ICT Research Excellence at Faculty of Information Technology, Brno University of Technology

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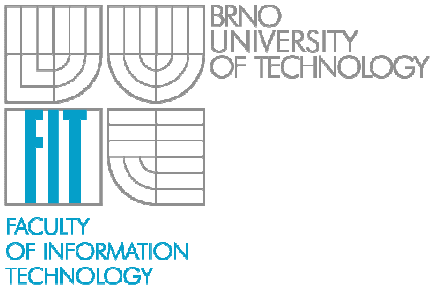

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Faculty of Information Technology - general

- Established January 1, 2002; education and research in IT at BUT since 1964

Venue

- Cartesian monastery (1371, +2008)
- New building (built 2007)

People

- Students ~2600, academic ~100

Departments

- Department of Computer Systems
- Department of Information Systems
- Department of Intelligent Systems
- Department of Computer Graphics and Multimedia

Research Areas:

- Applied evolutionary algorithms
- Computer architecture
- Computer networks communication protocols and embedded systems
- Computer graphics
- Diagnostics
- Evolutionary design and evolvable hardware
- Formal models
- Formal verification
- Hardware/software co-design
- High performance computing,
- Information and database systems
- Intelligent systems
- IT Security and biometry
- Management of software engineering
- Medical computer graphics
- Natural language processing
- Petri nets
- Reconfigurable architecture, FPGA-based acceleration
- Speech processing,
- System modelling and simulation.

Research Focus

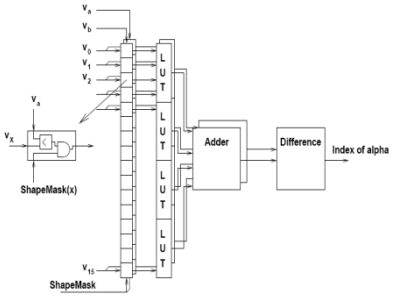
- Algorithms for raster graphics/images/video
- Object detection and recognition
- Hardware and GPU accelerated methods

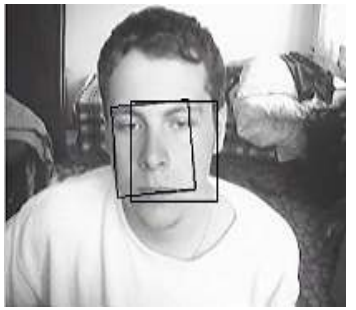
Research projects

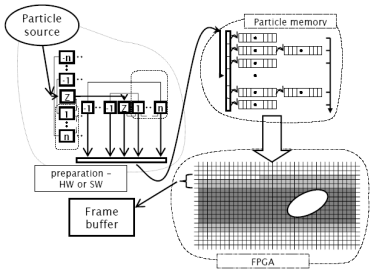
- EU funded FP6, FP7: *AMI*, *AMIDA*, *CARETAKER*, WeKnowIt, 2005-2009, mostly video/security
- Czech Centre of basic research: *Centre of Computer Graphics*, 2006-2010, graphics
- Czech grant agencies: *RIPAC*, *BioMarker*, *Image recognition algorithms*, *Programmable hardware*, 2004-2010, mostly image/video HW
- Newly submitted FP7 STREP + ARTEMIS projects

Research results

- Novel object detection and recognition methods based on machine learning
- Hardware (FPGA)/GPU accelerated image processing and graphics algorithms
- Accelerated graphics rendering structures including particle&holography rendering
- Trajectory analysis and tracking methods
- Participation and success in NIST TRECVID evaluation campaign

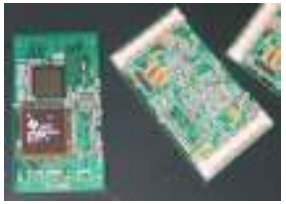






Contact persons

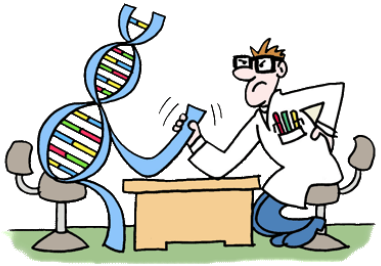
- Ing. Adam Herout, Ph.D. (herout@fit.vutbr.cz)
- Doc.Dr.Ing. Pavel Zemčík (zemcik@fit.vutbr.cz)



