The Modification and Testing of an Electronic Flight Bag in the Field

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Introduction

With the invention of tablet computers, society has accelerated its rejection of paper as a medium to store and access data. One such occupation that is benefitting from the tablet revolution is aviation. Just a couple of years ago, pilots would lug 40lb flight bags when they flew.. These bags contained essential documents such as operation manuals, airway charts, and airport facility diagrams. All of this information can now be stored in Electronic Flight Bags: aviation software for tablets. The introduction of Electronic Flight Bags into industry has created several benefits. One such benefit is weight reduction. Besides making it physically easier for pilots, the weight reduction has dramatically reduced aircraft fuel burn. Airlines such as American Airlines are saving approximately $1.2 million dollars annually in fuel since their switch to Electronic Flight Bags [1]. Another benefit of Electronic Flight Bags is increased safety.

The goal of this research project was to enhance the safety characteristics of an Electronic Flight Bag further through the development of modifications to an existing application and collect data on how pilots use the application in the real world. Since the study consists of human subjects piloting aircraft, the legal process to run the study has been extensive. This has led to the study being postponed to a later date. The remainder of this paper will discuss the modifications made and the research methodology.

EFB Modifications

Avare, a widely downloaded and open sourced electronic flight bag application, was chosen for the basis to make modifications. Modifications were made to support pilots in each "Contextual Control Mode" [2]. The primary focus of the modifications were on the procedural and optimizing states. The goal of the modifications is to free up time and mental energy for pilots. By doing so, pilots can focus more on important tasks and thus increase flight safety.

The modifications made to assist pilots in the procedural context control mode consist of two new pages to the application: Plan and Radio. A complaint by pilots in a previous study was the lack of planning features in Avare. Figure 1 depicts the new Plan page. At the top of the page are two text input boxes corresponding to the adjacent buttons Create Route and Search. The Create Route button is the quickest way to create a plan. A pilot just has to add a list of waypoint ids to the Create Route Input. The search feature allows pilots to lookup waypoints by code, location, or city. An example of searching for waypoints in Lagrange, Ga is given in Figure 2. A person can add a waypoint to the list just by tapping it from the Search List. Once a waypoint is added to the plan, it shows up in as a bar as highlighted by the orange square in Figure 1. The waypoint object displays its id and waypoint type. When connected to GPS, the waypoint object will also display distance, estimated time of arrival, course, heading, and fuel burn. If the tablet is connected to an ADS-B receiver, the waypoint object will display winds aloft at that location and calculate a more accurate fuel burn. Waypoints can be reordered by dragging from the Drag Button. Waypoints can be deleted by swiping left on the waypoint object. The Totals Bar at the top of the waypoint list will display total distance, time, and fuel consumption for the trip. The Totals Bar allows pilots to quantitatively compare various routes for the most optimal path for their specific need. Once a plan is finalized, it can be activated by pressing the Deactivate/Activate Toggle Button located in the Button cluster. When activated, the Deactivate/Activate Toggle Button turns green, and the route is displayed on the main navigation map as shown in Figure 3. If the plan is to be used at a later date, it can be saved and loaded by tapping on the corresponding buttons in the Button Cluster. The new plan page gives pilots the ability to optimize and speed up the procedural task of creating flight plans.

Another procedural task of flying an aircraft is establishing communications and tuning to navigation aids. In general, pilots have to look up communication and navigational frequencies in large tables. The Radio page, depicted in Figure 4, assists pilots in communication and navigation by depicting relevant frequencies to the flight plan. The top of the Radio page is a button that allows the pilot to toggle between displaying frequencies for all of the plan waypoints and frequencies only at the destination. The Radio page gives pilots the ability to find radio frequencies with ease.

Research Methodology

The research study consists of two parts. The first part is collecting data from real world flights. Once the study is approved for testing, the application would be distributed to consenting pilots. When a pilot uses the application during a flight, code running in the background will track the user's actions. Once the flight is complete and the pilot closes the application, a CSV file containing all of the user's actions is uploaded to a secure server. An example of the file is depicted in Figure 5. Along with each event tracked is a timestamp and GPS data: latitude, longitude, ground speed, and declination. The second part of the study is a post flight questionnaire. The questionnaire, which is to be completed after every flight while using Avare, will gather additional feedback and data. Example questions include "What type of flight was flown (VFR/IFR)," "Was the flight solo," "Did any out of the ordinary events occur," and "Were there any problems encountered while using the Application?"

