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AComIn: Advanced Computing for Innovation

**FP7 Capacity Programme
Research Potential of Convergence Regions**

D 4.3 Final Report on Innovation Capacity Building Activities

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EXECUTIVE SUMMARY

Deliverable D4.3 reports about the AComIn activities in Work Package 4 (WP4) “Development of Intellectual Property (IP) and Knowledge Transfer (KT) Plan and Innovation Capacity Building” in the Reporting period 2, project months 19-36. D4.3 presents:

- Patent applications submitted after project month 19;
- Completed projects in the Competitiveness Operational Programme, coordinated by Bulgarian SMEs which collaborate with IICT as a research partner providing innovation;
- Technology transfer to industrial companies and partners from the public sector in various schemes: contracted research, developments in joint research projects and international collaboration.

In terms of numbers, the activities in knowledge transfer can be reported as follows:

- 6 completed projects in the Competitiveness Operational Programme, coordinated by Bulgarian SMEs which collaborate with IICT as a research partner providing innovation;
- 8 projects for contracted research, 7 of them with companies;
- 14 projects for joint developments, where the AComIn team contributed pilot studies and/or prototypes, 3 of them with companies;
- 2 projects for pilot developments in international collaborations with Universities in Germany and Italy;
- 4 contacts with Business Representatives, 2 of them subsidiaries of large international industry, who are potential collaborators in future joint activities.

Most of the reported contacts with User are implemented using the devices of Smart Lab – the set of high tech equipment purchased via AComIn.

The Added Value of AComIn to the IICT Research and Innovation potential can be assessed from several perspectives:

- IICT increased its patent filing capacity via AComIn;
- IICT increased its capacity to carry out contracted research;
- The institute established liaisons with the largest industrial clusters and professional organisations in Bulgaria;
- IICT attracts more PhD students and young researchers and involves them in the cooperative innovation activities, which trains them how to bridge the academia and industry.

No deviations from the WP4 schedule, defined in the AComIn Technical Annex, are encountered.

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Summary	Deliverable D4.3 reports about the AComIn activities in Work Package 4 (WP4) "Development of Intellectual Property (IP) and Knowledge Transfer (KT) Plan and Innovation Capacity Building" in project months 19-36. D4.3 presents the coherent set of innovation-related normative documents for IICT, developed within AComIn, the submitted patent applications and the contacts established with Users including agreements for contracted research.
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Keywords	Innovation Policy, Patent applications, Technology transfer, Collaborative research, Contracted research
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1 INTRODUCTION

As defined in the Technical Annex of AComIn, Workpackage 4 (WP4) deals with the “Development of Innovation Policy (IP) and Knowledge Transfer (KT) plan and innovation capacity building”. Two WP4 Tasks are foreseen in the Technical Annex:

TASK 4.1: Implementation of IP and KT Strategy at IICT (months 1-36):

- (i) Discussion of the (meanwhile elaborated) IP policies of IICT and proposal for their harmonisation with the best EU practices;
- (ii) Wide training campaign aiming to raise the level of IP awareness among the whole staff of IICT, including the PhDs.

TASK 4.2: Protection of IP to the European and Bulgarian Patent Offices (months 13 – 36). Three patent applications are expected to be submitted to the European Patent Office based on novel AComIn results (months 19-36). Patent applications will be delivered to the Bulgarian Patent Office too, reflecting innovative ideas generated in the project years 2-3.

Section 2 of this report overviews the drafts of the regulatory documents, elaborated within AComIn and proposed to the IICT governing bodies (the Director, the Director Council, and the Scientific Council of the Institute). These developments are related to Task 4.1 activity (i).

Section 3 of this Deliverable summarises the results of the collaboration with the AComIn Innovation consultant Dr. Frank Heemskerck who visited IICT twice: in AComIn reporting period 1 and AComIn reporting period 2. The report is related to Task 4.1 activity (ii).

Section 4 presents the patent applications made within AComIn in project years 2-3. Two applications are submitted to WIPO (World Intellectual Property Organisation) and one more is in preparation. Two applications were submitted to the Bulgarian Patent Office (BPO) and four more are in preparation. Given that WP4 will run until 31 January 2016, the number of submitted patent applications corresponds to the plans made in the AComIn Technical Annex. These activities are related to Task 4.2.

Section 5 of D4.3 presents the contacts to industrial Users and Users/partners from the public sector that were established in AComIn years 2-3, especially after the installation of Smart Lab. According to the Sustainability strategy of IICT, elaborated by AComIn at month 24 (see D7.6 at <http://iict.bas.bg/acomin/deliverables.html>), the role of external partners is crucial for the sustainable development of the Institute. Therefore as part of the AComIn Strategy for innovation capacity development, IICT regularly interacts with the industry at national level. Equipped with SmartLab, the institute is highly involved in dialogs with Users in order to narrow the gap between theory and practice and furthermore, to ensure additional funding. Some IICT seniors see their research activities as a base for development of practical implementations that are oriented to the needs of the society. Due to its flexible structure and independent regulatory documents the Institute easily makes agreements and signs contracts with third parties. Thus Section 5 presents the increased capability of IICT to transfer scientific knowledge into market applications.

Section 6 assesses the Added Value of AComIn Innovation activities to the strengthening of the IICT research capacity.

2 IMPLEMENTATION OF INNOVATION POLICY AND KNOWLEDGE TRANSFER PLAN AT IICT

Deliverable D4.1 “Suggestions for Tuning the IICT Innovation Strategy to the Best EU Practices” (accessible via the Team Zone of the AComIn site) was presented in AComIn WP4 at the end of year 1 (month 12), and proposed the first innovation-related institute’s Regulatory documents in the Bulgarian Academy of Sciences. It contains two major documents:

- A draft of the IICT Innovation Strategy and
- Suggestions for tuning the Innovation Strategy to the best EU practices.

Deliverable D4.2 “Innovation Capacity Building Activities” was proposed in AComIn month 18, see <http://iict.bas.bg/acomin/deliverables.html>. It elaborates further the normative framework in IICT by providing drafts of

- Intellectual Property Policy of IICT and
- IICT Exploitation and Dissemination Plan, with structural descriptions of Exploitable results and Risk assessment tables for the Exploitable results.

Deliverable D7.6 “Strategy for Sustainable Development of the Institute of Information and Communication Technologies” (see <http://iict.bas.bg/acomin/deliverables.html>) was proposed in month 24. It contains:

- Measures for implementing the IICT Sustainable Development Strategy as well as
- Indicators for Successful implementation of IICT’s Sustainable Development Strategy.

All these documents, taken as a whole, provide a consistent normative framework for the development of IICT Innovation potential.

3 COLLABORATION WITH THE ACOMIN INNOVATION CONSULTANT DR FRANK HEEMSKERK

Dr. Frank Heemskerk (founder of Research & Innovation Management Services bvba /RIMS/<http://www.rimsinternational.eu/>) is a world recognised expert in the field of innovation and technology transfer. He was invited to act as a subcontractor of AComIn with two major tasks:

- (i) with his professional advice, to help IICT to develop the first IP Policy and Innovation Strategy in the Bulgarian Academy of Sciences, and in general to help IICT to align its innovation related activities to the best EU practices;
- (ii) to give lectures in hot issues related to valorisation of academic results and technology transfer from academia to industry, sharing his specific experience of a researcher who moved to activities related to innovation capacity building.

On 10-12 July 2013 (AComIn Reporting period 1) Dr. Heemskerk visited IICT for 2 days and joined the team developing the draft of the Innovation strategy, in order to give advices how to align the institute’s Innovation Activities to the best EU practices.

On 24-26 November 2014 (AComIn Reporting period 2) Dr. Heemskerk visited again IICT in order to discuss further AComIn developments concerning strengthening the Institute’s innovation potential and to give lectures at an innovation seminar.