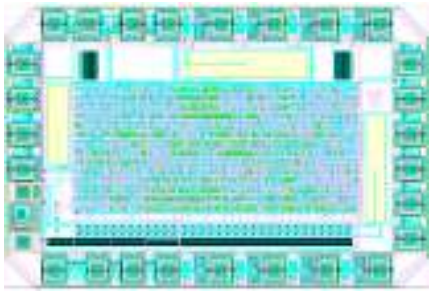
Evolutionary design and evolvable hardware

- **Research topics**
  - Evolutionary design of innovative/patentable solutions: area-efficient image filters for FPGAs (**patent pending**), area-efficient multiple-constant multipliers, benchmark circuits for diagnostic CAD tools, polymorphic circuits, secrecy amplification protocols for WSNs, optimal/safe communication schedules for parallel architectures…
  - Adaptive hardware
    - dynamic circuit evolution in FPGA using virtual reconfigurable circuits
    - polymorphic electronics: reconfiguration controlled by Vdd level
- **Projects**
  - Design and hardware implementation of a patent-invention machine (GACR 102/07/0850, 2007-2009)
  - Methods of polymorphic digital circuit design (GACR 102/06/0599, 2006-2008)
- In cooperation with
  - University of Oslo, MU Brno
- **Contact**:

  Lukáš Sekanina (sekanina@fit.vutbr.cz)



Silver Medal at Human-competitive Awards in Genetic and Evolutionary computation (GECCO, Atlanta, 2008)



REPOMO32: Reconfigurable polymorphic ASIC developed at FIT

VeriFIT: Automated Verification I.

- **Main focus of the group**
  - Automated analysis and verification
    - Automated formal analysis and verification of programs via model checking and/or static analysis
    - Automated formal verification of hardware modules, protocols, ...
    - Dynamic (runtime) analysis of concurrent programs
  - Self-healing of concurrency-related errors at runtime

- **Selected projects**
  - 6th framework EU IST STREP project **SHADOWS**
    - aimed at self-healing, lead by IBM Haifa Research Lab, cooperation with Telefónica, IAI, NetTechnologies, Comverse, ...
  - Participation on 5th framework EU IST project **ADVANCE**
    - Verification of telecommunication protocols
  - 11 projects of the Czech Science Foundation
  - 2 Czech-French Barrande projects

VeriFIT: Automated Verification II.

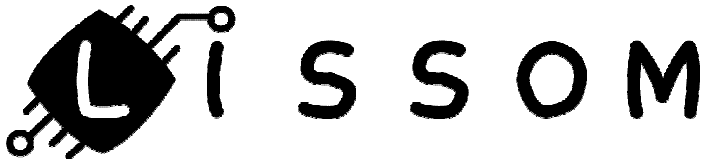
- **Selected results**
  - Automata-based methods for **formal verification** of systems with *parameters, queues, counters, arrays, or recursive data structures* (analyzing complex pointer manipulations in lists, trees, ...)
  - New algorithms for **detecting data races** in Java programs, combining *static and dynamic analysis*
  - Techniques for **self-healing of concurrency-related bugs** by *adding missing locks* or by *influencing the scheduler* at runtime

- **Contacts**

  `http://www.fit.vutbr.cz/research/groups/verifit`

  - **Tomáš Vojnar**, `vojnar@fit.vutbr.cz`
  - **Bohuslav Křena**, `krena@fit.vutbr.cz`
  - **Milan Češka**, `ceska@fit.vutbr.cz`

Hardware/software co-design



- Tools for Hardware/Software co-design
- **Research topics**
  - Retargetable compilers
  - Simulation of Multiprocessor System on Chip and Application Specific Instruction-set Processors
  - High level synthesis of programmable architectures
  - Architecture description languages
- Team of 4 employees, 4 PhD students and 4 MSc students

