

2020

Bachelor, Master, Diploma Thesis

Vol. 12.2

AIRBUS

Airbus Defence & Space GmbH

05.03.2020

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Efficiency assessment of Virtual Reality applications in comparison with Desktop PCs

Introduction

The department of Human Factors Engineering and Flight Deck is responsible for the design and creation of Human Machine Interfaces (HMI) applied to different platforms such as fighter aircraft, transport aircraft, ground control stations, etc. These activities cover the entire development process from requirements engineering, development of HMI design drafts, specification and prototyping as well as HMI tests, certification and qualification activities. These activities include extensive validation and verification operations. In order to assess the objective quality of HMI designs and interfaces, we utilise a wide range of tools and methods in representative evaluations.

Thesis Description

Virtual Reality (VR) systems are currently driven by consumer market and games industry. However, if it is desired to use it in daily business, many questions concerning display and interaction are still open. In order to create a serious competition towards ordinary desktop systems, completely new presentation and interaction paradigms will have to be developed that are adapted to the technical hardware limitations. For example, a VR-based system with less keyboard input must be as quick as a standard desktop system with mouse and keyboard. Consequently, a VR system must probably offer the user more input assistance. Context-sensitive input, simple menu hierarchies and larger interaction areas are only a few ideas that shall be collected, reviewed, designed and prototypically implemented and tested.

Thesis Expectations

This Master's thesis shall create the concept for a VR system that could compete against an ordinary desktop system with respect to interaction. The focus lies on interaction speed and input accuracy. The study shall be structured into a theoretical research part and a practical 'test phase', which leads to a comprehensive literature review, combined with a creative idea collection, and eventually a prototypical implementation that can be tested with users. The expected result consists of an analysis which kind of activities that are currently conducted at desktop systems, can be potentially executed in VR in an efficient and effective manner.

Target Group:

MSc students in the area of computer science or related field

Duration:

7 Month

Task Analysis, Modelling and Simulation as aids in Human Machine Interface Design and Evaluation

Introduction

The department of Human Factors Engineering and Flight Deck is responsible for the design and creation of Human Machine Interfaces (HMI) applied to different platforms such as fighter aircraft, transport aircraft, ground control stations, etc. These activities cover the entire development process from requirements engineering, development of HMI design drafts, specification and prototyping as well as HMI tests, certification and qualification activities. These activities include extensive validation and verification operations. In order to assess the objective quality of HMI designs and interfaces, we utilise a wide range of tools and methods in representative evaluations.

Thesis Description

The working on goal oriented tasks with the help of technical systems is mediated by the user interface. The operator workload while performing tasks is a direct function of the interface and a core responsibility while designing the interface. The evaluation of the operator workload with the user interface is therefore an important actuating variable. In the frame of task analysis, the operator workload is often assessed with structured questionnaires. The task activities and operator workload data are the basis for task flow modelling and helps optimise future operator interfaces. The simulation results of such task flows have to be validated by data from subject studies to assess the predictive validity of the simulation.

Thesis Expectations

For the thesis, a structured task analysis is to be performed with domain experts including an empirical workload and task time estimation. To achieve this, tasks and task work flows, task times, workload types and levels have to be compiled. The results shall be the basis for a workload- and timing simulation. For the simulated tasks, a subject study is to be planned and conducted to contrast the simulation results in terms of predictive validity of the simulation. The results are to be documented as parameters of predictive validity of the simulation as well as a cost-benefit-ratio. Here, the assets and drawbacks of a workload simulation shall be explicated when using the method in the frame of interface design.

Target group

MSc students in the area of computer science or related field

Duration:

7 Month

Cognitive Modelling for Limiting Solution Space in Human Machine Interaction Design

Introduction

The department Human Factors Engineering and Flight Deck is responsible for concept and design of human machine interfaces (HMI) for a wide range of platforms such as combat aircraft, transport and mission aircraft, as well as ground control stations etc. These activities encompass the full development cycle from requirements engineering, the creation of HMI concepts, design specifications and prototyping up to verification and validation activities, which include formal qualification and certification aspects. In this context, the department uses a broad spectre of different tools to enable a representative, objective evaluation of HMI concepts and designs.