On 24 November 2014 Dr. Heemskerk met Prof. Galia Angelova, AComIn coordinator, and Prof. Svetozar Margenov, the director of IICT. They discussed the IICT Innovation strategy and the the IICT Sustainability strategy, produced within AComIn and offered to the IICT governing bodies for implementation. They also discussed an Action Plan how to implement the IICT Innovation strategy and further opportunities for innovation potential development that will be opened in the Operational Programme “Science and Education for Intelligent Growth” (2014-2020).

On 25 November 2014 a full-day Innovation Workshop was held at the IICT premises. In the morning two lectures were delivered by AComIn seniors - Prof. Galia Angelova and Prof. Dimitar Karastoynov. In the afternoon, Dr Heemskerk presented two lectures: “*Research, Innovation and Society Impact: Stimulating Innovation in an International/global context*” and “*Innovation for Value creation in practice*”. Demonstrations of innovative applications, created using the AComIn Smart Lab, followed the lectures. The event was attended by 25 participants.



On 26 November 2015 Dr. Heemskerk met members of the Sofia Municipality Innovation Expert Council (Prof. Ivan Dimov – Chair of the Scientific Council of IICT, Prof. Kostadin Kostadinov – AComIn Innovation consultant and Vice-Minister of Education and Science, and representatives of Sofia Municipality) and discussed with them the initiative to develop an Innovation Strategy of Sofia.

4 PATENT APPLICATIONS

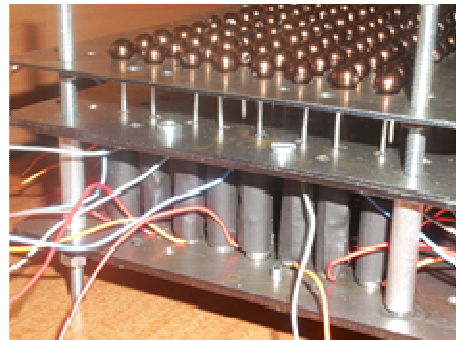
According to the AComIn Technical Annex, 3 international patent applications are planned as well as several applications to the Bulgarian Patent Office. By 30 September 2015 two Patent Applications are submitted to WIPO and other two – to BPO. Further applications are in preparation and will be submitted by 31 January 2016.

4.1 WIPO Patents: Braille Display, Nail

BRILLE DISPLAY - authors D. Karastoyanov, I. Yatchev, K. Hinov, Y. Balabosov

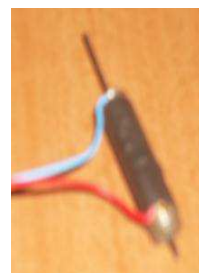
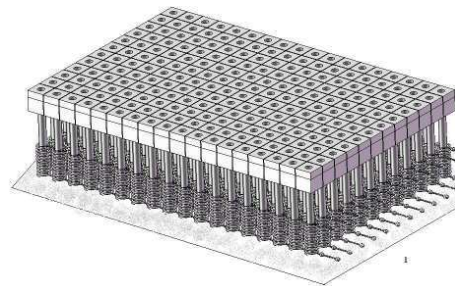
WIPO Patent Application No PCT / BG 2014 / 000038, 24 October 2014
Application in the Bulgarian Patent Office № 111638, 29 November 2013

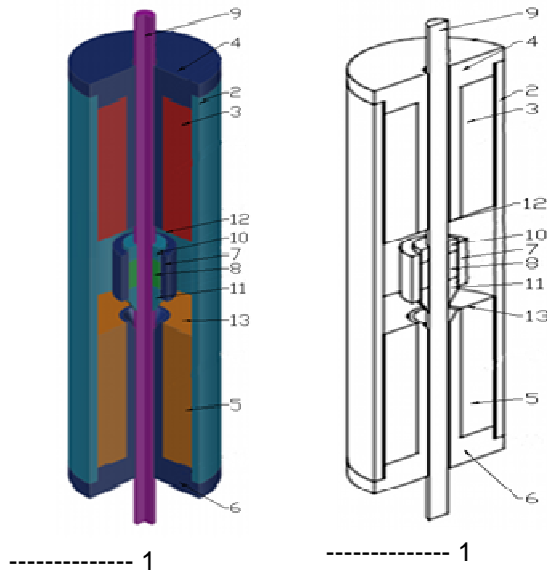
The Braille screen is a matrix with linear electromagnetic micro drives and non-magnetic needles, passing through the axes of the electromagnets. Over the electromagnets is mounted a grid with holes. The needles go through the holes and move up pimples. The visually impaired people feel them in a tactile way and can adopt symbols and graphics.



The Braille display is used to create an auxiliary textual / graphical computer interface for visually impaired people.

After the delivery of the Smart Lab devices and more especially the thermocamera FLIR P640, the Braille matrix sketched above have been improved. The subject of investigation was the termodistribution given the high number electromagnetic linear microdrives. Moreover the distribution of electromagnetic field has been investigated as well as mutual influence between the linear electromagnetic microdrives. In this way SmartLab devices helped substantially to justify the invention. The claims in the proposal for the Braille display, submitted to WIPO on 24 October 2014, has better characteristics compared to the earlier version submitted to the Bulgarian Patent Office.





One element of the Braille screen looks as follows:

- 1 – base
- 2, 4, 6 – magnetic cores
- 3, 5 – coils
- 7 – non-magnetic cylindrical body
- 8 – permanent magnet
- 9 – non-magnetic needle
- 10, 11 – ferromagnetic washers
- 12, 13 – magnetic poles

NAIL – authors D. Karastoyanov, T. Penchev, P. Bodurov, P. Sirakov

WIPO Patent Application No PCT / BG 2015 / 000023, 23 July 2015
 Application in the Bulgarian Patent Office № 111824, 18 September 2014

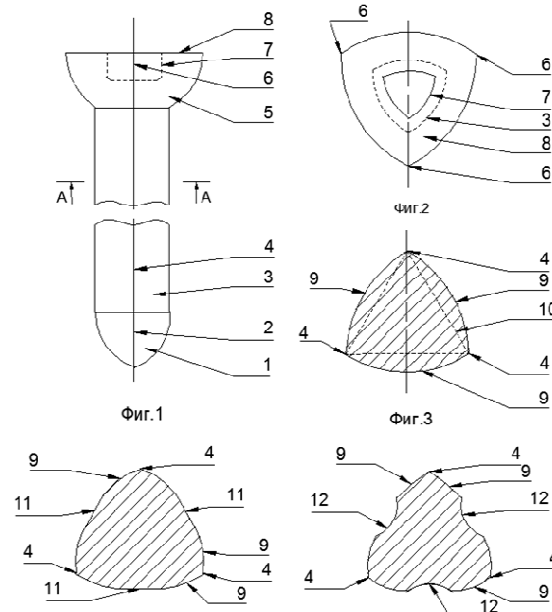
The invention relates to a nail comprised of a body with the shape of an equilateral triangle with convex sides, representing the arcs. At the upper end of the body a head is shaped of three convex parts of a sphere and, at its upper side the head is flat, and in its centre a groove is formed having the shape of a triangle with convex sides. The body ends up with a peak at its bottom end representing a triangular spheroidal convex pyramid whose sides are part of a sphere.



The elements of the Nail are as follows:

- 1 – the gad of the Nail
- 3 – the body of the Nail
- 5 – the head of the Nail
- 2, 4, 6 – edges of the Nail's parts
- 7 – a groove in the head
- 8 – a flat of the head
- 9 – bulging arched sides
- 10 – sides of the triangles
- 11 – linear variant of the arcs
- 12 – grooved variant of the arcs

The nail is used in construction, in the furniture industry and in households.



