

Report from Brno University of Technology

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In 2011, 233 students were awarded by master's degree diploma at the Faculty of Information Technology, Brno University of Technology. Master's degree program Information Technology, offered by the faculty, has currently 10 branches. In branch Bioinformatics and Biocomputing, it was 8 graduates, in branch Information Technology Security 4 graduates, Information systems 74 graduates, Intelligent systems 25 graduates, Management and Information Technologies 18 graduates, Mathematical Methods in Information Technology 2 graduates, Computer Graphics and Multimedia 68 graduates, Computer and Embedded Systems 11 graduates, Computer Networks and Communications 14 graduates and branch Computer Systems and Networks 9 graduates.

Diploma theses of 60 graduates were assessed by excellent grade. Moreover, some of them were so exceptional (e.g. by means of quality, extent, results or contribution), that they were awarded by Dean's award. These theses are briefly introduced in this paper. Some of excellent theses were also applied to variety of competitions. One of them, thesis named Hardware Accelerated Functional Verification by Marcela Šimková won the 1st prize in the Diploma thesis of the year competition organised by Abra software company.

Dean's Award for Excellent Master Thesis

Student: Michael Angelov
Thesis title: Augmented Reality for Commercials
Supervisor: Vítězslav Beran
Annotation: Thesis presents a possible application of augmented reality in domain of commercials. Architecture of a mobile application is designed and presented. The system is able to detect and track specific objects (e.g. printed commercials, logos) in mobile phone camera in real time and provide some extra information about the detected object towards the user. Thesis also provides a review of contemporary used techniques in object recognition, object tracking and image retrieval from image databases.

Student: Václav Bartoš
Thesis title: Network Anomaly Detection
Supervisor: Martin Žádník
Annotation: The aim of this thesis is to improve systems and methods for anomaly detection in computer networks. At first, basic categories of network security systems and number of methods used for anomaly detection are described. The core of the thesis is focused on an optimization of the method based on detection of changes of distributions of packet features originally proposed by

Lakhina et al. This method is described in detail and two optimizations are proposed – the first is focused on the speed up and memory efficiency utilizing hashing schemes, the second improves its detection capabilities by exploiting combination of various traffic features and detection functions. The optimizations are evaluated through experiments on real data with artificially generated as well as real anomalies.

Student: Marek Černý
Thesis title: IPv6 Modelling in OMNeT++
Supervisor: Vladimír Veselý
Annotation: This paper is a part of ongoing research of computer networks modelling and simulation and it explores current capabilities of INET framework in OMNeT++ to support IPv6 addressing and routing. OMNeT++ is a general discrete-event simulator commonly used to build various computer simulations. It can be extended by INET that supplies models of protocols and devices from TCP/IP environment. We've managed to create extensions to this framework called ANSA to support IPv4/IPv6 dual-stack router and host for static and also dynamic routing. All new models together with existing ones could be setup via new transparent XML-based configuration file. We also introduce an OSPFv3 module that implements most of auxiliary features and is ready for future development of the routing protocol core.

Student: Vojtěch Drahoš
Thesis title: Server for Automatic IPv6 Tunnel Connectivity
Supervisor: Petr Matoušek
Annotation: One of the major problems of modern Internet is an upcoming depletion of IPv4 address space. This work focuses on expansion of IPv6 clients using automatic tunnelling via TIC protocol. Major part of this work includes design and implementation of the server part of tunnel broker system. The system was successfully implemented and deployed at CZ.NIC. This system enables users a free registration to the broker system at <http://ayiya.labs.nic.cz>. After successful registration, automatic IPv6 tunnel is created and now the user communicates to Internet by IPv6 protocol without intervention of his or her ISP.

Student: Marián Hacaj
Thesis title: Simple Flight Simulator for Windows Phone 7
Supervisor: Adam Herout
Annotation: The thesis describes programming of 3D

applications, mainly games, on the Windows Phone 7 platform and lightly compares this approach with the Silverlight platform. It also describes the XNA framework in detail and touches some problems of programming airplane simulators. In the second part of this thesis, the reader can find a complete description of the implemented simple airplane simulation for the Windows Phone 7 platform, which is based on the XNA framework. The game consists of terrain, sky, plane, scene, simple physics and the game logic.