Research Topic

Cognitive modelling of interaction processes between human and computer via so-called cognitive architectures has made substantial progress in recent years. As an example, it is currently already possible to predict the time required for simple interaction tasks such as navigation through a menu tree, including the associated probabilities of error, with impressive precision. This opens up entirely new possibilities in the process of creating human-machine interfaces. While it is neither desirable nor possible to replace actual evaluation with prospective users, this technology could be a substantial aid in down-selecting the most promising designs, e.g. in terms of interaction times or error potential, from a multitude of possible solutions. After all, it is essential from an experiment design perspective to limit the number of design variants in a comparative evaluation assessment. Presently, this selection of variants is performed mainly based on experience with existing human machine interfaces, general plausibility considerations (educated guesses), or the individual preferences of the team involved.

Expectations

Using the menu for the management of electronic checklists in a mission aircraft as an example, this master thesis shall investigate which menu structure is best suited for a given set of abnormal and emergency procedures in terms of access times, probability of error, and general usability. In this context, the effort for cognitive modelling of the respective variants has to be considered, including the critical factors determining this effort. Furthermore, it is to be investigated whether cognitive modelling is suitable for deriving general design criteria for the design of menu structures for electronic checklists. The analytic results obtained by cognitive modelling shall be compared to and validated by corresponding user assessments.

Target group

MSc students in the area of computer science or related field

Duration:

7 Month

Human Factors Evaluation von head-worn Virtual und Augmented Reality Displays

Introduction

The department of Human Factors Engineering and Flight Deck is responsible for the design and creation of Human Machine Interfaces (HMI) applied to different platforms such as fighter aircraft, transport aircraft, ground control stations, etc. These activities cover the entire development process from requirements engineering, development of HMI design drafts, specification and prototyping as well as HMI tests, certification and qualification activities. These activities include extensive validation and verification operations. In order to assess the objective quality of HMI designs and interfaces, we utilise a wide range of tools and methods in representative evaluations.

In the area of human factors engineering virtual techniques like power wall or CAVE are used to design and evaluate virtual prototypes. These methods are cost effective and support design decisions in very early phases of product development.

Thesis Description

For the use of semi-immersive (e.g. HoloLens) and full-immersive (e.g. Oculus Rift) head-worn displays in professional environments it has to be evaluated if this displays have a negative, stressing or restricting effect on the user compared to traditional computer monitors or other well-established techniques.

Thereby different aspects have to be reviewed and evaluated regarding the used technology. Among others these are motion sickness, strain on the human visual system by the new display systems, self-perception, orientation and integration of virtual content into real environments.

Depending on the focus of the work laboratory- or even flight-based evaluations have to be conducted with the according technologies.

Thesis Expectations

A literature research has to be conducted to compile an analysis which lists already known implications of semi-immersive and full-immersive systems on human users. Based on this analysis a model for one defined technology shall be derived which quantifies the negative implications of this technology. To test this model an experiment has to be designed und conducted. The results of this experiment shall flow back into the model for necessary adaption or optimisation. After that the model shall be used to define rules how to avoid or minimize the negative implications of the technology on the human user.

Target group

MSc students in the area of computer science or related field

Duration:

7 Month

Interfacing X-Plane and a Prototype EFIS

Project description:

This project aims at interfacing a prototype electronic flight instrument system (EFIS) and X-Plane: a prototype EFIS software in the Human Factors Engineering and Flight Deck (GE) department is to be connected to X-Plane. This requires adaptation work both in the EFIS software created in VAPS XT and C / C ++ , as well as on the aircraft and system models in X-Plane. There is an existing modular interface to FlightGear that can be used as a template. For the Bachelor thesis, both solutions should be compared and benchmarked.

Required Knowledge:

Object-oriented programming, ideally C / C ++, knowledge of X-Plane or other desktop flight simulations are an advantage.