Lissom: achievements, projects, products, contact

- **Significant achievements**
  - A generator of ultra fast cycle accurate interpreted simulator
    - E.g. speed of **MIPS generated simulator** about **10MHz** (average speed of certain simulators about 3,2 MHz)
- Project
  - **Language and development environment for microprocessor design**, FT-TA3/128, MPO ČR, 2006-2010
- Products
  - Hruška T., Masařík K., Kolář D., Přikryl Z.: **Tools for simulation of Application Specific Instruction-set Processors**, software, 2008
  - Hruška T., Kolář D., Lukáš R., Masařík K.: **Instruction Set Tools Lissom**, software, 2007
- Publications
  - Přikryl Z., Hruška T., Masařík K.: **Distributed Simulation and Profiling of Multiprocessor Systems on a Chip**, In: WSEAS Transactions on Circuits, Vol. 7, No. 8, 2008, Athens, GR, p. 788-799, ISSN 1109-2734
- **Contact**
  - Prof. Ing. Tomáš Hruška, CSc. (hruska@fit.vutbr.cz)

IT Security and Biometry Group I.

- **Main scope** of the group
  - Biometric security systems
    - Biometry in general, liveness detection, vein-based recognition, fingerprint image quality analysis, hand geometry based recognition
  - Network security and cryptography
    - Attacks on hardware secure devices, reputation/trust-based systems, security of protocols on IP, analysis of the P2P networks, security of the wireless networks, cryptography, smart card security, sensor and ad-hoc networks, cryptography and cryptanalysis, applied cryptography.
  - Miscellaneous security oriented projects
- **Patents and utility model**
  - Method and Apparatus for Detecting Biometric Features
    - International patent application no.: PCT/EP2006/009533
  - Device for recognition of 3D shape of hand
    - Pending patent application
  - Liveness detection based on the optical changes
    - National utility model no.: 19364

IT Security and Biometry Group II.

- **Products**
  - Liveness detection – device for the liveness detection
  - ISTA – image stabilization device and algorithm
  - JavaANPR – automatic number plate recognition
  - SCSAT 02, 04 – device for analysis of smart-card side channels
  - Prototype of a system for file analysis in the P2P networks
- **Miscellaneous results and projects**
  - SEDAQ – Sensor data acquisition unit
  - Fingerprint quality testing
  - Technical evaluation of biometric systems
  - Many national and international cooperation:
    - National: EVPU s.r.o., Oprox a.s., Digitus s.r.o.
    - International: Fraunhofer Gesellschaft, Texas Instruments, ST Microelectronics, Microchip
- **Contacts**
  - Petr Hanacek (hanacek@fit.vutbr.cz)
  - Martin Drahansky (drahan@fit.vutbr.cz)
  - Filip Orsag (orsag@fit.vutbr.cz)

Natural Language Processing (NLP) Group

- Machine learning in natural language processing
- Information extraction from texts the web
- Knowledge mining in the biomedical domain
- Uncertainty reasoning in the semantic web
- Machine translation

Industrial cooperation:

- The sole object of the Agency shall be to carry out the tasks assigned to it by the Treaty . It shall be governed by the provisions of the Treaty and of these statutes .
- Výhradním předmětem činnosti Agentury je plnit úkoly svěřené jí Smlouvou. Řídí se ustanoveními Smlouvy a těmito stanovami.

e of tion	subject	object	relevance
_for	SCFG	RNA secondary structure prediction	0.66
cribed	CKY algorithm	Cocke-Kasami-Younger	0.81
ction_	ribosomal frameshifting	RNA	0.73
r_ ns	HMM	Hidden Markov Models	0.69
	RNA	molecule	0.45
	protein	molecule	0.45

NLP Group – running projects

- **KiWi** – Knowledge in Wiki
  - STREP EU-7FP-IST 211932, 2008-2011
  - collaborative knowledge management, powered by the Semantic Web
- **WeKnowIt** – Emerging, Collective Intelligence for Personal, Organisational and Social Use
  - IP EU-7FP-IST 215453, 2008-2011
  - intelligence that emerges from the collaboration and competition among many individuals
- **Biomarker** – Text Mining for Early Diagnostics of Cancer Diseases
  - Czech Ministry of Education, Large National Project, 2006-2011