Some Smart Lab devices were used for justification of the claims in the Nail patent application – more especially the EDEM Software and the 3D Printer ProJet 460+. The NAIL sketched above have been modeled and printed. The subject of investigation was the body of the Nail with the shape of a Reloe triangle. Different types of the Nail head have been investigated as well as different shapes of the Nail gad. In this way SmartLab devices helped substantially to justify the invention. The claims in the proposal for the Nail, submitted to WIPO on 23 July 2015, has better characteristics compared to the similar versions submitted earlier to the Patent Offices in other Countries – for example USA.

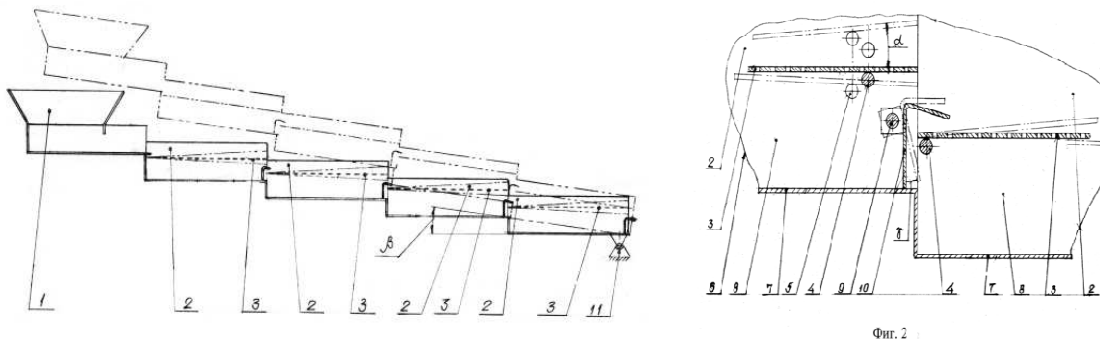
4.2 Applications to the Bulgarian Patent Office

Two applications based on AComIn studies were submitted in 2015:

V. Abadjiev, E. Abadjieva, D. Karastoyanov. **Gravitational Enrichment Device.** *Bulgarian patent application* No 111918, 3 February 2015

The device is intended for direct separation of heavy components contained in the enriched material, in particular for enrichment materials from spill fields. The device adjusts quickly and easily to the optimum enrichment process of raw materials with different characteristics, increasing the amount of fine classes in the treated material.

The device includes a feeding trough (1) and a multi-cell sluice with cascade cameras (2), a colander (3) mounted at the bottom of each chamber (2) and cross thresholds (10) on the border of two adjacent chambers (2). The colander (3) placed in each chamber (2) makes a changing angle (α) with the bottom (7) of the chamber (2) and the transverse threshold (10) is slidably mounted and is rotatable at an angle (γ) at the axis (9) between two adjacent chambers (2) in a manner providing the separation and connection of adjacent chambers (2), and a multi-chamber sluice and the feed chute (1) are mounted to a stationary stand (11) under a varying angle (β) to the horizon.



The Smart Lab devices enabled the experimental tests related to the invention. The Laser Nano Sizer Analysette 22 Nano Tech+ was used to study the material after enrichment by the device sketched above. The subject of investigation was the size and size distribution of the fine class particles. Moreover the presence of heavy components has been investigated. The claim in the proposal for the Enrichment device, submitted to the Bulgarian Patent Office on 3 February 2015, has better characteristics compared to earlier versions submitted to the Bulgarian Patent Office.

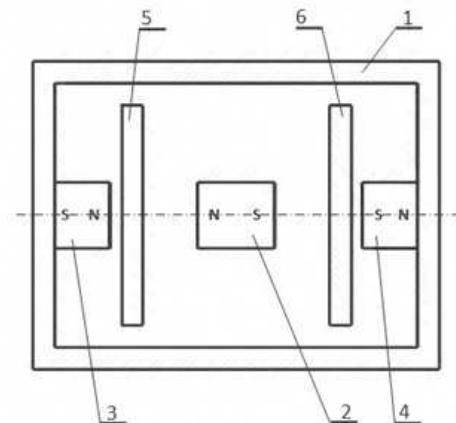
D. Karastoyanov, I. Yatchev, K. Hinov. **Polarity Electromagnet**. *Bulgarian patent application* No 112130, September 30, 2015

The invention relates to a polarized electromagnet with applications for a vibration drive, or a drive with one and two stable positions of mechanical, hydraulic, pneumatic, and electrical switching devices and equipment for automation systems.

A polarized electromagnet is a structure containing a core (1), fixed permanent magnets (3) and (4), a movable permanent magnet - anchor (2) and controllable electromagnetic screens (5) and (6). The position of the movable permanent magnet - anchor (2) in relation to the fixed permanent magnets (3) and (4) is operated by the electromagnetic screens (5) and (6).

An advantage of the invention is the possibility to take one or two stable positions, depending on the control mode of selected anchor (2), or to perform a vibrational movement.

Smart Lab devices were used for justifying the claims of the device especially the high speed camera Nac Memrecam HX6 and the thermo camera FLIR P640. The Txe electromagnet sketched above has been filmed in action. The subject of investigation was the speed of the switching. Moreover the temperature distribution and the presence of eventually hot points have been investigated.



4.3 Applications in Preparation for Submission

The following applications, inspired by experiments with the AComIn Smart Lab devices, are under preparation for submission on 30 September 2015:

- To WIPO: D. Karastoyanov, T. Penchev, P. Bodurov, P. Sirakov. NAIL 2
- To the Bulgarian Patent Office:
 - D. Karastoyanov, T. Penchev, P. Bodurov, P. Sirakov. NAIL 2
 - D. Karastoyanov, T. Penchev, P. Bodurov, S. Gyoshev. NAIL 3
 - D. Karastoyanov, T. Penchev, P. Bodurov, P. Sirakov. BURNING BODY (logs and pellets)
 - D. Karastoyanov, N. Stoimenov. LIFTER BAR (for ball mills)

In this way the plan in the AComIn Technical Annex “submission of three international patent applications as well as several applications to the Bulgarian Patent Office” will be fully implemented by the end of WP4 activity.

5 TECHNOLOGY TRANSFER TO INDUSTRIAL COMPANIES AND PARTNERS FROM THE PUBLIC SECTOR

The following mechanisms of knowledge transfer and collaboration were used in AComIn (most actively in year 3, after the installation of Smart Lab):

- *Performing collaborative research in research partnerships/projects* funded by third parties – e.g. the Operational Programmes, the Innovation Fund,
- *Providing contracted research* for Users,
- *Developing pilot prototypes* for companies and Users from the public sector,
- *Providing technical services* (e.g. testing),
- *Consulting*,
- *Networking with Users* (stimulated by dedicated seminars, informal meetings, talks) including hosting conferences and events with industrial participation – e.g. the “Mathematics in Industry” workshops as well as the Doors Open Days.

The last activity (Networking) is considered in more detail in D2.4 “Building User Communities” (month 36). Here we present the knowledge transfer activities related to joint work with particular Users.

5.1 Collaborative Research in Projects Funded by the Operational Programmes

Searching national research grants for applied and experimental development, IICT seniors submitted to the Operational Programme “Competitiveness” six projects directly related to the AComIn topics. These proposals were inspired by the research plans elaborated during AComIn submission (on 3/01/2012) and were submitted in January-June 2012 to three Competitiveness calls for increasing the research potential of Small and Medium Enterprises in Bulgaria. For all of them, the coordinating organisation is a Bulgarian SME; it is supposed that the SME is interested in absorbing innovation that will be brought by an academic partner. These six Competitiveness projects with total budget of 360 000 euro run in parallel to AComIn and proved to be a bridge for Technology Transfer between academia and SMEs. Meanwhile all of them are successfully completed. (We note that IICT submitted 13 proposals to the Competitiveness calls but only six of them are inspired by the AComIn research plans).

Here we present the titles and some administrative data for the AComIn-related projects:

Project BG161PO003-1.1.06-0001-C0001

TITLE: Innovative technology for efficiency evaluation of ERP systems in small and medium enterprises

COMPANY-BENEFICIARY: ERP Bulgaria Ltd. with R&D activities related to the development of software for efficient management of business processes.