Target group

Bachelor students in the area of computer science or related field

Duration:

7 Month

Autoflight System Control Panel Extension

Project description:

This Bachelor thesis aims at the extension of an existing connection of the autoflight control panel in a simulation cockpit to a flight simulation environment. The department Human Factors Engineering & Flight Deck (GE) maintains a simulation cockpit for the development and initial testing of future pilot assistance systems. However, only the Rotary Encoders in the Autoflight Control Panel are currently connected to a desktop flight simulation via Raspberry PI and Ethernet, e.g. for a pre-selection of altitude and speed. However, the pushbuttons for the activation of the autopilot and various special functions are still missing. In the frame of this thesis, the hardware and software interface of the Autoflight System Control Panel is to be expanded by the push buttons.

Required knowledge:

Object-oriented programming, ideally C / C ++, knowledge of microelectronics, especially Raspberry PI or Arduino etc., and manual skills (e.g. soldering) are an advantage.

Target group

Bachelor students in the area of computer science or related field

Duration:

7 Month

Using Knowledge Acquisition and Simulation to predict Pilot Workload

Introduction

The department of Human Factors Engineering and Flight Deck is responsible for the design and creation of Human Machine Interfaces (HMI) applied to different platforms such as fighter aircraft, transport aircraft, ground control stations, etc. These activities cover the entire development process from requirements engineering, development of HMI design drafts, specification and prototyping as well as HMI tests, certification and qualification activities. These activities include extensive validation and verification operations. In order to assess the objective quality of HMI designs and interfaces, we utilise a wide range of tools and methods in representative evaluations.

Thesis Description

Workload prediction and estimation represents one basis for the design of user interfaces, including the appropriate level of automation to assist the human operators in challenging phases of flight. In this context, it also serves the baseline for the development of user-centred approaches for workload adaptive pilot associate systems. Both applications rely on an accurate model of workload such as Wicken's multi-source theory to estimate the required resources by use of demand vectors. The data needed for the demand vector is currently gathered from subject matter experts using knowledge acquisition techniques. This approach requires a selection of an efficient methodology that extracts the expert knowledge accurately. The results provide the baseline for a simulation to predict pilot workload. Therefore, the objective of this study is to identify an appropriate knowledge extraction technique, to gather data for the demand vector and to conduct a simulation and analysis of the pilot workload in the context of military aviation.

Thesis Expectations

For the thesis, a use case in the context of military aviation will be provided by Airbus. Based on the use case, a structured analysis shall be performed together with domain experts. The results shall be documented using the Airbus extended hierarchical task analysis tool. After that, a literature review and a definition of criteria shall be conducted to identify the most appropriate knowledge acquisition technique for gathering data of the demand vector. For the defined technique, a subject study shall be planned and performed together with a representative sample. Finally, a workload simulation of the use case shall be developed and conducted using Matlab SimEvent to estimate the resource consumption and overall mental workload of the human operator. Airbus provides the basic framework of this simulation. The results shall be documented, analysed and discussed in the context of military aviation.

Target group

MSc students in the area of psychology and human factors engineering.

Duration:

7 Month

Mathematical Analysis of Defects Distribution of Onboard Aircraft Software

Background:

Airbus Defence and Space is developing embedded realtime software for military aircraft. All problems detected during the various development phases are handled in a defined and controlled way. A huge amount of statistical data is available for the current and previous development projects.

Statement of Work:

- Analysis of the available data on problems found in the software and the software specifications during development
- Preparation of a mathematical model to describe the dependencies of problem data distribution on project parameters

Required Skills:

- Mathematical analysis skills
- Medium programming skills

Target Group:

Master/Bachelor students in the field of computer science or mathematics

Duration:

7 months

Secure Data Handling for Onboard Aircraft Software Applications

Introduction

For the correct functionality of aircraft software applications the distributed onboard computers are exchanging data. The exchange of data is not restricted to computers within a platform, but is taking place also across platforms. The exchanged data are given classifications depending on the respective context.

