
UPGRADE OF THE BITD TO AN ONLINE MULTIROLE SIMULATOR

AKTUALIZÁCIA BITD NA ONLINE VIACÚČELOVÝ SIMULÁTOR

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Abstract

Thanks to the possibility of new technologies, there are several alternatives to upgrade the current hardware and software of flight simulators, such as the implementation of photorealistic scenarios, a better field of view or a realistic flight model of a selected aircraft. A part is devoted to the current technical parameters of the ELITE S612 BITD simulator. The practical part describes three options for computer software, followed by three options for replacing hardware and three options for updating the visual system.

Keywords

BITD, Flight simulator, upgrade, hardware, software

1. Introduction

Synthetic flight training devices were a necessity for pilot training due to their low operational costs and as they are safer a solution rather than training some manoeuvres and procedures on a real aircraft. With this need the use of synthetic flight training devices dates back to 1905. Since then gradual technological developments which reflected flight simulation training devices in a manner that use of these devices became more frequent and effective allowed regulatory bodies to implement flight training devices to be used as a part of pilot training. With this implementation, approved training organisations can lower their training costs and produce a safer solution.

The Sanders Teacher counts as the beginning of the flight simulation training devices but was not the most convenient way to train pilots since it was like a windsock pointing towards the direction of the wind and a steady wind was needed to achieve control surfaces to roll, yaw and pitch the simulator. In the 1920s The Link trainer also known as "the blue box" which was a seat on top of vacuum-operated bellows, was introduced by Edward Albert Link. The Link trainer was widely used due to its magnificent impact on pilot training for IMC. [1]

After World War II with the start of usage thermionic valves for solving complex sets, flight simulator training devices started to generate images. The image which was being generated for pilots was collected via a camera mounted on a gimbal mechanism. This camera and gimbal mechanism were placed on a board that contained the simulated environment of the airport and surroundings and by following the aircraft's simulated position the camera displayed the resulting image via a CRT screen to pilots so that pilots would have a visual sense of flying.[1]

In today's era, we can find collimated displayed flight training devices that allow pilots to focus to infinity instead of focusing on closely positioned displays, motion systems that tricks the human balance in order to increase the realism of the flight simulation.

2. Theoretical framework and current state of the BITD

As flight simulators training devices gradually upgraded technically a need for standardisation was mandatory to keep standards high that's why in the early 1970s several meetings were held by IAFSTA. Afterwards IAFSTA disbanded in 1973 due to unkind reaction to open forum. In the same year, Airlines re-grouped with the same need and with an invitation from IATA, the first meeting of the Flight Simulator Technical Sub-Committee was held in Denver, USA.[2]

2.1. Regulations

Nowadays, flight simulator training device manufacturers have to build and fulfil the requirements which are set in order to certify the simulator by the regulatory body which ICAO undertakes those qualifications and requirements in ICAO Doc 9625 Manual of Criteria for the Qualification of Flight Simulators. This document was published in 1995 and contained installation and recurrent checking of flight simulators for countries that were represented in ICAO. [4] [5]

2.2. Flight simulator categorisation

As not every simulator is suitable for every training therefore there is a minimum requirement for a specific training application. EASA divides flight simulation training devices under eleven levels which are BITD, FNPT Level 1, FNPT Level 2, FNPT MCC, FTD Level 1, FTD Level 2, FTD Level 3, FTD Level 4,

FFS Level A, FFS Level B, FFS Level C and FFS Level D. BITD which stands for basic aviation training device is a synthetic flight training device where student pilots can get to know with instruments on a basic level.

2.3. Logging of Flight Simulator Time

As flight simulators are more enhanced pilots are able to log simulator experience as simulator flight time. However, the amount of allowed simulator flight time logging towards integrated and modular training programs differ for all types of pilot licenses.

2.4. The current state of the BITD

The S612's setup is 390cm wide, 430cm long and 240cm high with a weight of around 400kg's and a maximum power consumption of 9000W. The whole system is powered by 230V AC. The components and specifications which this S612 consists of are divided into four sub-headings in order to make a more detailed analysis.



Figure 1: ELITE S612 BITD located in Zilina Airport. Source: Authors.

2.4.1. Cockpit

The cockpit of S612 stands on a wooden base, and the hull is made out of fibreglass with a plexiglass windshield. Inside the cockpit, an adjustable pilot seat with a spring-loaded yoke mechanism, a single-engine power quadrant, and self-centring pedals are placed ergonomically. The instrument panel consists of 4 plates that have switches and buttons. There is a 17inch TFT monitor located under a plastic sheet with aligned cuts so that it reproduces the flight instruments which are being displayed on the monitor. With the same technique a 15inch TFT monitor tilted 90° is placed on the right side of the flight instruments monitor to Bachelor thesis 25 display navigational and engine instruments. In addition, an AP3000 avionic stack is mounted on the instrument's panel. This setup is also referred to by ELITE as iGate core. Adjustable white light for reading charts, checklists, etc. is mounted to the overhead panel as well as an adjustable red light for main panel illumination is provided.