Leader and contact person: Pavel Smrž, smrz@fit.vutbr.cz

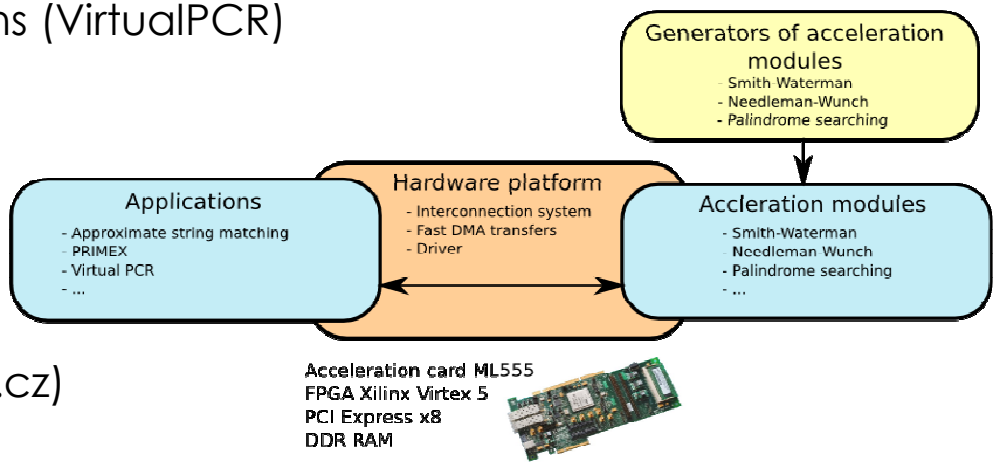
FPGA-based acceleration - network applications

- **Research topics**
  - Acceleration of network applications using FPGA for 10+ Gbps
- **Projects**
  - Liberouter
  - EU: 6NET, SCAMPI, GEANT2 …
- **Original approaches** proposed in areas of
  - network monitoring,
  - intrusion detection systems,
  - protocol identification,
  - flow analysis etc.
- **Special cards** developed
  - COMBO6 with Virtex 2 Pro, COMBOv2 with Virtex-5
- In cooperation with
  - CESNET, MU Brno
  - Stanford University, University of Cambridge
  - Xilinx Inc.
- **Spin-off**: INVEA-TECH
- **Contact**: Jan Kořenek (korenek@fit.vutbr.cz)

Kobierský, P.: Hardware Acceleration of Protocol Identification. The best MSc thesis in IT 2008 (Czech Rep.)

FPGA-based acceleration - bioinformatics

- **Research topics**
  - Acceleration of complex computation tasks in bioinformatics using reconfigurable FPGA chips
- **Projects**
  - In vitro and in silico identification of non-canonical DNA structures in genomic sequences (GA204/08/1560, 2008-2010)
- **Original approaches** proposed in areas of
  - Approximate string matching (Smith-Waterman, Needleman-Wunch, PRIMEX) ~ speed up 1000x
  - Approximate palindrome detection ~ speed up 4000x
  - Simulations of chemical reactions (VirtualPCR)
- In cooperation with
  - MU Brno



- **Contact**

Tomáš Martínek (martinto@fit.vutbr.cz)

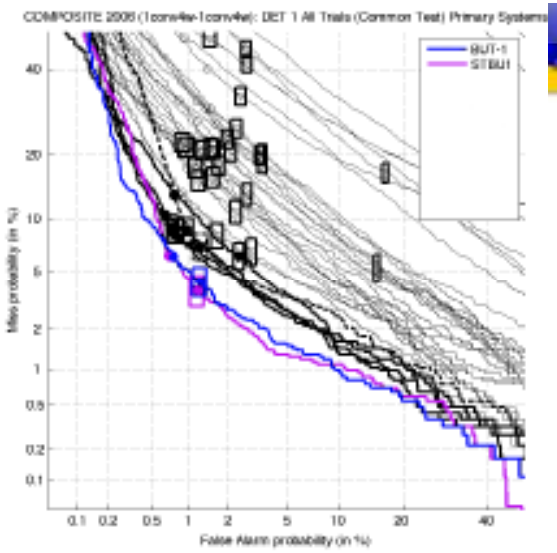
Speech@FIT - speech processing research at FIT

