed reality prototype, we conducted a user study with twelve pilots in a full-sized flight simulator. Our measures show that the prototype positively influenced the participants' situational awareness and overall landing routine efficiency, who also had generally favorable views regarding mixed reality in the cockpit. This work shows the utility of mixed reality technologies while emphasizing future research directions in general aviation.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Mixed / augmented reality**; • **Applied computing** → **Avionics**.

KEYWORDS

General Aviation, Augmented Reality, Mixed Reality, Highlighting, Workload, Situational Awareness

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1 INTRODUCTION AND BACKGROUND

The potential of Mixed Reality (MR) technologies in the aviation sector has been known for decades. Both military [1, 10] and commercial [2] applications of MR are used in today's aircraft cockpits, improving upon the well-established gauge- and display-based cockpits. They allow pilots to gaze outside the aircraft while simultaneously displaying vital flight information on top of the real world. However, a major part of aviation does not occur in military

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or commercial aircraft. Most flights are operated by General Aviation (GA)[1] pilots [6]. The aforementioned developments largely ignore the safety practices and needs of GA operations wherein the usability, dependability, and safety constraints differ widely for new technologies. A total of approximately 211k active GA aircraft were registered in the U.S. in 2018, with around 167k (~ 80%) of those being motorized fixed-wing airplanes. Of those fixed-wing aircraft, over 75% are Single Engine Piston (SEP) aircraft with an average age of 46.8 years [6]. This indicates that innovative technologies in the field of GA take decades to reach widespread use in currently flown aircraft, especially considering the age of the current GA fleet.

Rather than employing MR in permanently installed avionic systems, it might be utilized as a part of the Electronic Flight Bag (EFB) instead. EFBs describe the personal electronic equipment that pilots bring along onto the aircraft. This enables GA pilots to use new MR technologies as they see fit, not being limited by the state of the technologies being available through the aircraft itself. As most GA flights are performed under Visual Flight Rules (VFR), meaning that navigation is done mainly visually and not primarily based on instrument readouts, one potential application is the visualization of traffic, airports, visual markers, and more through Augmented Reality (AR) devices.

Exceptionally high workloads in the cockpit are not uncommon, and situational awareness is crucial for a successful flight. While previous research has already been conducted in the field of displaying current flight information via AR [7, 8, 16], highlighting relevant Points of Interest (POIs) in the real world via AR has not been done yet. Not adding redundant information, such as current flight parameters already shown on gauges, into the field of view of pilots, but rather facilitating the pilot into locating themselves, traffic, and geographical POIs might yield fruitful results in terms of supporting the workload of pilots and subsequently reducing human errors in flight scenarios.

To understand how AR impacts the pilot flight experience, we investigate the design and efficiency of AR technologies for GA pilot support to reduce their workload while increasing awareness (see Figure 1). Although previous research has suggested AR as a tool for augmenting pilot workload [4, 5, 12], its feasibility and efficiency have not been evaluated yet. Hence, we present a concept of an AR application supporting pilots. The prototype uses a Head-Mounted Display (HMD) to display a subset of the aforementioned POIs, such as traffic and airports. We conducted a user study with twelve pilots in a flight simulator to evaluate pilot task load and awareness when using AR.

CONTRIBUTION STATEMENT

This work presents a twofold contribution:

(1) We present the initial design concept of an AR application intending to support GA pilots during their flight routine.
(2) We ground the feasibility of this application by conducting a study with GA pilots (N=12). We evaluate the potential of AR through real-world flight routines as a tool to mitigate workload while fostering awareness.

2 INITIAL DESIGN OF A MIXED REALITY PROTOTYPE FOR PILOTS

Herein, we conceptualize and describe the AR prototype and its intended application. Initiating the landing process is a cognitively demanding task that includes several factors to consider (e.g., maintaining radio contact, monitoring surroundings and flight parameters, and following the flight pattern). Thus, the landing process is one of the most demanding moments in aviation operations, requiring the pilot's full attention, who has to carefully manage their workload and attend to the many operations at this time. This is reflected by the aviation accident statistics by the NTSB[2,3], with more than a third of all accidents in the civil sector happening during the approach and landing phase alone. Next, errors in decision-making and perception were found to be a deciding factor in nearly a third of all GA accidents which can be attributed to human error [18]. For these reasons, the prototype offers the visualization of both airports and traffic (i.e., POIs) to support the pilots during their landing procedures.