PRINCIPAL INVESTIGATOR from IICT SIDE: Assoc. Prof. Dr. Vladimir Monov

STARTING DATE: 17 July 2012

DURATION: 24 months

Project BG161PO003-1.1.06-0004-C0001

TITLE: Innovative technology solutions for radiofrequency thermoablation

COMPANY-BENEFICIARY: AMET Ltd. Sofia, Bulgaria, with R&D activities related to the development, modern manufacturing and distribution of electronic medical equipment and modules, mechanical parts and units for incorporation.

PRINCIPAL INVESTIGATOR from IICT SIDE: Prof. Dr.Sc. Svetozar Margenov

STARTING DATE: 27 July 2012

DURATION: 24 months

Project BG161PO003-1.1.06-0023-C0001

TITLE: Analysis and identification of inexplicit relations in large scale numerical data: applications in economics and technological analysis

COMPANY-BENEFICIARY: ADISS Lab Ltd, with R&D activities related to the development of integrated information systems and business analytics tools

PRINCIPAL INVESTIGATOR from IICT SIDE: Prof. Dr.Sc. Todor Stoilov, Ph.D.

STARTING DATE: 24 September 2012

DURATION: 30 months

Project BG161PO003-1.1.06-0023-C0001

TITLE: Distributed Information System for Group Control, Distance Diagnostic and Service of Specialised Industrial Robots

COMPANY-BENEFICIARY: SPESIMA GMBH, Sofia, Bulgaria - part of the FRECH Holding, Germany, with R&D activities related to the development of automation systems

PRINCIPAL INVESTIGATOR from IICT SIDE: Prof. Dr. Dimitar Karastoyanov

STARTING DATE: 1 October 2012

DURATION: 24 months

Project BG161PO003-1.1.06-0023-C0001

TITLE: Experimental Development of Software Libraries for Improvement of Image Quality and Stabilisation using Inertial Sensors

COMPANY-BENEFICIARY: MM Solutions AD, Sofia; with R&D activities in the area of complete imaging solutions for mobile camera devices

PRINCIPAL INVESTIGATOR from IICT SIDE: Assoc. Prof. Dr. Dimo Dimov

STARTING DATE: 7 December 2012

DURATION: 30 months

Project BG161PO003-1.1.06-0023-C0001

TITLE: Industrial Research for New Technologies in Image Stabilization and Image Quality Enhancement by Implementation of Inertial Sensors

COMPANY-BENEFICIARY: MM Solutions AD, Sofia; with R&D activities in the area of complete imaging solutions for mobile camera devices

PRINCIPAL INVESTIGATOR from IICT SIDE: Assoc. Prof. Dr. Kiril Alexiev

STARTING DATE: 7 December 2012

DURATION: 30 months

Further details about these projects are given in Deliverable D4.2 "Innovation Capacity Building Activities" uploaded at <http://iict.bas.bg/acomin/deliverables.html>.

5.2 Contracted Research

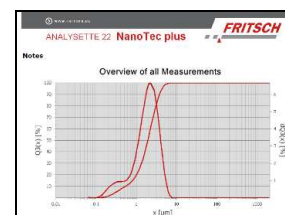
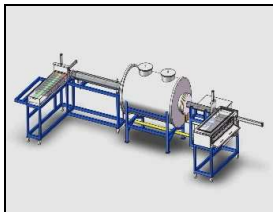
RETEL JSK

RETEL is a company based in Pirdop, Bulgaria, and deals with the delivery of complete equipment for the mining industry regarding processes of milling and enrichment of ore materials. The company currently works on the research project "Innovative technology for production of high temperature materials and alloys containing nanoelements" funded by National Innovation Fund 2015-2017. In the frames of the project the so called Tamanova furnace for melting of mixtures of metals is widely used, incl. nano-sized, powders, at temperatures up to 2300°C, as well as for the quenching of the different machine elements - the teeth of excavators, peaks of the drilling blades and others.

For this purpose it is very important to know the structure of composite materials and their particles size. With the appliances of the SmartLab equipment and in accordance with the contract with RETEL, the tasks in the frame of the project AComIn concern the research and development of models for the distribution of particles with a size of 0.01 - 2000 µm in samples of bulk materials - various types of metal powders and / or nanoparticles by using the laser nano granulomer Analysette 22 Nano Tech + for size and distribution of particles.

Also of great importance is the uniformity of the process of cooling of the output after it was exposed to high temperatures - metals and alloys, which affects their hardness and durability, as well as the quality of the castings. Another commitment included in the contract with RETEL is the study of the temperature image of the cooling of materials and alloys of various types of metal powders and / or nano-particles ranging from 2000°C up to 500°C by using the thermal camera FLIR P640.

In the future RETEL is planning to buy the Intellectual Property rights on two of our patents – (i) a method for the restoration of work surface of shafts for extruding sheet material by applying a chemical nickel coating incorporating nano elements (SiC and Al₂O₃), and (ii) a piezo driven robot with micro joints with 2 or 3 degree of freedom for the control of the quality of metallized work surfaces.



ECO BIO ENGINEERING

ECO BIO ENGINEERING is a company engaged in a wide range of activities in large - scale modelling and engineering of industrial, archaeological and urban details. We have a contract to carry out a research for the development of new conceptual ways of 3D scanning by building 3D models with the mobile 3D scanner VIUScan, development of 3D models with 3D software, parameterization of 3D models, processing of the received data, followed by search, analysis, design and visualization of 3D models of industrial, municipal and archaeological sites with the aim to find innovative solutions and testing new models in the field of 3D printing by using the professional 3D Printer Pro Jet 460+.

The company also deals with the study of the constituent materials of the objects (structure, composition, size). Another activity in our contract with them is connected to the

research and development of models for the distribution of particles with a size of 0.01 - 2000 μm in dry mixtures, solutions and suspensions by using the laser nano granulometer Analysette 22 Nano Tech + for size and distribution of particles as well as the Study and reconstruction of internal 3D structure of industrial, municipal and archaeological sites by scanning with 3D tomography industrial STDS 600-200 XTH 225 and processing the 3D images.

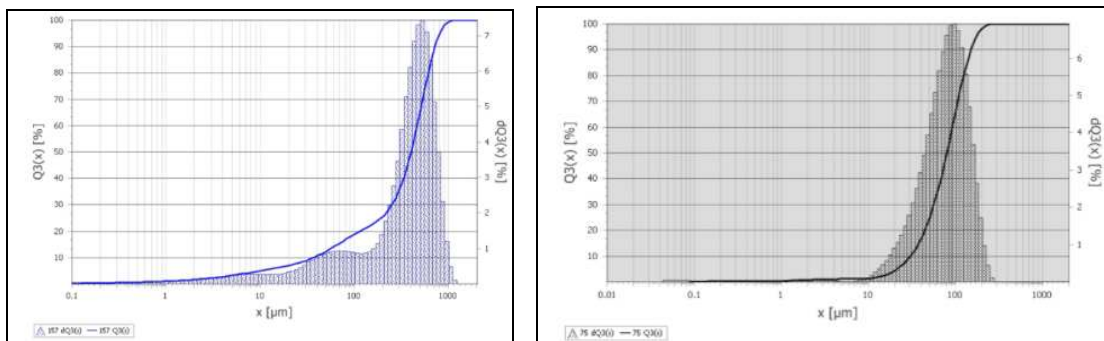
The broad spectrum of company activities also includes the development and distribution of protective equipment (body armour, etc.) for government organizations and individuals. In this connection, with our help, the company carried out a study of the high-speed processes of interaction and penetration of different physical bodies in newly developed high-tech materials by means of recording the processes with the high-speed camera Nac Memrecam HX6.