Student: Jakub Horník

Thesis title: Compiler Back-end of Subset of Language C for 8-bit Processor

Supervisor: Zbyněk Křivka

Annotation: A compiler allows us to describe an algorithm in a high-level programming language with a higher level of abstraction and readability than a low-level machine code. This thesis describes the design of a compiler back-end of subset of language C for 8-bit soft-core processor Xilinx PicoBlaze (version 3). The design is described from the initial selection of a suitable framework to the implementation itself. The compiler architecture strictly separates front-end and back-end parts. As a suitable framework for C front-end, Small Device C Compiler is used. The back-end part is developed as new compiler port with PicoBlaze-3 assembly language as its target language. This implementation replaces old and unusable PCComp compiler for this processor.

Student: Michal Hrubý

Thesis title: Exploitation of Graphics Processor as Accelerator - OpenCL Technology

Supervisor: Pavel Zemčík

Annotation: This master thesis topic is the OpenCL technology and its exploitation in the task of object detection in image. The introductory part is devoted towards description of OpenCL fundamentals as well as the theory of object detection. The analysis of the method is performed and a design is proposed with consideration of the OpenCL possibilities. The work also includes description of implementation of the object detection application and experimental evaluation of the detection performance. Finally, a summary of the achieved results is given.

Student: Jiří Kalus

Thesis title: GSM Alarm Support on Mobile Device

Supervisor: Jiří Koutný

Annotation: This master's thesis describes the mobile application that provides the support to control the GSM/GPS alarms. Based on the possibilities of modern security equipment and mobile devices, the application adds new functionality for these alarms. This work mainly describes selecting the appropriate mobile platform, application designs and the independence on the specific alarm. Implementation of the application is realized for OS Android. In conclusion, the results and possible extension of the application are talked over.

Student: Peter Lisák

Thesis title: Human Recognition by Finger Veins

Supervisor: Radim Dvořák

Annotation: The master's thesis deals with biometric

systems, especially these based on human recognition by finger veins. It describes some development principles of the new biometric system. It proposes some new approaches to the comparison of finger vein patterns and their fast identification in sizable databases. Verification is based on templates comparison by similarity and distance measures with proposed alignment approaches. The proposed method of identification is based on the combination of clustering and genetic algorithm. The second option is using the indexing tree structure and searching by range query.

Student: Jiří Matoušek

Thesis title: Network Traffic Simulation and Generation

Supervisor: Pavol Korček

Annotation: Development of computer networks able to operate at the speed of 10 Gb/s imposes new requirements on newly developed network devices and also on a process of their testing. Such devices are tested by replaying synthetic or previously captured network traffic on an input link of the tested device. We must be able to perform both tasks also at full wire speed. Current testing devices are either not able to operate at the speed of 10 Gb/s or they are too expensive. Therefore, the aim of this thesis is to design and implement a hardware accelerated application able to generate and replay network traffic at the speed of 10 Gb/s. The application is accelerated in the FPGA of the COMBOv2 card and it also utilizes the NetCOPE platform. Architecture of the application is modular, which allows easy implementation of different modes of operation. The application implements both capturing and replaying network traffic at full wire speed, but traffic can be limited to a specified value of bitrate at the output. The thesis is concluded by a comparison of the implemented application and the packet generator implemented on the NetFPGA platform. According to this comparison, the implemented application is better than the NetFPGA packet generator.

Student: Milan Meisl

Thesis title: Design and Construction of a Two-Wheel Mobile Robot

Supervisor: Filip Orság

Annotation: This thesis deals with design and construction of a two-wheel mobile robot. In order to prepare high-quality project, a testing carriage has been constructed providing useful basic information for the final design and construction of the robot. Except for the introduction and conclusion, the thesis consists of four main parts. The first part of the thesis briefly introduces robotics generally and is followed by a theoretical part focused at components necessary for the construction of the robot and Segway vehicle, which served as an inspiration for the functionality of the robot. Then there are described the individual methods of stabilization of the robot using several different types of sensors with a discussion about choices made. The electrical design follows with a complete description of the circuits, which were considered optimal for the designed wiring. Next part of the thesis focuses on the construction of the two-wheeled carriage and covers construction of the mechanical components, design of the printed circuit boards, design of the software and its implementation. The work is finished by experimental results and evaluation of the results.