2.1 Design Considerations

The maximum range of considered POIs was decided to be 10 NM (~ 18.5 km), covering the area which can be reached in less than 5 min assuming a cruise airspeed of 120 kn ($\sim 220\,\frac{\text{km}}{\text{h}}$), which is ordinary for GA aircraft. Airports were chosen as static POIs to be highlighted, as they are the arguably most important landmarks to be found and identified (see Figure 2b). Traffic was selected to be highlighted to be able to examine the highlighting of dynamic POIs as well (see Figure 2a).

Plenty of Traffic Collision Avoidance Systems (TCAS) already exist in the commercial aviation sector. With that come already tested and well-known symbologies, rendering the creation of new designs from scratch unnecessary. Due to this, the prototype will adapt the traffic display symbology as defined in the official TCAS guideline [3].

The design of their virtual highlighting differs from those emphasizing traffic since airports are static POIs. Currently, only one symbol is used for all different types of airports (see Figure 2b). In addition, the Euclidean distance to the airport is given. Above the pictogram, a label is displayed, showing further information about the airport. By default, all types of airports are highlighted. Even though the pilot might not wish to approach the airport, knowing the location of a nearby airport can assist in estimating expected traffic, airspaces, and airport traffic patterns to steer away from and keep in mind.

2.2 Implementation

The two main parts of the study setup and implementation are the HMD and the flight simulator in which it was used. We use a

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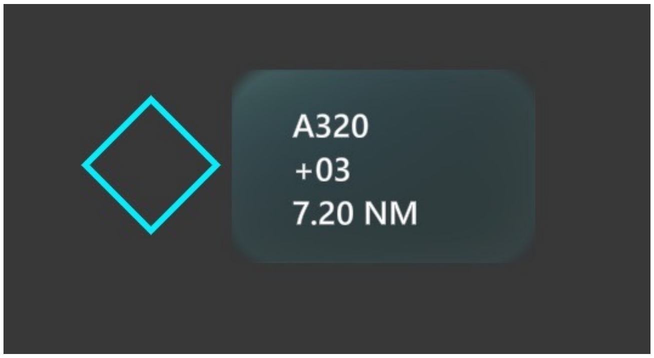
[1] The International Civil Aviation Organization (ICAO) defines GA as any civil aircraft operation that does not entail transportation of cargo, passengers for hire, or aerial work (e.g., surveying, search and rescue operations) [11].

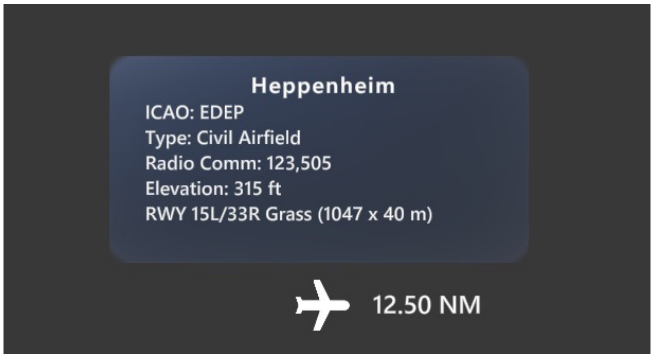
[2] NTSB Aviation Accident Database Synposes:
https://www.ntsb.gov/Pages/AviationQuery.aspx

[3] NTSB Annual Summary of US Civil Aviation Accidents:
https://www.ntsb.gov/safety/data/Pages/AviationDataStats2019.aspx



A320
+03
7.20 NM

(a) Exemplary virtual component for an aircraft in the vicinity. This instance shows an airliner of type "A320" at a distance of 7.2 NM and 300 ft above, currently not posing a threat.



Heppenheim
ICAO: EDEP
Type: Civil Airfield
Radio Comm: 123,505
Elevation: 315 ft
RWY 15L/33R Grass (1047 x 40 m)

12.50 NM

(b) Exemplary virtual component to accompany an airport in the vicinity. This instance shows the Heppenheim airport at a Euclidean distance of 12.5 NM with further relevant information.

Figure 2: The used traffic and airport symbology.