Figure2: ELITE S612 BITD's hull. Source: Authors.

2.4.2. Instructors station

The Instructors station is equipped with two 17inch monitors, a mouse, a keyboard, a printer to and master witches for starting up and shutting down the system.

2.4.3. Computers

ELITE S612 has two computers which are the HostPC and the Image generator. They are connected via an ethernet switch. The HostPC is the main computer on which the core simulation software is running. HostPC is connected directly to iGate core via a USB cable. The specification of the computer:

- Operating system – Windows XP,
- CPU – Intel Core 2 Duo E8400,
- GPU – Nvidia Quadro NVS 290,
- RAM – 2 GB,
- Motherboard - SUPERMICRO C2SBX.

The Image generator is used for providing visual display output for the given viewpoint position by the HostPC. The output is sent to the projector, where later the image would be displayed to the projection wall. The specification of the computer:

- Operating system – Windows XP,
- CPU – Intel Core 2 Duo E8400,
- GPU – Nvidia GeForce 9800 GT,
- RAM – 2 GB,
- Motherboard - SUPERMICRO C2SBX.

2.4.4. Other

In order to display the images which are being generated by the Image generator, an NEC NP310 projector is connected to the Image generator via a video graphics array cable and displays the image to a projection wall which is a white synthetic material with an aluminium frame. A KVM switch is used to use a keyboard and mouse between two computers and to provide the instructor with the visual image as well as a NetGear ethernet switch to allow two computers to communicate each order.

3. Objective and methodology

3.1. Objective

Main Objective

Listing upgrade options for ELITE S612 BITD in order to improve software and hardware wisely so that it can connect to an online platform with today's technological availabilities.

Partial Objectives

- Gathering information about divisions of FSTD's and regulations from EASA and FAA

- Analysing the current ELITE S612 BITD's specifications.
- Considering opportunities to use for ELITE S612 BITD computer hardware wise.
- Considering opportunities to use for flight simulation software
- Considering opportunities to use for improvements on flight simulation software.

3.2. Methodology

The main source of information during the preparation was domestic and foreign literature in the form of:

- Book sources,
- Studies on flight simulation devices issues,
- Internet resources,
- Publications from professional journals.

The methods characterize the subject, objective and type of study. The following logical methods were used to work with these materials:

- Method of collecting and processing information was employed in storing sources and sorting information in the scientific area of the problem,
- Method of analysis was applied in the part devoted to the current state of the solved issue in the evaluation of the current procedures,
- The synthesis method was applied in a deep analysis of information sources,
- The comparative method used when assessing regulations in individual states.

The method of collecting and processing information is applied mainly in the initial phase. In the next phase, the methods of processing the information obtained were modified. Methods of analysis and synthesis are used for the conclusive assessment of analysed information. The method of analysis can be imagined as the division of an object, phenomenon or thought object into its elements or parts, dividing its particular elements and their subsequent independent exploration. Performing the analysis performed through the following steps:

- Dividing the analysed issue into several parts according to different factors of action,
- Identifying the subjects most affected by the subject matter,
- Identification of conditions that are most identifiable by factors affecting the issue,
- Quantitative and qualitative determination of the predominant factors affecting the phenomenon under consideration.

During the elaboration of the work, the above-mentioned points were followed which provided a sufficiently good analysis of the

phenomena in question, reflecting their continuity and internal events.

4. Upgrade of the BITD

The options for upgrade possibilities for ELITE S612 BITD considering price, fidelity, redundancy, performance benefits, and lifespan.

4.1. Ideal computer options for ELITE S612

In comparison to current HostPC and ImageGenerator computers, which were assembled back in 2008 the amount of processing power needed to be achieved for a sustainable flight experience for current and upcoming flight simulator software computers on these would not be possible to run on current computer hardware without an upgrade. That's why I have chosen the optimal computer components in order to fulfil and exceed the requirements which today's flight simulation software requires.

Considering the amount of processing power needed to achieve high-fidelity, decisions for the best brand and model of the component are made by using <https://www.passmark.com/> website. The computer options with components and prices are shown on following tables.

Table1: High-end computer configuration. Source: Authors.

Components	Manufacturer	Model	Price
CPU	Intel	Core i9-11900KF	550€
Video card	Nvidia/EVGA	EVGA GeForce RTX 3090 FTW3 ULTRA HYDRO COPPER GAMING	2X 2097€
RAM	Kingston	HyperX FURY 128GB DDR4 3600MHz	868€
Storage	WD	Black SN850 M.2 NVMe SSD	208€
Motherboard	MSI	MEG Z590 GODLIKE	889€
Cooling	Corsair	Hydro X Series iCUE XH305i RGB Custom Cooling Kit	577€
Power supply	Corsair	AX1600i Digital ATX	473€
Case	Cooler Master	MasterCase H500P	183€
Operating system	Microsoft	Windows 10 Pro 64bit	167€
Total			8109€

Table 2: High to mid range computer configuration. Source: Authors.