Student: Martin Pešek

Thesis title: Knowledge Discovery in Spatio-Temporal Data

Supervisor: Jaroslav Zendulka

Annotation: The thesis deals with knowledge discovery in spatio-temporal data, which is currently a rapidly evolving area of research in information technology. It focuses, in particular, on moving objects data in the form of trajectories with an emphasis on the methods for trajectory outlier detection. The thesis also deals with the process of implementation of the trajectory outlier detection algorithm called TOP-EYE. The algorithm is experimentally evaluated on two different data sets. The first one contains trajectories extracted from videos processed by a multi-camera surveillance system. The other one is a database of hurricane paths in the Atlantic Ocean.

Student: Tomáš Pospíšil

Thesis title: Development of SQL/XML Functionality in PostgreSQL Database

Supervisor: Petr Chmelář

Annotation: The aim of this thesis is to propose a way to implement the missing XML functionality for the database system PostgreSQL. The second chapter discusses the theoretical paradigm with an XML-related technologies like Xpath or XQuery. The third chapter discusses the ISO SQL standards and it describes the current level of implementation of native XML databases versus traditional relational databases. The last part focuses on different approaches and it proposes a solution to implement the XML API to PostgreSQL, which validates XML documents against XSD, DTD and RelaxNG schemes. The next point is focused on XML indexing techniques and a new index based on GiST.

Student: Jakub Rusnák

Thesis title: Visualization of Program Flow of Executable Files

Supervisor: Pavel Zemčík

Annotation: This master thesis topic is the concept and implementation of visualization of program flow of executable files. The focus is on the structure of Microsoft Windows executable file format and methods of instructions encoding. The thesis also describes contemporary methods of "malware" analysis, especially the analysis of program flow. The state of the art in "malware" visualization methods and recent tools for 3D data visualization are described as well. The objective of the work was design and implementation of 3D visualization of jumps in executable files. The main result is the visualization tool which helps to identify different samples of "malware" from normal code.

Student: Zdeněk Sojma

Thesis title: Object Tracking in Video

Supervisor: Adam Herout

Annotation: This master's thesis describes principles of the most widely used object tracking systems in video and then mainly focuses on characterization and on implementation of an interactive offline tracking system for generic color objects. The algorithm is characterized by a high evaluation accuracy of object trajectory. The system creates the output trajectory from input data specified by the user; the inputs may be interactively modified and added

to improve the system accuracy. The algorithm is based on a detector which uses color bin features and on the temporal coherence of object motion to generate multiple candidate object trajectories. The optimal output trajectory is then calculated by dynamic programming whose parameters are also interactively modified by the user. The system achieves 15-70 fps on a 480x360 video. The thesis describes the implementation of the testing application whose purpose is to optimally evaluate the tracker accuracy. The final results are also discussed.

Student: Jaroslav Strouhal

Thesis title: Software Integration

Supervisor: Jitka Kreslíková

Annotation: The aim of this master's thesis is to analyse the software integration decision-making process and to design and propose an effective IT-based solution to this problem, which could be implemented seamlessly into the local information system of an existing enterprise using the given enterprise's data formats and interface. The thesis begins by mentioning the current software equipment state as well as information technology development strategy of the given enterprise and goes on by describing the data types, interfaces, data storage and information requirements of individual user groups within the whole enterprise. The thesis then proposes a set of techniques for integrating the individual software tools into the current environment. Each proposed integration case describes the source and target resources, then focuses on the reasoning behind the suggested integration proposal and finally, concludes with describing a generalized method for successfully implementing the suggested integration. ETL (Extract, Transform and Load) integration tool has been developed in order to streamline the whole integration process. The ETL tool's functionality has been verified by deploying the tool on a live data sample.