Microsoft HoloLens 2[4] as the HMD as it can be operated without any further computers. It is agnostic to the environment that it is used in, enabling the user to start and stop using it as desired. The GA flight simulator is based on the *Diamond DA40-180* aircraft by Diamond Aircraft, a widely known and operated GA aircraft. It uses a full-size cockpit replica manufactured by Diamond Aircraft to the exact specifications of its actual aircraft. A 180° round-view projector setup allows for an immersive flight experience with realistic visuals and a broad field of view. The flight mechanics subsystem is set up and configured the same as flight simulators certified by the EASA for pilot training.

The weather of the simulated environment was set to scattered clouds at high altitudes, and the time was set to 10 o'clock in the morning, ensuring good visibility throughout the experiment. No wind, gusts, or any other weather phenomena were set, and no faults or incidents which could lead to deviations from standard procedures were triggered.

The flight simulator supplied the *HoloLens 2* with all relevant information regarding the current simulation environment (e.g., location and attitude of the aircraft, simulated traffic information), which an application running directly on the *HoloLens 2* filtered and displayed as necessary. The flight simulator and the *HoloLens 2* communicated over UDP as new data is constantly generated and sent by the flight simulator, making fast and connectionless communication more important than an error-free reliable transmission.

3 METHODOLOGY

To be able to assess the impact of the prototype, a within-subject design was chosen. Two landings were conducted per participant; once while wearing the *HoloLens 2* and once without it. Therefore, the only independent variable has two levels: flying *without prototype* and *with prototype*. Each participant was asked to give information about all traffic in their vicinity that they knew of thrice during each approach. These questions were always asked at the same time during their flight, ensuring that all participants could at least theoretically see the same traffic as everyone else, disregarding the actual flight performances regarding flight path and airspeed, which logically influences the traffic locations around the simulated aircraft. Each landing was planned identically, only differing in the use of the prototype and the airport which was to be approached. Even though the airport is not a condition intended for evaluation, a balanced Latin square distribution of both the airport and the usage of the prototype was chosen to minimize potential correlations between the airport and the prototype. The initial aircraft position was roughly 8 NM far from the airport to be approached and at an altitude of 3000 ft.

3.1 Measures, Data Recording, and Analysis

The NASA-TLX [9] was chosen to gain insights into the assessment of the perceived task load by the participants [14]. The User Experience Questionnaire (UEQ) [17] benchmarked the overall user experience during the performed landing. One Likert Scale Questionnaire was filled out after the experiments to assess the participant's overall opinions about their experiences and the use of MR in GA cockpits. The questions are depicted in Figure 6. In addition, we recorded the flight paths to compare the different approaches.

As the study was designed as a within-group study, the quantitative measures were evaluated using paired sample t-tests. The assumption of normality for the data sets was ensured by using the Shapiro-Wilk test. No weighting was applied to the NASA-TLX scales and the raw NASA-TLX (RTLX) was used.

3.2 Procedure

The study began by explaining the general procedure to the participant. After consent was given, an initial questionnaire was filled out to record demographic data and the participant's stances toward technology and GA. The participants could then independently test the *HoloLens 2* and the flight simulator. The *HoloLens 2* was calibrated to the user's eyes, and a sample interaction scene was loaded so familiarization with the holographic display and the interaction modalities of the device could happen. For the flight simulator test, participants were allowed to fly wherever and however they wished, except at the airports chosen for the subsequent landings.

Before each landing, participants received a short briefing informing them of their current position and heading. We assumed

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[4] https://www.microsoft.com/en-us/hololens

that landing permission was already granted, requiring the following of an airport traffic pattern before initiating the landing. A sectional chart of the region was available to the participants, and no radio communication was required. After each landing, the NASA-TLX and UEQ were filled out. In addition, after both landings, the final Likert scale questionnaire was filled out. Figure 3 depicts the study procedure.

3.3 Participants

Overall, 12 participants (11 male, 1 female) aged between 24 to 31 years ($\bar{x} = 28$, $s = 2.09$) were recruited for the study. The study was advertised through a mailing list of the institute where the flight simulator is located and by sending direct invitations to regional flying clubs.

The mean flight time as pilot-in-command was 239.34 h ($s =$ 259.44 h) for all types of aircraft and 107.92 h ($s =$ 187.56 h) for SEP aircraft specifically. An overview of all participants is given in Table 1.