Components	Manufacturer	Model	Price
CPU	AMD	Ryzen 7 5800X	474€
Video card	Nvidia/Gigabyte	GIGABYTE RTX 3080 EAGLE 10G GV-N3080EAGLE-10GD	2X 1141€
RAM	Corsair	Dominator Platinum 16GB RGB DDR4 3600MHz	474€
Storage	WD	Black SN850 M.2 NVMe SSD 1TB	208€
Motherboard	MSI	Prestige X570 CREATION	502€
Cooling	Corsair	H150i Elite Capellix	176€
Power supply	SilverStone	Strider Platinum ST1200-PTS 1200 W	293€
Case	Corsair	Corsair Crystal 570X RGB	196€
Operating system	Windows	Windows 10 Pro 64bit	167€
Total			4772€

Table 3: Mid range computer configuration. Source: Authors.

Components	Manufacturer	Model	Price
CPU	AMD	Ryzen 5 5600X	336€
Video card	Nvidia/Gigabyte	GeForce RTX 3070 GAMING OC 8G	2X 840€
RAM	Kingston	HyperX 16GB KIT DDR4 2666 MHz CL16 FURY series	2X 89€
Storage	Samsung	970 EVO 1TB	139€
Motherboard	ASUS	ProArt B550-CREATOR	253€
Cooling	NOCTUA	NH-U12S SE-AM4	79€
Power supply	SilverStone	SFX-L Titanium SX800-LTI 800W	210€
Case	FSP	Fortron CMT211A	48€
Operating system	Microsoft	Windows 10 Home 64bit	128€
Total			2962€

4.2. Visual system upgrade options for ELITE S612

Visual system upgrade options are divided into two subheadings which are hardware upgrade options and software upgrade options in order to explain more deeply since the visual systems of flight simulation training devices has a very important role.

4.2.1. Hardware upgrade options

The current single-channel visual system is running on a projector which has 1024x768 resolution with an aspect ratio of 4:3. Which as a result we end up with narrow horizontal field of view. I have given three options to solve this issue

- The first option is to use three monitors on a monitor stand placed in front of the simulator cockpit so that we could achieve an increase in the field of view. Thanks to the use of monitors instead of projectors, the ambient light would not affect the image contrast.
- The second option is to use the current visual system setup and add the same components in order to increase the field of view which is an inexpensive option considering that one projector and projector wall is already installed.
- The third option is to place a circular white projection wall with a radius of 189cm and a circumference of 802cm to achieve a 270° horizontal field of view. The projectors have to be short-throw since otherwise, the image displayed would overlap with the S612 BITD's hull.

4.2.2. Software upgrade options

In this subheading, three options for flight simulator software that could be used as an upgrade over the current XTS flight simulator software which is running on ELITE S612 BITD were given. Which are:

- X-plane 11 by Laminar Research. 65€.
- Prepar3D by Lockheed Martin costs. 163€
- Microsoft Flight Simulator by Asobo Studio. 70€

Since X-plane11 and Prepar3D do not include an orthophoto scenery, unlike Microsoft Flight Simulator to take a step further, an implementation of satellite imagery could be possible with a software called Ortho4XP. This program enables satellite imagery also vector data such as building positions, roads, parks, etc. to be injected to the scenery of the chosen flight simulator software.

4.3. Flight model/Aircraft upgrade options for ELITE S612

The flight model is highly dependent on the aircraft used in flight simulator software. The flight simulator software options which have been chosen on the table 4 in compliance with ELITE S612 BITD's instrument placement.

Table 4: Flight simulation software aircraft options. Source: Authors.

Flight Simulator Software	Third-Party Developer	Aircraft	Price
X-Plane	Alabeo	C172RG CUTLASS II	25€
Prepar3D	Alabeo	C172RG CUTLASS II	25€
X-Plane	Just Flight	PA-28R Arrow III	38€
Prepar3D	Just Flight	PA-28R Arrow III	38€
Microsoft Flight Simulator	Just Flight	PA-28R Arrow III	38€

4.4. Connecting ELITE S612 to an online platform

The connection of flight simulator software is possible with online platforms which are IVAO and VATSIM. Both of IVAO and VATSIM are created to provide an environment for flight simulator software users which is realistic and educational. The pilot student can easily practice ATC communications by implementing one of these platforms on ELITE S612 BITD.

5. Conclusion

ELITE S612 BITD owned by University of Žilina has a grate upgrade opportunity hardware and software wisely which could be used to help pilot students for training instruments, ATC communications and giving a sense of flight for those who haven't started on their flight training while having a photo realistic scenery experience. In order to achieve this level of experience a upgrade is mandatory since the current running flight simulation software in ELITE S612 BITD does not support further upgradeability. Opportunities of an upgrade could be taken even further by implementing orthophoto scenery of multiple countries.

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