Student: Martin Stríž

Thesis title: Platform for Development of Rich Internet Applications

Supervisor: Adam Herout

Annotation: This thesis aims to design and implement a platform for Rich Internet Applications based on technologies suitable for Java and JavaScript programming languages. The emphasis is put on choosing the appropriate software stack from available libraries, using proper principles of object-oriented design and programming and possibility of long term support of the resulting application. The text describes the developed platform and sample applications created using the platform.

Student: Tomas Suchomel

Thesis title: IPv6 Geolocation and Visualization

Supervisor: Petr Matoušek

Annotation: This work focuses on geolocation and visualization of IPv6 addresses. Its main goal is to design geolocation database with IPv6 addresses and regularly update it. The tool also includes visual tool to display geographic locations of the IPv6 addresses on the world map. The implemented system gathers data from public Whois databases. Then, geographical addresses are mapped into coordinates using Google Maps Geocoding API. Locations of IPv6 addresses are visualized via web-based Google Maps API. The system is available at <http://staging.labs.nic.cz/ip2geo/>.

Student: Marcela Šimková

Thesis title: Hardware Accelerated Functional Verification

Supervisor: Michal Kajan

Annotation: Functional verification is a widespread technique to check whether a hardware system satisfies a given correctness specification. The complexity of modern computer systems is rapidly rising and the verification process takes a significant amount of time. The analysis part of this thesis describes the requirements on a system for acceleration of functional verification, the most important being the option to easily enable acceleration and time equivalence of an accelerated and a non-accelerated run of a verification. The thesis further introduces a design of a verification framework that exploits the field-programmable gate array technology, while retaining the possibility to run verification in the user-friendly debugging environment of a simulator. According to the experiments carried out on a prototype implementation, the achieved acceleration is proportional to the number of checked transactions and the complexity of the verified system. The maximum acceleration achieved on the set of experiments was over 130 times.

Student: Ivan Vogel

Thesis title: Application for the Data Processing in the Area of Evolutionary Biology

Supervisor: Pavel Očenášek

Annotation: Phylogenetic tree inference is a very common method for visualising evolutionary relationships among species. This thesis focuses on explanation of mathematical theory behind molecular phylogenetics as well as design of a modified algorithm for phylogenetic tree inference based on intra-group analysis of nucleotide and amino acid sequences. Furthermore, it describes the object design and implementation of the proposed methods in Python language, as well as its integration into powerful bioinformatic portal. The proposed modified algorithmic solutions give better results comparing to standard methods, especially on the field of clustering of predefined groups. Finally, future work as well as an application of proposed methods to other fields of information technology are discussed.

Student: Martin Wilczák

Thesis title: Scene Rendering in Modern Computer Games

Supervisor: Rudolf Kajan

Annotation: This work starts with an analysis of state-of-the-art methods for lighting calculations of large scenes used in modern computer games, while focusing on independently developed games. These indie games, as they are commonly called, are developed in small teams with severely constrained budget which limits their options for realistic visuals. The result of this work is a design of an architecture for rendering of complex scenes based on the XNA framework and description of implementation used in resulting independently developed game. Our approach allows for easy integration of advanced techniques like forward and deferred shading methods, various methods for casting shadows, simulation of particle systems and applying post-processing effects into indie games.

Student: Michal Zachariáš

Thesis title: Indie Game Development

Supervisor: Rudolf Kajan

Annotation: The aim of this work was to create an indie game (independently-developed game) with educational aspect. As theme we have chosen wildfires - how to fight them and especially how to prevent them. The player is supposed to extinguish fire as fast as he can and thus save the largest area of forest possible and all civilians threatened by the fire. The text of the thesis describes how to implement a 3D engine for real-time strategy games built on the XNA framework and how to incorporate elements such as realistic water, GPU based particle systems, fire spreading, large detailed terrain, graphical user interface, and intelligent units; behaviour into the gameplay. Our game - Firefighters: Whatever it Takes! - was awarded 3rd place in international competition Imagine Cup by Microsoft Corporation in the Game Design category.