4 RESULTS

This chapter presents the results following the data analysis performed after the study. In the following, the condition *With MR Prototype* will be denominated with a subscript "W" and the condition *Without MR Prototype* will be denominated with a subscript "WO". All error bars indicate the standard error.

4.1 NASA-TLX

The NASA-TLX questionnaire was used to assess the pilots' perceived task load. The analysis of the overall RTLX yielded no significant differences ($t(11) = -1.54,\ p = .151$), even though the mean overall RTLX value for the *With MR Prototype* condition ($\bar{x}_\text{W} = 46.6$, $s_\text{W} = 5.23$) was substantially lower than the one for the *Without MR Prototype* condition ($\bar{x}_\text{WO} = 54.6$, $s_\text{WO} = 6.09$).

Figure 4a shows the accumulated RTLX results for all participants in one, and Figure 4b shows the combined RTLX values per participant. The RTLX values for the condition *Without MR Prototype* were subtracted from the RTLX values for the condition *With MR Prototype* to directly show which condition had the lower perceived workload for each participant. Herein, seven participants reported a lower perceived workload during the *With MR Prototype* condition; one saw no difference, and the rest ($n = 4$) reported a lower workload when not using the prototype.

4.2 Flight Paths

The flight paths that the participants flew were compared for both airports; Figure 5 shows the approaches to one of the two. All approaches for one condition are superimposed on a regional map to allow for a comparison between the two groups. As seen in Figure 5a, the general shape of an airport traffic pattern was visible when the prototype was used. While the length of the downwind differs between approaches, the distance to the runway is similar for almost all participants, disregarding one approach where the participant only joined the traffic pattern at the base leg.

However, in Figure 5b the airport traffic pattern can hardly be recognized. Multiple participants approaching the airport in the *Without MR Prototype* condition missed the usual traffic pattern entry (into the downwind). Furthermore, three participants chose to go around, aborting their current landing and trying anew. Only one participant chose to go around in the *With MR Prototype* condition.

4.3 User Experience Questionnaire

The *Attractiveness* ($t(11) = -1.98,\ p = .073$) was rated high for both conditions; no significant difference could be found between the two. However, significant differences could be noted in regards to *Perspicuity* ($t(11) = -2.27,\ p < .05$), *Stimulation* ($t(11) = -2.96,\ p < 0.05$), and *Novelty* ($t(11) = -7.17, p < .001$). The *Novelty* rating for the *Without MR prototype* is especially notable as it is the only one gathering generally negative assessments. The values for *Efficiency* ($t(11) = -1.54,\ p = 0.151$) and *Dependability* ($t(11) = -2.00,\ p = .070$) fell in favor of the *With MR Prototype* condition, but showed no significant deviations.

4.4 Likert Questionnaire

The results of the concluding questionnaire, consisting of four Likert scale questions, showed generally favorable views towards both the prototype and MR in GA. Participants unanimously agreed that the displayed information regarding other traffic was helpful. The helpfulness of displayed information regarding airports was not as unequivocal, but still clearly in favor of it. Herein, one participant found the traffic highlighting somewhat not helpful, and two participants answered with "Maybe". These results are also shown in Figure 6.

4.5 Traffic in Sight

The detected traffic varied strongly in between conditions ($t(11) = -10.7,\ p < .001$). As two aircraft were always in the vicinity of the participant and each participant was asked to report all aircraft they could see three times during landing; six aircraft could potentially be seen per landing. On average, only 0.25 aircraft were detected during the whole approach and landing without the help of the prototype. However, during the *With MR prototype* conditions, an average of 3.5 aircraft were detected and reported back.

5 DISCUSSION

For a new technology in the GA sector to be accepted and adopted, it has to offer a sufficient user experience in addition to its essential features. The evaluation of the UEQ in Section 4.3 shows that the user experience when flying with the prototype is descriptively at least equal to or better than the user experience in a generic cockpit. Participants felt that their current surroundings were easier to comprehend, and the high novelty value indicates that the initial acceptance, were it to be used in real flight, could also be rather high.