Conclusion

Through the collection of data from multiple flights, patterns can be formed depicting pilot behavior. One patterns could depict how far out a pilot on average would reference an airport diagram. By learning this pattern, code could be developed to make the application more adaptive such as using geofencing to automatically display relevant data once a pilot comes close enough to a waypoint or destination. Other patterns could be discerned to display additional data automatically based on altitude, or speed. The data collected from the surveys would be used to correlate additional events to specific flight scenarios described by the pilots. By automating the display of certain data, pilots will be able to spend less time searching data. This will allow pilots to focus on more important tasks and thus lower the risk of pilot error.

Appendix

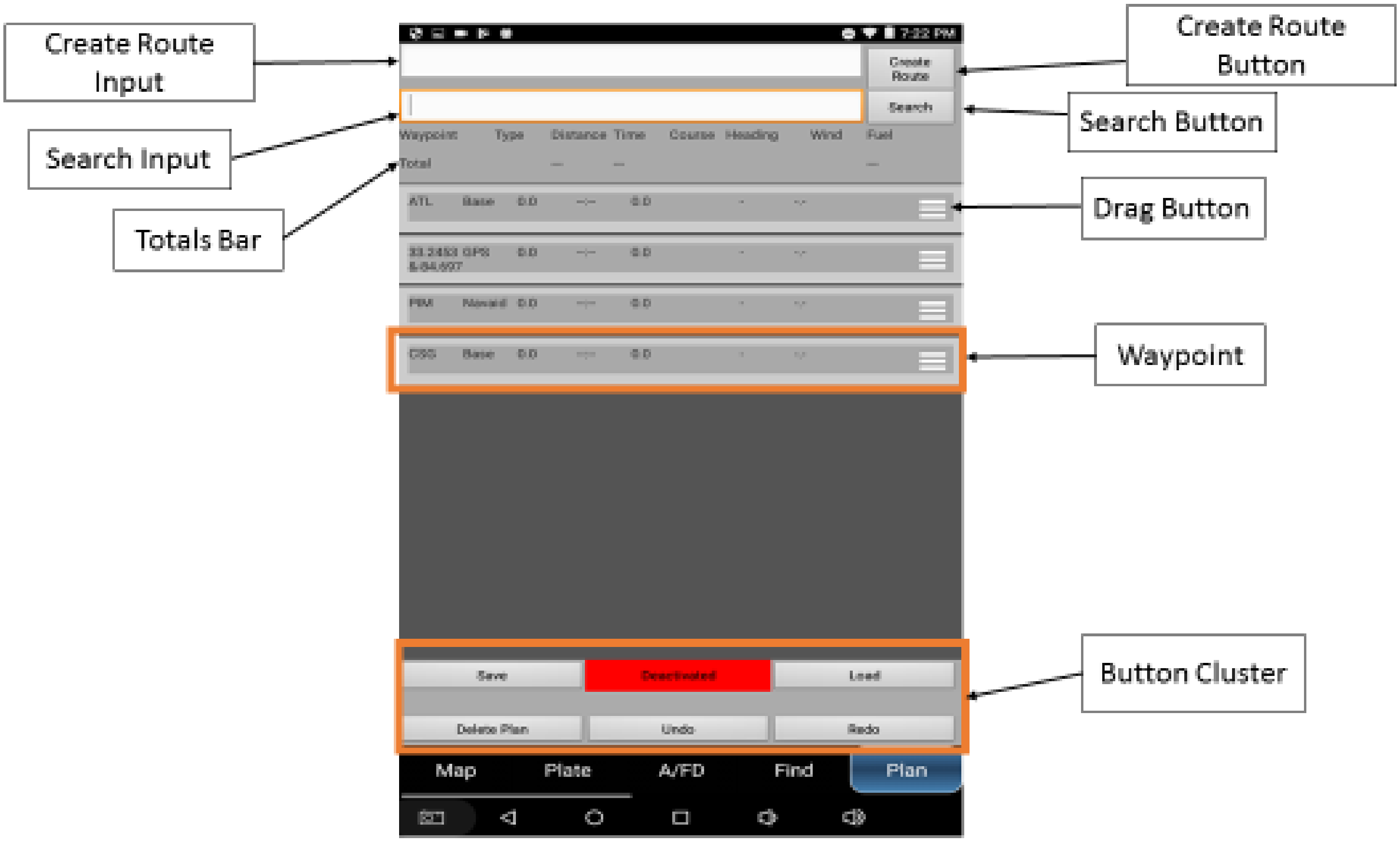

Figure 1. Plan Page

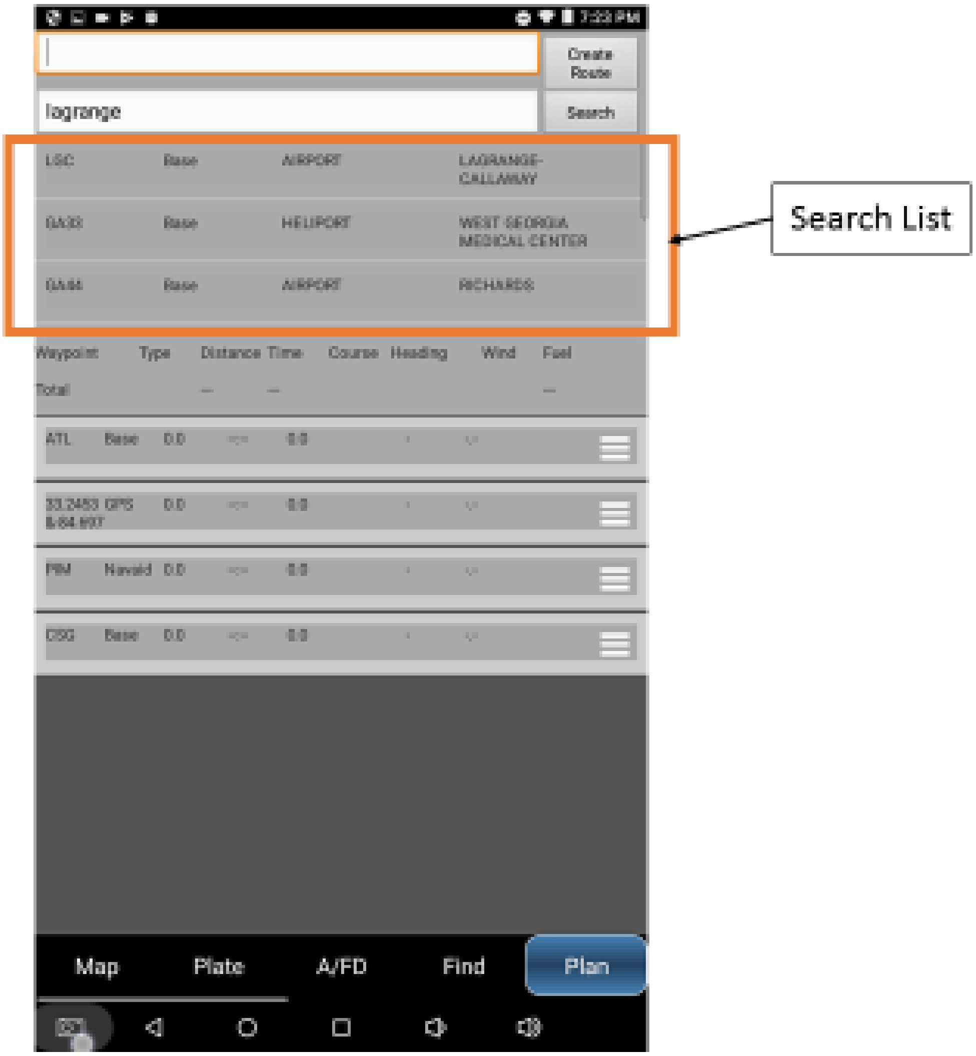

Figure 2. Search Example

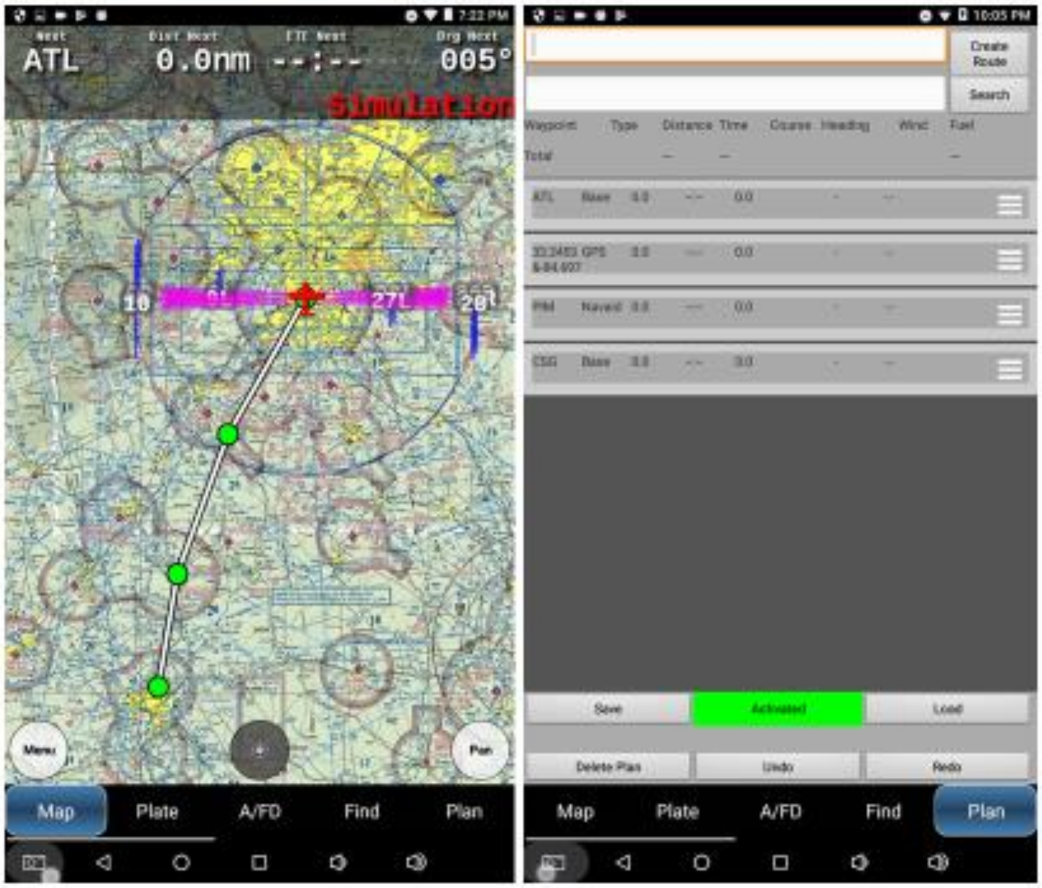

Figure 3. Plan Activated

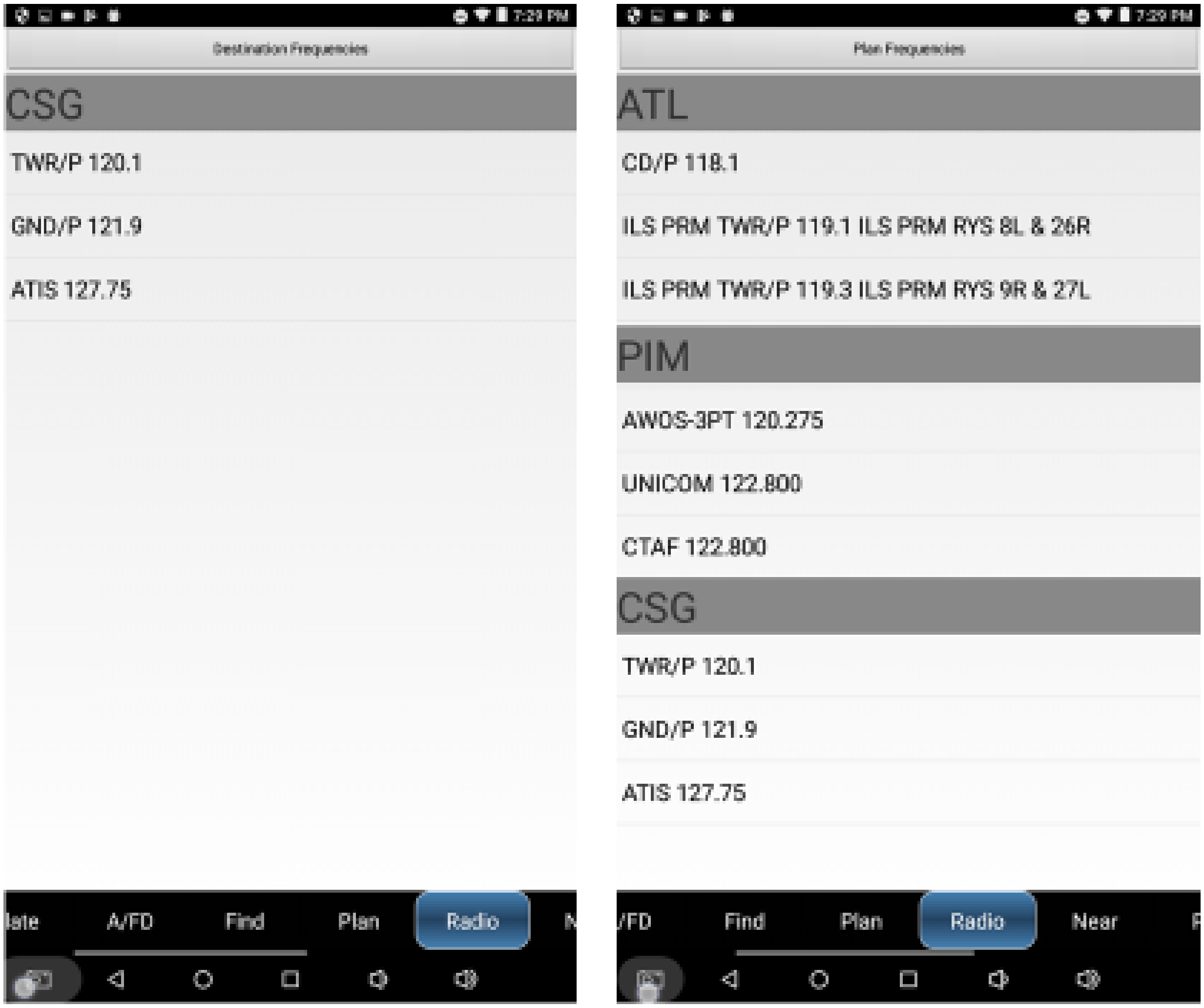

Figure 4. Radio Page

Event	Time in ms	Latitude	Longitude	Altitude	Ground Speed in Kt	Declination
Location-Hide Menu	1.502E+12	33.77425	-84.3957	0	0	5.18524456
LocationView-LongPress	1.502E+12	33.77425	-84.3957	512	81	5.18524456
Location-PlanTo	1.502E+12	33.77425	-84.3957	725	92	5.18524456
Location-Hide Menu	1.502E+12	33.8756	-84.302	872	107	5.264419079
Location-Hide Menu	1.502E+12	33.77425	-84.3957	1234	112	5.18524456
Location-Hide Menu	1.502E+12	33.77425	-84.3957	1675	109	5.18524456
LocationView-LongPress	1.502E+12	33.77425	-84.3957	2341	107	5.18524456
Location-PlanTo	1.502E+12	33.77425	-84.3957	2339	104	5.18524456