Thesis Description

- Analysis of existing classifications
- Analysis of existing approaches for labelling data items with classifications
- Analysis of existing and post quantum cryptographic algorithms
- Analysis of existing onboard/offboard aircraft communication systems
- Development of an approach for labelling data items taking into account extensible classification schemes and the restrictions given by aircraft communication systems
- Development of a software demonstrator on networked PCs

Thesis Expectations

After the analysis of existing approaches a new concept for labelling data on onboard and offboard aircraft communication systems is developed. This concept is then implemented using an appropriate programming language including a GUI. The software is developed for the demonstration on regular networked PCs, where the user is able to specify the labels of the data and the required cryptographic algorithms.

Required Skills:

- Modeling skills (e. g. SysML, UML)
- Programming skills (e. g. C, C++, Java) including graphical frameworks such as Qt or GTK
- TCP/IP network stack

Target Group:

Master/Bachelor students in the field of computer science

Duration:

7 months

Analysis of UDP Multicast and Unicast in Terms of Performance and Reliability

Introduction

During an Airbus Group wide research program a protocol named VISTAS (Virtual Interoperable Simulation for Tests of Avionics) was defined and later approved as an EuroCAE standard which

- mainly builds on UDP Multicast and
- relies concerning its performance and reliability on a controlled hardware setup.

Due to reports from internet forums and initial internal tests (mainly done in Airbus Toulouse) there are rumors in the room concerning the performance of UDP Multicast which conflict with the original idea of the defined protocol.

Thesis Description

The goal of this thesis is

- to analyze the validity of such expectations and
- to identify variables, which influence these issues.

Following an analysis of published research, a test strategy has to be elaborated. Further, a test environment shall be built with different network connections on different speed levels (1Gbit, 100Mbit) and different synchronization between transmitter and receiver (e.g. throttling the transmitter or loosing data).

The analysis shall be done mainly on Linux CentOS and additionally on Windows 7 and 10.

Thesis Expectations

For the thesis, a structured task analysis shall be performed with domain experts including an experimental work.

The result of this thesis shall be a paperwork clearly describing the method to measure the performance and reliability. It shall clearly state,

- by which elements (lower bandwidth, hardware, network adapters, driver, OS) and
- in which ways

the UDP Multicast performance is influenced.

Target Group

Master or Diploma students

- in the area of computer science, electrical engineering, or related fields
- with programming skills (C/C++) and
- a strong interest in networking.

Duration:

7 Month

Analysis of Ethernet Based Protocols for Low Latency Shared Memory Implementation

Introduction

Airbus Defense and Space has developed a distributed test support system (distributed AIDASS) which is based on PCI express over cable. This communication system

- provides a distributed (e.g. 10 to 100m) shared memory system with low latency, but
- is somehow exotic and relatively high priced (compared with Ethernet).

It shall be analyzed, to what extent specialized Ethernet based protocols can replace PCI express over cable and thus provide a powerful, stable and cost efficient communication layer for the distributed AIDASS.

Thesis Description

Based on a thorough review of published research and Airbus internal work, the major candidates for Ethernet based protocols (e.g. remote DMA, RoCE, Converged Ethernet, iWARP) shall be identified and analyzed w.r.t the costs and the requirements of distributed AIDASS.

In arrangement with Airbus experts, the most promising candidates shall be selected and analyzed in more depth, if possible with the help of prototypes. Measurements concerning the performance and system load shall be made, whenever possible.

The analysis shall be done mainly on Linux CentOS.

Thesis Expectations

It is expected to gain a deeper insight, on how a lossless and low latency transmission can be achieved using published protocols.

Besides

- the achievable performance,
- the induced system load (e.g. by intermediate data copies), as well as
- the constraints put on the networking infrastructure

should be elaborated.

Target Group

Master or Diploma students

- in the area of computer science, electrical engineering, or related fields
- with programming skills (C/C++) and
- a strong interest in networking.

Duration:

7 Month

Overall Contact and Coordinaton:

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