On average, more than half of all aircraft in a 10 NM radius could be recognized when using the prototype. At the same time, many participants could not report back even one aircraft without the prototype. However, most participants noted that even with the prototype, they could not distinguish an actual aircraft from the sky and relied on the correctness of the traffic holograms. The issue of reporting aircraft for which only a hologram can be seen might, however, be regarded as controversial as it leads to regulatory concerns which are not addressed by current legislation yet. Is an

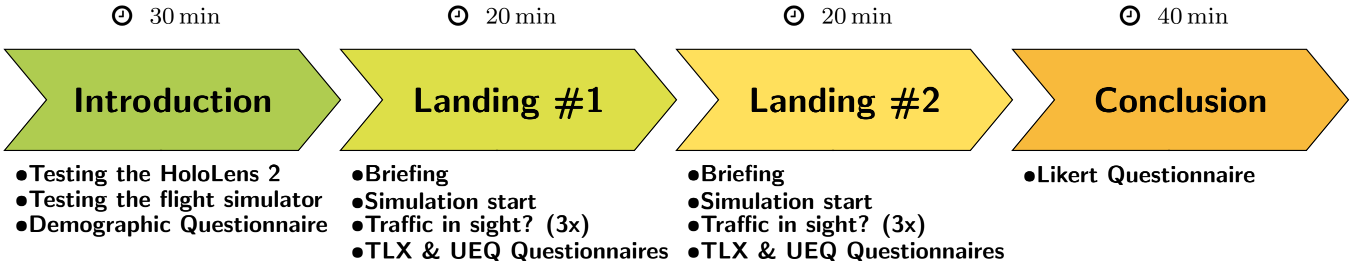
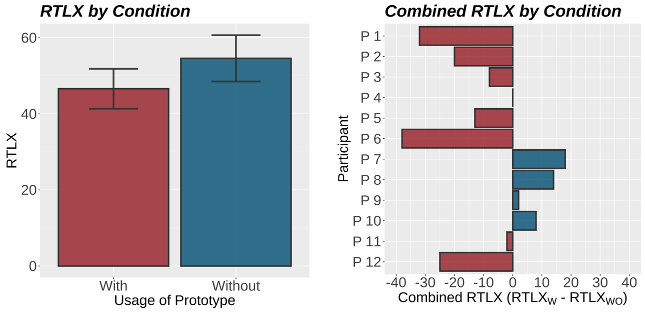


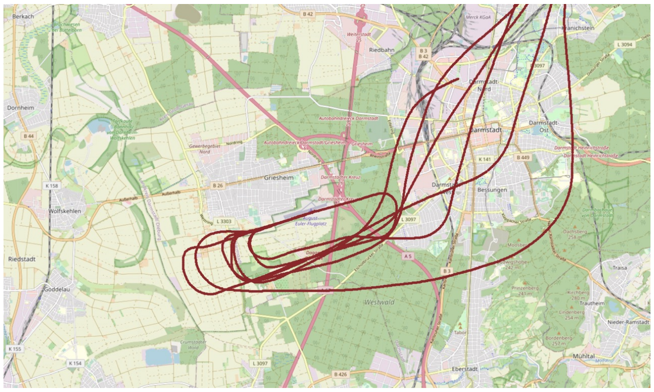
Figure 3: The procedure of the study is depicted in this flow diagram. After introducing the participants to the hardware and study itself and demographics were recorded, they each performed two landings. The prototype was used for one landing; the other was done without it. Various data were acquired during these experiments.



(a) After averaging all NASA-TLX assessments of all participants, no significant differences between the two conditions were found.

(b) The combined RTLX values per participant show that over half of the participants perceived a lower workload when using the prototype.

Figure 4: Quantitative results of the study. For the NASA-TLX evaluation, the ratings were taken as is ("raw"), and no weighting of the associated scales was applied.



(a) Flight paths recorded during the *With MR Prototype* condition.

(b) Flight paths recorded during the *Without MR Prototype* condition.

Figure 5: Plots of the flight paths that the participants flew during their approach to one of the airports. All paths are superimposed onto a map of the region.

aircraft in sight if a virtual object is shown at its precise location, even if the naked eye cannot distinguish the aircraft? Incorrect data can lure users into a false sense of security, as many participants acknowledged themselves.

Yet, the study showed that the prototype increases situational awareness regarding traffic in a controlled environment. The influence of incomplete, missing, or even downright false data (e.g., through faulty or misused technology) might change this assessment in the future. Still, supposing that all information purveyed by the holograms is correct, participants were aware of other aircraft that they were otherwise not.

