IMMERSIVE FLIGHT TRAINING ON A BUDGET: AFFORDABLE FLIGHT SIMULATOR EXPLORING VIRTUAL REALITY AND MOTION PLATFORM *

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Introduction

Flight simulator dates back to the early years of 20 century. The first simulators were rudimentary mechanical devices with limited capabilities that were maintained manually by the crew and the instructor. The personnel was responsible for giving the trainee the experience that reproduced in flight conditions e.g. Antoinne 7 simulator that consisted of two barrels set on top of each other in an unstable manner, requiring the pilot, sitting in the cockpit, to use the rudder to balance the crosswise gauge with the horizon [1]. Then automation based on pneumatics was introduced e.g. Link Trainer simulator that was based on the mechanism of pumps and valves that was responsible for the reaction to pilot controls and giving readouts of instruments installed in the cabin [2]. A significant impact on the development of simulators has the introduction of computers. Initially, computers were used to simulate the behaviour of aircraft instruments. With the advancement of computational power and visualization technology, computers allowed for the introduction of highly realistic visual environments that simulate the actual conditions of flight [3-4]. Another significant development was the integration of virtual reality, which enabled trainees to immerse themselves in the aircraft environment visually [5]. At the same time prices of Head Mounted Displays for Virtual Reality were dropping. Recently we have seen the emergence of another technology that can improve the immersion of the pilot: cheap and compact motion platforms.

Visual Virtual reality

Visual Virtual Reality is a technology that allows the user to visually immerse in a computer-generated world. Usually, such an immersion is obtained with Head Mounted Displays that hold the screen as well as a system of lenses through which the users view generated visualizations. HMD holds the sensors that are responsible for the detection of head movements, so the generated graphics can accommodate to the direction of the user gaze. There is a wide variety of such devices available on the market and there is a constant stream of improvements when it comes to the resolution of utilized displays, the latency of generated graphics in the relation to the head movement as well as the Field of View provided by the visualisation system. In the proposed system initially, HP Reverb G2 VR Headset was applied. It is one of the most advanced yet cost-effective HMDs available on the market. It delivers two 2.89’’ LCD panes that have 2160 x 2160 per eye resolution, a refresh rate frequency of 90Hz, and a system of lenses with allows for horizontal/vertical FOV at the level of 98°/114°. The only problem was that G2 requires cables in order to provide a visual signal and power. Therefore utilization of this device at the level of motion platform is limited. Therefore, the platform was allowed to rotate only in a limited range. This problem was solved with the application of wireless HMD Pico 4 Enterprise (see Fig. 1). This device possesses two 2.56’’ displays with 2160 x 2160 per eye resolution and a refresh rate frequency of 90Hz. Although the resolution is the same as G2 size of the screen is smaller

therefore there is a lower FOV (diagonal FOV is equal to 105°). Head movement tracking is based on built-in cameras, the battery allows for 2 hours of constant utilization.

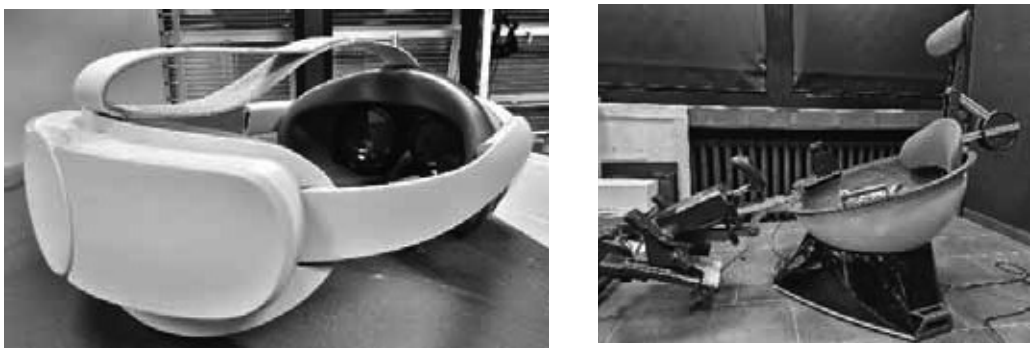

Fig. 1. Pico VR headset and YawVr Motion Platform.

Motion platform

In recent years we see the emergence of cheap motion platforms that can be applied in plane simulators. A wide variety of vendors provide devices that introduce various levels of abilities in the area of degrees of freedom of movement as well as available API. We selected the YawVR platform because it allows for 3 degrees of freedom, and unlimited 360 degrees of rotation as well as an integration plugin for Unity – one of the most popular cross-platform game engines. We extended the YawVR platform with a set of plane controllers (LOGITECH G Saitek PRO Flight Yoke System) and added a special counterweight at the back of the seat in order to balance the structure (Fig. 1).

Fig. 2. Plane in virtual space of developed flight simulator (left) and in flight cockpit of a plane with visualization of YawVr platform (right)

The Simulation Software

The simulator was developed with the Unity game engine. In order to connect with the YawVr platform a plugin provided by the vendor was exploited. In Fig. 2 the in-flight cockpit of implemented simulation software integrated with the motion platform was presented. In addition, we utilized the ‘Simple Airplane Physics Toolkit - Lift, Drag, Thrust’ asset for the purpose of plane physics simulation. The asset provides also visualization for the plane body and cockpit (see Fig. 2 left). In order to activate virtual reality, the ‘Virtual Reality Supported’ option was selected in the Unity engine.

Summary

This paper presents the concept of an affordable flight simulator based on Virtual Reality, a motion platform and software developed by the members of the Silesian University of Technology Student Science Club of Virtual Flight vFly.

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