The company also deals with the energy efficiency of buildings and facilities, particularly in the extracting and mining industries. For this purpose was contracted a study of the thermal image in thermal processes, mechanical deformations and electronic circuitry, energy efficiency of buildings and appliances, analysis of thermograms using an infrared thermal camera FLIR P640, and a study of the movement and interaction of many particles by modelling the size, shape and number of the particles with the EDEM Software, simulating them in bulk materials and an analysis of the results.



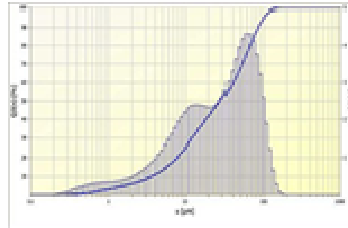
DIAMOND PROPERTIES

Diamond Properties deals with the study and distribution of powders as well as their mixtures and solutions for industrial users and need verification of data on the purchased by them raw materials. For this purpose we perform a research and development of models for the distribution of particle with a size of 0.01 - 2000 μm in samples of solutions of bulk materials - various solutions, emulsions and mixtures and / or the contained nanoparticles after filtration and percolation using the laser nano granulometer Analysette 22 Nano Tech + for size and distribution of particles.



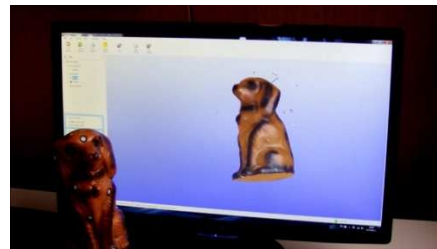
INTERAROMA

Interaroma produces different clear fruit juices and nectars. For their production it is very important that the constituent particles of juices and materials have a set size and have the same or similar size. This is the reason why the company needed the research, analysis and visualization of the size and distribution of particles in the concentrates of fruit juices and emulsions using the laser nano granulometer Analysette 22 Nano Tech + for size and distribution of particles.



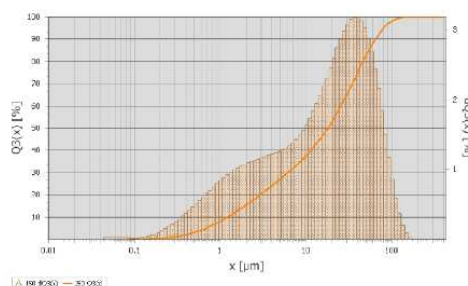
B&W CONSULTANT

B&W Consultant is engaged in the design and production of promotional materials - the design and manufacture of badges, decorations and medals. For some of their projects we perform the construction of 3D models of different types of badges, as well as medals, and 3D color printing of the model in order to visualize, find the proper size and to create medals.



NATIONAL INSTITUTE OF GEOPYSICS, GEODESY and GEOGRAPHY – Bulgarian Academy of Sciences

The Institute is an academic research organisation with numerous national and international projects. One of them is the research project ASCOR, No IZZO 142,978 in the frames of the Bulgarian-Swiss program "Research" in the period from 2011 to 2016. In accordance with the project they explore the composition of different types of salts, resins and others. According to our contract we help them with the research and development of models concerning the distribution of particles with a size of 0.01 - 2000 µm in soil samples - various types of clays using the Laser Nano Granulometer Analysette 22 Nano Tech + for measuring the size and distribution of particles.



EFFICIENT SEARCH OF SIMILAR AUDIO SEGMENTS for a Bulgarian TV-related company

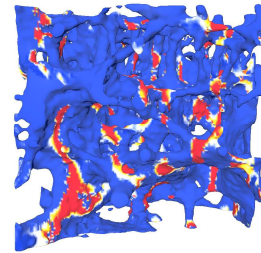
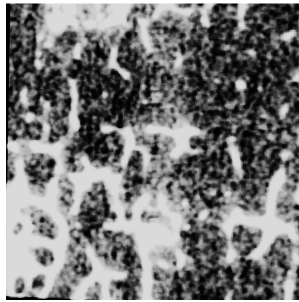
IICT has a contract for implementation of the first real-life application of an effective method for searching similar audio segments in large audio collections. In year 3 AComIn supported the development of a pilot prototype, based on original ideas for similarity search that ensure high reliability in noisy environments and exclusively high speed of searching of “similar” audio records. A pilot prototype for reliable automatic annotation of subtitled audio signals at phonemic level was demonstrated in AComIn as well. These recent results exploit the Speech Lab installed in the project. The AComIn pilots open the door for processing audio segments that contain speech in Bulgarian language. The contracted application will be used for on-line monitoring of audio advertisements broadcasted on dozens of Bulgarian TVs and radios. Currently the monitoring is done by processing the videos by image recognition algorithms in a service called “Life TV data” (see the photo below) but the audio recognition will enable faster and more reliable identification of TV advertisements as well as additional functionality for monitoring of radio advertisements within 3 second after broadcasting them. In this particular case the on-line tracking of broadcasted advertisements is associated with customer behavior in the respective advertised on-line shopping sites. But in fact this implementation is only one example of various multi-functional applications that exploit fast search in sound processing.



MICROSTRUCTURE ANALYSIS OF BONE TISSUE for an International Research Team

IICT joined an international research team working in the area of Mechanical Design with specific interest in the development of biomedical devices. One of the topics which was elaborated the last 20 years is "Methodology for diagnosis and monitoring of Metabolic Bone Diseases, especially Osteoporosis, and Bone Fracture Healing". The method is based on the assessment of Modal Damping Factor (MDF) and is supported by analytical and experimental tools. The methodology was evaluated by series of clinical trials on humans and animals in vivo and in vitro. Specifically the MDF data was compared with the data acquired with conventional methods for bone structure assessment. The IICT team took part in the CT scanning and microstructure analysis of large series of samples in order to insert the scanned data in the

analytical model supported by ANSYS, thus enabling the 3D analytical representation of specimens.



5.3 Developments in Joint Research Projects

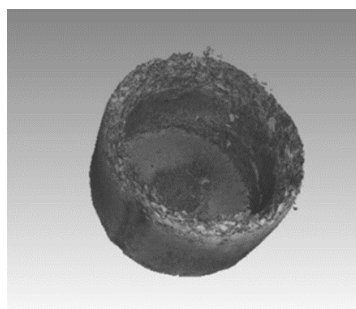
ELECTRICAL FACULTY OF TECHNICAL UNIVERSITY – SOFIA

The **Electrical faculty** explores large electrical items and devices - transformers, electric motors and electronic circuits. Due to an improper design and / or incorrect connection these items and devices develop often big tensions and they lead to a greater heat loss and often to damages and accidents. For their correction and prevention at the design stage, we conducted joint studies analysing thermal images in thermal processes in large electrical circuits and electrical appliances, energy efficiency and analysis of thermograms by using the thermal camera FLIR P640.



FACULTY OF MECHANICAL ENGINEERING OF THE TECHNICAL UNIVERSITY – SOFIA

The **Faculty** of Mechanical Engineering deals with educational topics related to deformation of metals, including briquetting of scrap metal, studying changes of the structure in cases of elastic and plastic deformations and others. We support the educational and research process through a joint study of high-speed processes concerning the briquetting of metal shavings and powders necessary for the optimization of briquetting of waste products with the purpose of secondary melting by using the high-speed camera Nac Memrecam HX6 and by scanning with the 3D tomography industrial STDS 600-200 XTH 225 and processing the 3D images.



SUBSIDIARY OF TECHNICAL UNIVERSITY – SOFIA IN PLOVDIV

The Plovdiv Branch of Technical University - Sofia examines temperature regimes in large cabinets to deploy powerful breakers, fuses and distributors, which emit high temperature and where normally is needed an extra ventilation and cooling. We support their research by studying the thermal image in thermal processes of power electrical circuits and appliances, energy efficiency and analysis of thermograms by using the thermal camera FLIR P640.