In the same way, participants seemed to be much more aware of their location regarding the approached airport. As Figure 5a and Figure 5b show, the airport traffic pattern is much more recognizable when the prototype was used. The participants could first find the airport and then approach it as is custom much easier.

Considering the margins of some of these combined RTLX values, it can safely be assumed that using the prototype resulted in a lower workload for some participants. However, it cannot be stated that the prototype can reduce the workload for all users. Hence, the use of MR in aviation is highly individual. As the experience of MR environments was new to most of them, the novelty and unfamiliarity of this approach to present information are assumed to be the leading factor as to why some participants perceived a higher workload instead. In these cases, the holograms might distract rather than support the users, even though they were regarded as helpful by most.

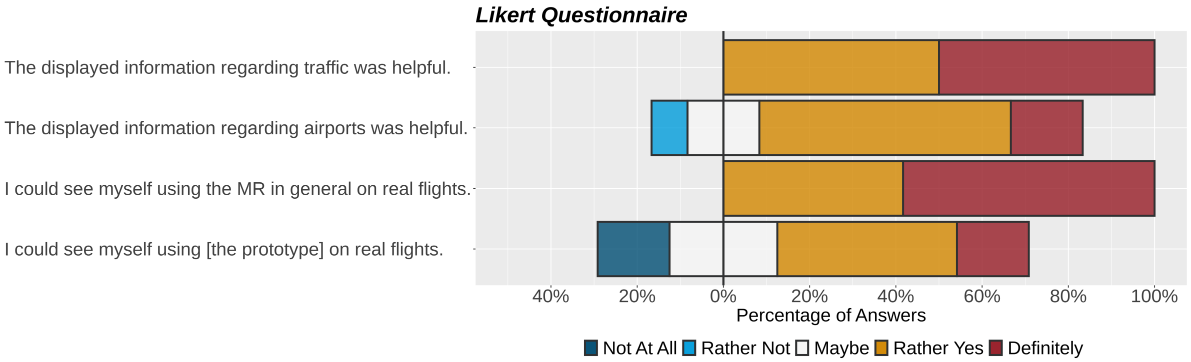


Figure 6: The results of the Likert scale questionnaire. The participants were generally in favor of both the prototype and MR as a whole.

5.1 Limitations and Future Work

An important study limitation is the controlled environment in which it was conducted. No significant weather or potentially dangerous traffic situations were programmed to occur herein. Furthermore, no radio communication was required, and the participants were aware that no actual aircraft was flown. Supervised testing of MR while operating a real aircraft will probably yield many new findings, as a truly realistic environment cannot be reliably achieved in a simulator. Next, the prototype has not been tested for performance with actual real-world data, including testing for novelty effects of the prototype [15]. While the connection to live databases has been achieved, the influence of a non-steady flow of information and its natural inaccuracies remains to be tested. Finally, the impact of direct MR interaction and its level of distraction must be evaluated. Although previous work researched how MR interaction can be improved in transportation [13], it has not been studied in the context of GA.

6 CONCLUSION

This work explored how MR can support GA pilots during their flights. We conducted a preliminary evaluation to investigate the impact on user experience and task load. We find that the user experience of flying an aircraft using MR was perceived positively. A clear majority of participants felt that the prototype was helpful and clearly showed that using MR in GA is feasible. The factors of novelty, clutter, and distractions directly in the user's field of view are some of the less critical, albeit still relevant, obstacles. At the same time, the overreliance on such technologies could pose severe threats to the safety onboard. The MR prototype showed that the current MR technology could be used for much more than simply displaying already available information to GA pilots. The presented research lays the foundation for pursuing MR in the aviation sector to increase the awareness and safety of GA pilots.