Location-Hide Menu	1.502E+12	34.0132	-84.597	2412	109	5.082231045
Plan-Delete	1.502E+12	34.0132	-84.597	3701	110	5.082231045
Location-Hide Menu	1.502E+12	33.77425	-84.3957	3755	111	5.185245991
LocationView-LongPress	1.502E+12	33.77425	-84.3957	3761	108	5.185245991
Location-PlanTo	1.502E+12	33.77425	-84.3957	3791	106	5.185245991
Location-Hide Menu	1.502E+12	33.9053	-84.4751	3744	109	5.149907589
Plan-Deactivate	1.502E+12	33.9037	-84.4751	3733	104	5.149907589
Plan-Deactivate	1.502E+12	33.9037	-84.4751	3721	102	5.149907589
Plan-Deactivate	1.502E+12	33.9037	-84.4751	3711	101	5.149907589
Location-Hide Menu	1.502E+12	33.77425	-84.3957	3721	109	5.185245991
Location-Hide Menu	1.502E+12	33.77425	-84.3957	3741	108	5.185245991
LocationView-LongPress	1.502E+12	33.77425	-84.3957	3742	109	5.185245991
Location-PlanTo	1.502E+12	33.77425	-84.3957	3751	109	5.185245991
Location-Hide Menu	1.502E+12	33.7791	-84.5214	3761	109	5.099814415
Location-Hide Menu	1.502E+12	33.77425	-84.3957	3747	110	5.185245991
LocationView-LongPress	1.502E+12	33.77425	-84.3957	3759	111	5.185245991
Location-GoTo	1.502E+12	33.77425	-84.3957	3788	107	5.185245991
Location-Hide Menu	1.502E+12	34.0132	-84.597	3792	105	5.082232475
‘Location-Hide Menu	1.502E+12	34.0132	-84.597	3801	102	5.082232475

Figure 5. Example Data

Reference

[1]M. Stibbe, "American Airlines Pilots Lose 40lb With Apple iPad Electronic Flight Bag", *Forbes.com*, 2017. [Online]. Available: https://www.forbes.com/sites/matthewstibbe/2013/05/03/american-airlines-pilots-lose-40lb-with-apple-ipad-electronic-flight-bag/#58ef1ebf5691. [Accessed: 02- Aug- 2017].

[2]E. Hollnagel, *Human Reliability Analysis: Context and Control*. London: Academic Press, 1993.