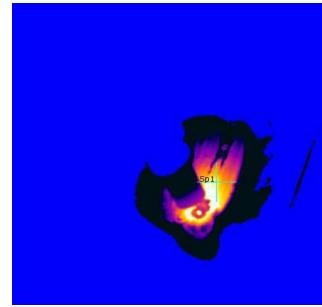
INSTITUTE OF MECHANICS – BULGARIAN ACADEMY OF SCIENCES

The institute works on issues related to the standardisation of plastic and elastic deformation of protective fences, guardrails, handrails and others for the needs of the Bulgarian State Standard. In this connection we study the high-speed processes of interaction and deformation of different physical bodies by shocks in hit railings and guardrails required to refine OBD protective equipment requirements by using the high-speed camera Nac Memrecam HX6.



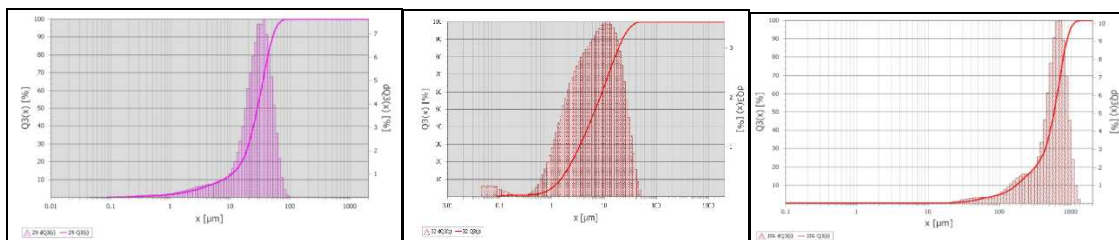
INSTITUTE OF METAL SCIENCES, BULGARIAN ACADEMY OF SCIENCES

The Institute designs and develops new welding material (welding electrodes) including nano-elements, which are expected to have a more uniform cooling of the weld – something that is prerequisite for a better quality of the weld, lack of pores, cracks and others. For this purpose it is necessary to study the processes immediately after welding – the cooling process from 2000°C to 500°C, followed by a possible further quenching by immersion in cold liquid. We support this research through an examination of the temperature image of the cooling process of welding metals for different kinds of welding for medium nano particles in the range of 2000°C– 500°C, necessary for the investigation of the influence on the nano-particle quality of the weld by using a thermal camera FLIR P640.



AGRICULTURAL ACADEMY

The Academy has a scientific research project about dried and freeze-dried foods that are used in extreme sports (mountaineering) and by travelling in aerospace. Typically, the material (meat, fruit, etc.) is ground into powder and it is important to have a particle set size, which is uniform. The fulfilment of this requirement is insured by the research and development of models for a distribution of particles with a size of 0.01 - 2000 μm in samples of bulk materials - various types of powders of dried and ground food to study the size and distribution of the particles using the laser nano granulometer Analysette 22 Nano Tech + for size and distribution of particles.



IMAGGA and AUTOMATIC IMAGE ANNOTATION

An important joint research exercise was performed between AComIn researchers and the Bulgarian start-up Imagga: a company supporting an Image Recognition Platform-as-a-Service that provides image tagging Application Programme Interfaces (APIs) for developers and businesses to build scalable, image intensive cloud applications (<https://imagga.com/>). Imagga Platform assigns English keywords as tags to the recognised image objects and in addition, associates to each image keywords that tag “similar” images in large external public collections. In this way Imagga team hopes to equip each image with sufficient amount of keywords that encode the content meaning and will help in the future retrieval and categorization of images. The collaboration with Imagga helped the AComIn team to identify interesting research questions.

As result of intensive research in the emerging area “Language and Vision”, the AComIn team proposed to Imagga some original algorithms and language technologies for improvement of their tagging as such:

- (i) preprocessing to avoid typos and unnecessary/repetitive morphological variations;
- (ii) algorithms for semantic analysis to discover some “redundant” tags with low relevance that can be removed as “noisy annotation”;
- (iii) algorithms for tag sense disambiguation that helps to guess with high accuracy the specific meaning used in the particular context of given tagset. This algorithm will help to reduce the errors in automatic translation of tags from English to another language.

The photos below illustrate the Imagga tag translation from English to Bulgarian. At the moment it is done without application of specific technologies oriented to identification of the most probable meaning of the keywords as used in the particular context of other tags for specific image. The next version of this task, implemented by Imagga and applied in real settings, will incorporate the tag sense disambiguation algorithm elaborated within AComIn. We note that AComIn researchers have received firm-based ideas and knowledge that were further integrated in the IICT research activities. The joint work between AComIn and Imagga is acknowledged at <http://imagga.com/publications>

The screenshot shows the 'Auto-Tagging demo' interface. On the left, there is a section 'Upload your photo' with a large image of a wind farm in a desert landscape. Below the image is a text input field for the 'Image URL' containing 'http://imagga.com/static/images/tagging/wind-farm-538576_640.jpg'. There is an 'Analyze' button. On the right, the 'Generated tags' section is set to 'English'. It displays a list of concepts with their respective percentages:

Concept	Percentage
sky	38.56%
turbine	25.00%
landscape	20.44%
energy	20.05%
power	18.50%
water	16.40%
electricity	15.82%
generator	15.57%
clouds	15.33%
environment	15.17%

Below the tags, there is a section 'Try with example images' with three small image thumbnails.

The screenshot shows the same 'Auto-Tagging demo' interface but with the language set to 'Bulgarian'. The 'Generated tags' section now displays the following concepts in Bulgarian:

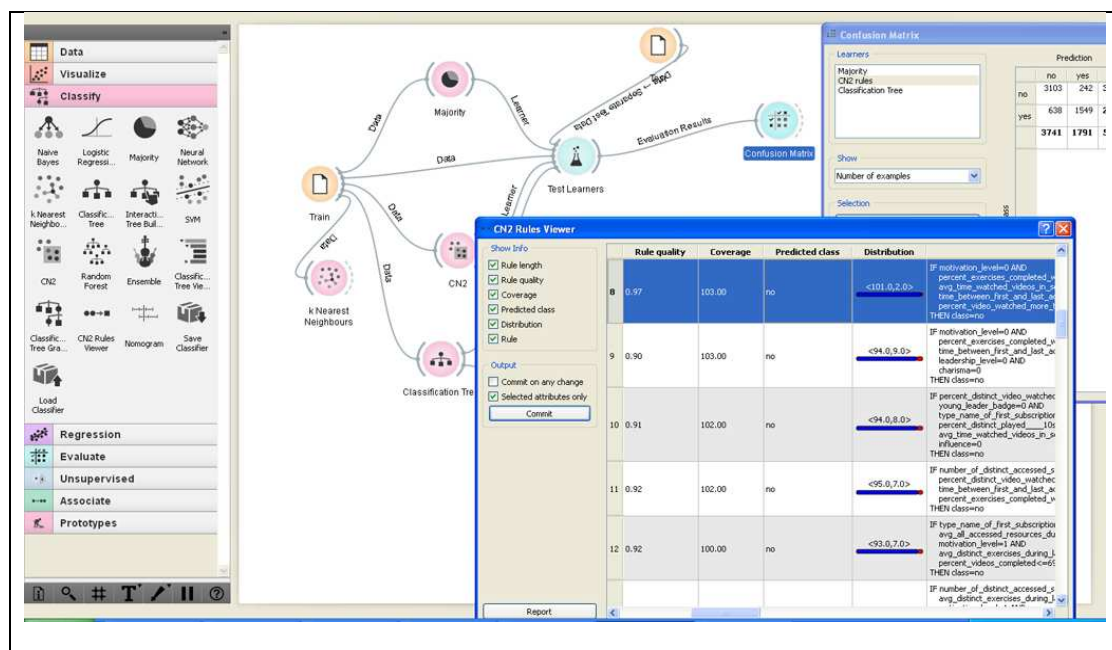
Concept	Percentage
небе	38.56%
турбина	25.00%
пейзаж	20.44%
енергия	20.05%
мощност	18.50%
вода	16.40%
електричество	15.82%
генератор	15.57%
облаците	15.33%
околна среда	15.17%

UCHA.SE and LEARNING ANALYTICS

UCHA.SE (<http://ucha.se/>) is the most popular Bulgarian platform with educational videos and exercises that help pupils learn more efficiently and improve their results at school. It is aimed at supporting the K-12 National Bulgarian Curricula through offering interactive instructional materials – videos and practice exercises – for all subjects. Currently it offers 4,393 videos in 17 subjects as well as Introductory level of English, German, French, and Spanish,

and Introduction to Programming. The portal offers more than 1000 tests. The videos are seen more than 13,4 million times by more than 400,000 users.