REFERENCES

[1] BAE Systems. 2016. Striker II: Performance Without Compromise.
[2] Chris Brady. 2011. *The Boeing 737 Technical Guide.*
[3] Federal Aviation Administration. 2011. TCAS Booklet v7.1.
[4] Sebastian S. Feger, Felix Ehrentraut, Christopher Katins, Philippe Palanque, and Thomas Kosch. 2022. HCI for General Aviation: Current State and Research Challenges. *Interactions* 29, 6 (nov 2022), 60–65. https://doi.org/10.1145/3564040
[5] Sebastian S Feger, Christopher Katins, Philippe Palanque, and Thomas Kosch. 2022. Tangible Interaction in the (General) Aviation Cockpit. (2022).
[6] General Aviation Manufacturers Association. 2019. GAMA Databook 2019.
[7] Andrey L. Gorbunov. 2014. Stereoscopic Augmented Reality in Visual Interface for Flight Control. *Aerospace Science and Technology* 38 (Oct. 2014), 116–123. https://doi.org/10.1016/j.ast.2014.08.002
[8] Paul M. Haiduk. 2017. *Display Formats for Smart Glasses to Support Pilots in General Aviation.* Ph. D. Dissertation. Technische Universität Darmstadt.
[9] Sandra G. Hart and Lowell E. Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In *Advances in Psychology*. Vol. 52. Elsevier, 139–183. https://doi.org/10.1016/S0166-4115(08)62386-9
[10] Keith L. Hiatt, Clarence E. Rash, and Kevin Heinecke. 2008. Visual Issues Associated with the Use of the Integrated Helmet and Display Sighting System (IHADSS) in the Apache Helicopter: Three Decades in Review. In *SPIE Defense and Security Symposium.* https://doi.org/10.1117/12.774499
[11] International Civil Aviation Organization. 2010. *Operation of Aircraft. Part I.*
[12] Christopher Katins, Sebastian Feger, and Thomas Kosch. 2022. No Margin for Errors: Using Extended Reality to Augment Users in Safety-Critical Environments. (2022).
[13] Thomas Kosch, Andrii Matviienko, Florian Müller, Jessica Bersch, Christopher Katins, Dominik Schön, and Max Mühlhäuser. 2022. NotiBike: Assessing Target Selection Techniques for Cyclist Notifications in Augmented Reality. *Proc. ACM Hum.-Comput. Interact.* (sep 2022). https://doi.org/10.1145/3546732
[14] Thomas Kosch, Jakob Karolus, Johannes Zagermann, Harald Reiterer, Albrecht Schmidt, and Paweł W. Woźniak. 2023. A Survey on Measuring Cognitive Workload in Human-Computer Interaction. *Comput. Surveys* (jan 2023). https://doi.org/10.1145/3582272
[15] Thomas Kosch, Robin Welsch, Lewis Chuang, and Albrecht Schmidt. 2023. The Placebo Effect of Artificial Intelligence in Human–Computer Interaction. *ACM Trans. Comput.-Hum. Interact.* 29, 6, Article 56 (jan 2023), 32 pages. https://doi.org/10.1145/3529225
[16] Peter M. Lenhart. 2006. *Räumliche Darstellung von Flugführungsinformationen in Head-Mounted-Displays.* Ph. D. Dissertation. Technische Universität Darmstadt.
[17] Martin Schrepp, Andreas Hinderks, and Jörg Thomaschewski. 2017. Construction of a Benchmark for the User Experience Questionnaire (UEQ). *International Journal of Interactive Multimedia and Artificial Intelligence* 4, 4 (2017). https://doi.org/10.9781/ijimai.2017.445
[18] Douglas Wiegmann, Troy Faaborg, Albert Boquet, Cristy Detwiler, Kali Holcomb, and Scott Shappell. 2006. Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis Using HFACS. (2006), 26.

A APPENDIX: PARTICIPANT DATA

Table 1: An overview of the participants of the study. Next to demographic data, the attained licenses (SPL = Glider Pilot License, LAPL = Light Aircraft Pilot License, PPL = Private Pilot License, MPL = Multi-Pilot License) and the time as pilot-in-command (PIC) for both aircraft in general and motorized GA aircraft are given. Two participants, marked with an asterisk (*), had flight simulator experience but did not yet finish their pilots' training.

PID	Age	Gender	Licenses	PIC Hours (Overall)	PIC Hours (Motorized GA Aircraft)
P1	28	M	SPL	100	10
P2*	31	M	-	0	0
P3	28	W	SPL	50	1
P4	26	M	SPL, LAPL	300	30
P5	30	M	SPL, LAPL	500	200
P6	27	M	SPL, LAPL	700	60
P7	30	M	PPL	650	650
P8*	24	M	-	0	0
P9	30	M	PPL, MPL	200	140
P10	27	M	SPL, LAPL	7	4
P11	26	M	SPL, PPL	350	200
P12	29	M	SPL, LAPL	15	0