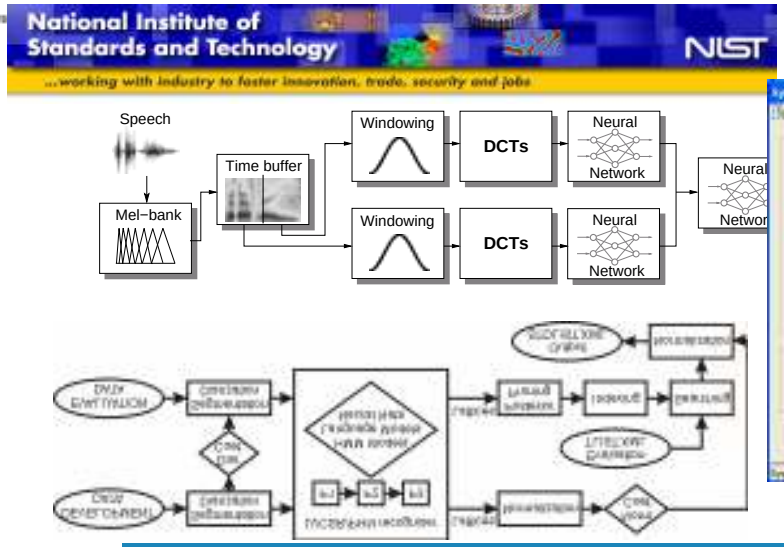
Research topic: Speech recognition (mainly for security and defense applications)

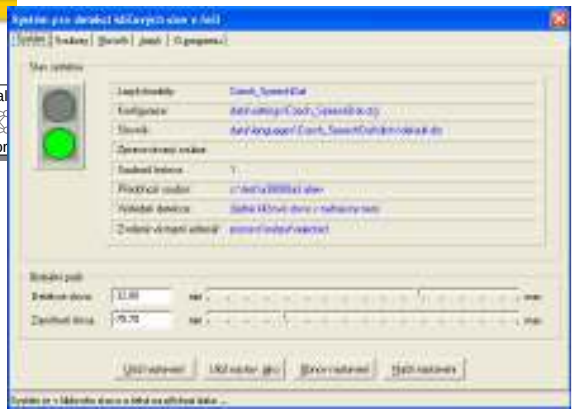
- Transcription
- Speaker identification
- Language identification
- Spoken term detection and keyword spotting

Achievements

- Performance proven in international evaluations organized by NIST
  - Excellence in language recognition (LRE 2005 and 2007)
  - Excellence in speaker recognition (SRE 2006 and 2008)
- Strong presence in prestigious events (Johns Hopkins University workshop)
- Open source software used worldwide
  - STK toolkit
  - Phone recognizer



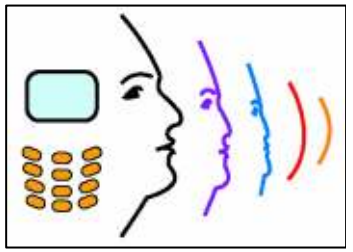
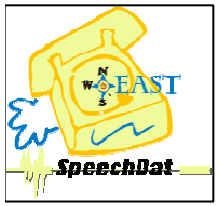




Speech@FIT funding

- **Faculty** (faculty members and faculty-wide research funds)
- **EU projects (FP[4567])**
  - Past: SpeechDat-E, SpeeCon, M4, AMI, CareTaker.
  - Running: AMIDA, MOBIO, weKnowIt.
- **US funding** – US Air Force EOARD
- **Local funding agencies** - Grant Agency of Czech Republic, Ministry of Education, Ministry of Trade and Commerce
- **Czech "force" ministries** – Defense, Interior
- **Industrial contracts**
- **Spin-off** – Phonexia, Ltd.



Speech@FIT – people and contacts

~20 people:

- faculty
- researchers
- grad and pre-grad students
- support staff

Bosses:

Research director:
Lukas Burget

Managing director
Honza Cernocky

Guru:
Hynek Hermansky

http://speech.fit.vutbr.cz/

Contact person for projects, cooperation, etc:
Honza Cernocky, cernocky@fit.vutbr.cz

Thank you for your attention!