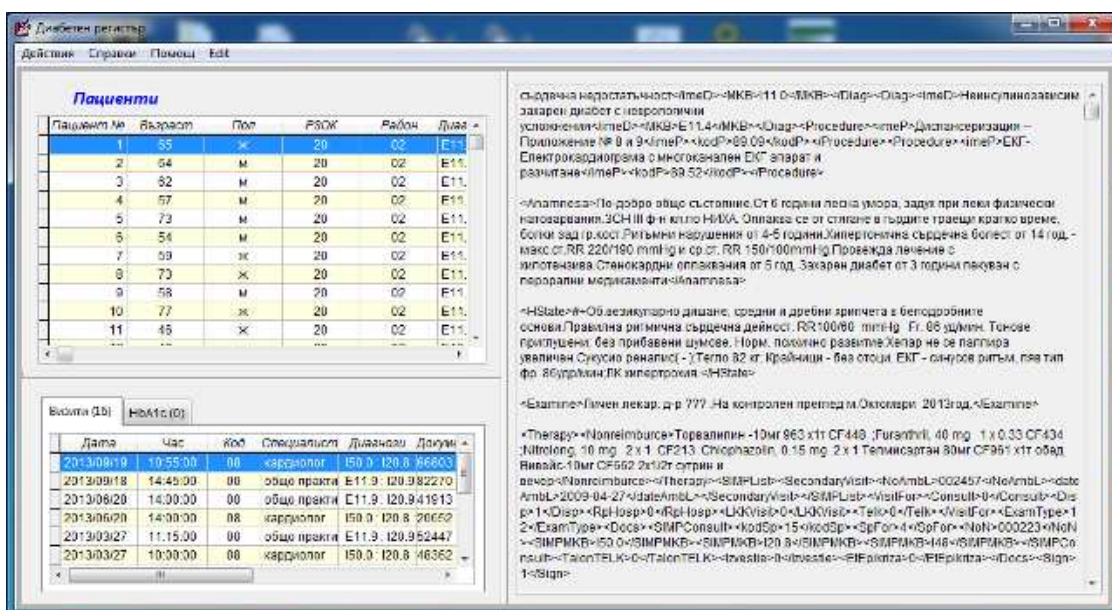
Together with the UCHA.SE developers and some incoming experienced researchers in AComIn, the project team carried out research that was aimed at improving the quality of educational services and the subscription rate by leveraging educational data mining. In this case the AComIn researchers learned from the portal developers. The UCHA.SE logs are analysed and two “models” were built: of (i) learners and (ii) educational resources. Applying machine learning methods, predictive dependences between the learner model attributes and the learner engagement with the portal were acquired and presented as rules. For instance, the most important features that characterise the continuous portal subscription and use are: number of consequent days to access the site, number of completed exercises and percentage of the video lessons watched more than once. The acquired rules will be applied for improving the site structure and development of new strategies how to attract the users.



UNIVERSITY SPECIALISED HOSPITAL for ACTIVE TREATMENT of ENDOCRINOLOGY "Acad. Ivan Penchev" (USHATE), MEDICAL UNIVERSITY - SOFIA

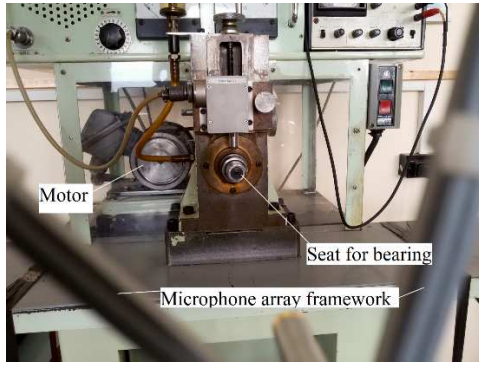
USHATE is a University hospital authorised by the Bulgarian Ministry of Health to host an anonymous Register of diabetic patients in Bulgaria. This Register contains 28 indicators of diabetic patients including age, sex, codes of diagnoses of diabetes and its complications, diabetes duration, risk factors, data about compensation, laboratory results, hospitalisations and prescribed medication. The AComIn experienced researchers helped for the automatic construction of the Register using language technologies and business analytics tools. The Register was generated from a Repository of more than 112 million pseudonymised reimbursement requests (Outpatient records) submitted to the National Health Insurance Fund (NHIF) in 2012-2014 for more than 5 million citizens, including 436,000 diabetic patients. The Outpatient records are semi-structured files with predefined XML-format so some parameters are explicitly encoded by XML tags. But significant information is kept in free text fragments: Case history, Family history, Risk factors, Patient status, Clinical tests and lab data as well as Prescribed treatment. Only the drugs reimbursed by the NHIF are coded, the other medication is described as free text. So the researchers of AComIn developed pilot prototypes for large

scale processing of Bulgarian clinical texts and automatic extraction of the most essential data in diabetes: values of body mass index (BMI), weight, blood pressure, glycated hemoglobin (HbA1c) and blood glucose, as well as drug names, daily dosages, frequency and route of admission. Thus an anonymous Register of Diabetes Mellitus patients was generated including extracted values of clinical test and lab data as well as values of arterial hypertension extracted with precision 92% and recall 98%. Since the NHIF collections are pseudonymised, it is possible to trace multiple visits of the same patient and monitor the patient history. Using the Diabetes Register, one can evaluate the compensation of diabetic patients in relation with their dispensation status. Another important application is to assess therapy efficiency. Using the collected and structured data, one can deliver various types of findings to decision makers in order to improve the public health policy and the management of Bulgarian healthcare system. The picture below shows the Register interface.

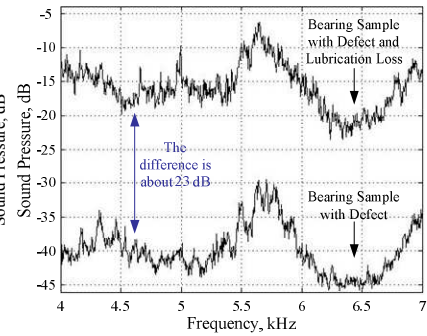
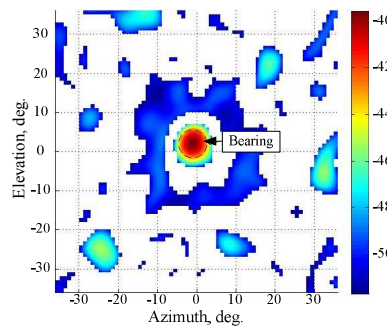
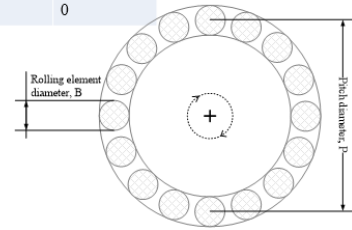


FACULTY OF MECHANICAL ENGINEERING OF THE TECHNICAL UNIVERSITY – SOFIA

The Faculty is involved in a non-destructive testing of rolling bearings. Defects and lubrication loss affect a lifetime of the bearing and may lead to a production line stops. Vibration and acoustic measurements are used for the testing of the bearings. The methods require contact of a sensor and the bearing under investigation. In collaboration with the faculty, a non-contact approach for testing of the rolling ball bearings is implemented using the Acoustic Camera, which is part of Smart Lab of AComIn project. Sound pressure estimates of the set of 20 bearings manufactured by SKF, NSK Ltd., KBS, and HF etc. have been obtained with frequency resolution 4 Hz, in the frequency range 10 Hz – 20 kHz. The lubrication loss increases the estimates of sound pressure from 3 dB to 33 dB. Automatic detection of the lubrication loss could be utilized by a thresholding technique. A recently developed smart approach enables feature extraction from the estimates of sound pressure, using Echo State Networks. Results of the measurements are valuable for the University as research results.



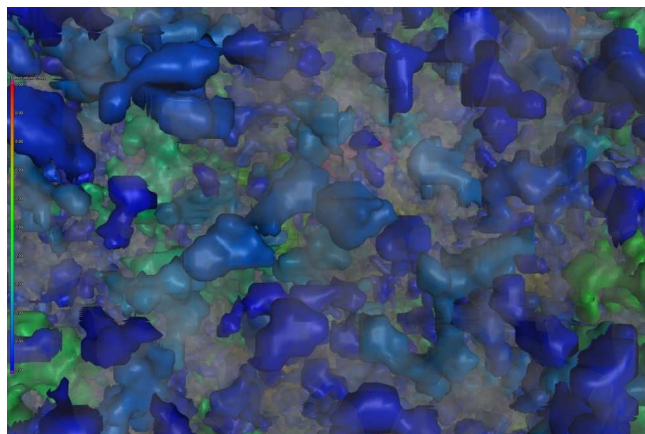
Parameters for SKF bearing "type" 6205.	
Number of rolling elements	9
Rolling element diameter B , mm	7.938
Pitch diameter P , mm	39.04
Contact angle, deg.	0



MICROSTRUCTURE ANALYSIS and NUMERICAL HOMOGENIZATION of NANO-COMPOSITES with the INSTITUTE OF MECHANICS – BULGARIAN ACADEMY OF SCIENCES

The AComIn team was involved in a joint research with the Open Laboratory for Experimental Mechanics of Micro and Nanomaterials at the Institute of Mechanics. The topic of research was microstructure analysis and numerical homogenization of nanocomposites based on industrial CT scanning data. Epoxybased nanocomposites are known for its outstanding mechanical properties like high elastic modulus, increased strength, barrier effects, flame retardancy, electroconductivity etc. with very small addition of nano particles.

The numerical homogenization of anisotropic linear elastic materials with strongly heterogeneous microstructure is studied. The developed algorithm is applied to the case of two-phase composite material: epoxy resin based nanocomposite incorporating nanoclay Cloisite. The voxel microstructure of the two-phase composite material is extracted from a high resolution computed tomography image. The image below shows the microstructure of epoxy clay composite.



STUDYING THE YELLOW PAVEMENTS IN SOFIA as a TEAM MEMBER

The AComIn team took part in the project "*Study of composition, structure, properties and production of yellow pavement in Sofia*". The yellow pavement is a prominent symbol of Sofia, which was declared national heritage in the beginning of 2014 by the Sofia municipal council. The project was developed by an initiative group of members involving "Bulgarian crystallographic society" and experts from the Institute of Mineralogy and Crystallography - BAS, Institute of Physical Chemistry - BAS, Institute of Catalysis - BAS, Institute of Information and Communication Technologies - BAS, Mining and Geology University "St. Ivan Rilski" and the University of Architecture, Civil Engineering and Geodesy – Sofia. The project was funded by Sofia Municipality under the "Europe 2014" program "*Promoting smart and sustainable urban development by strengthening innovative activities in the public sector, carried out in cooperation between citizens, public organizations and local authorities*". As a result, the chemical and phase composition of yellow bricks are defined; the thermal behavior and the relationship between heat treatment, structure and properties are established. Guidance is given on the selection of appropriate resources and methods for future production of "authentic" pavers.

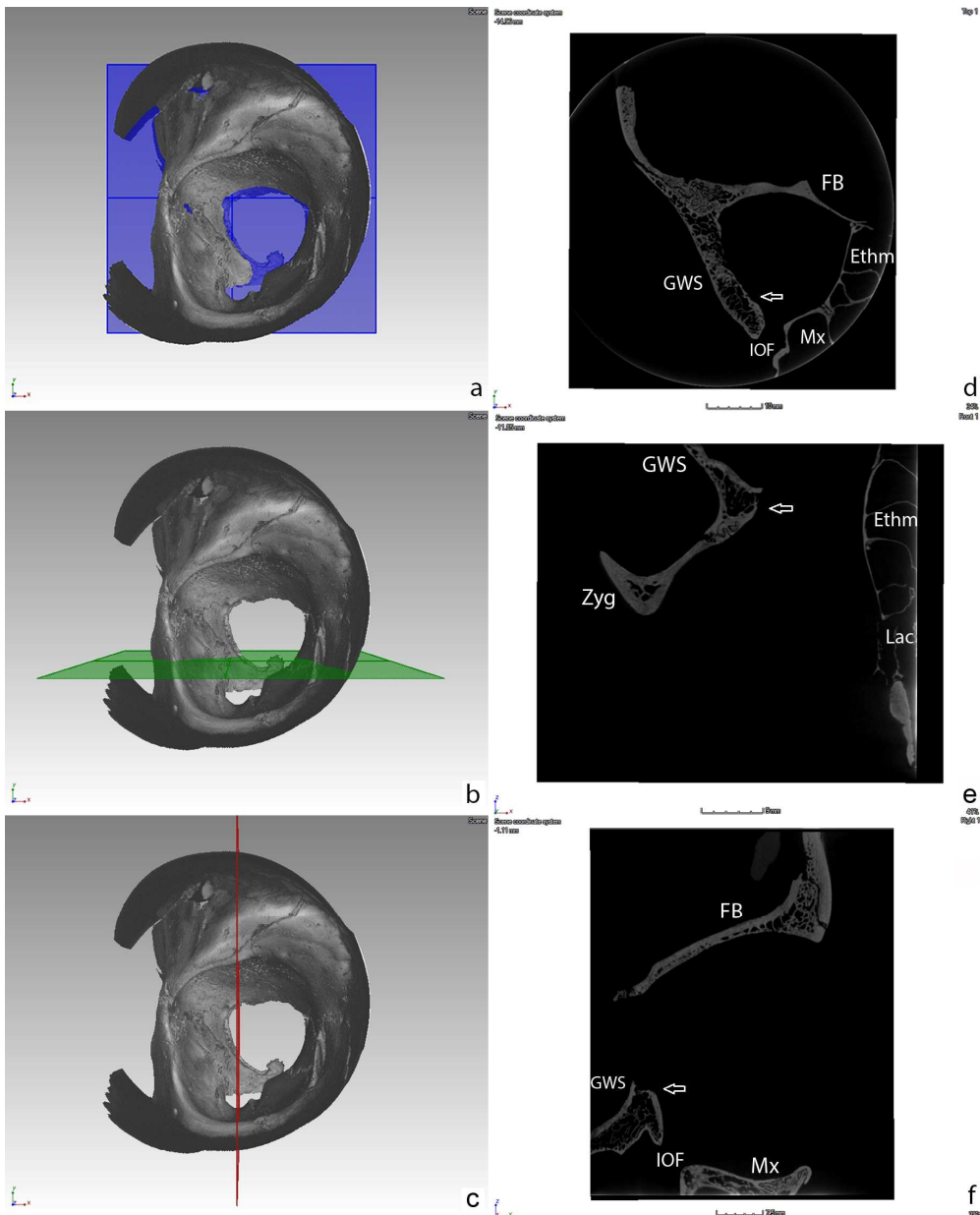
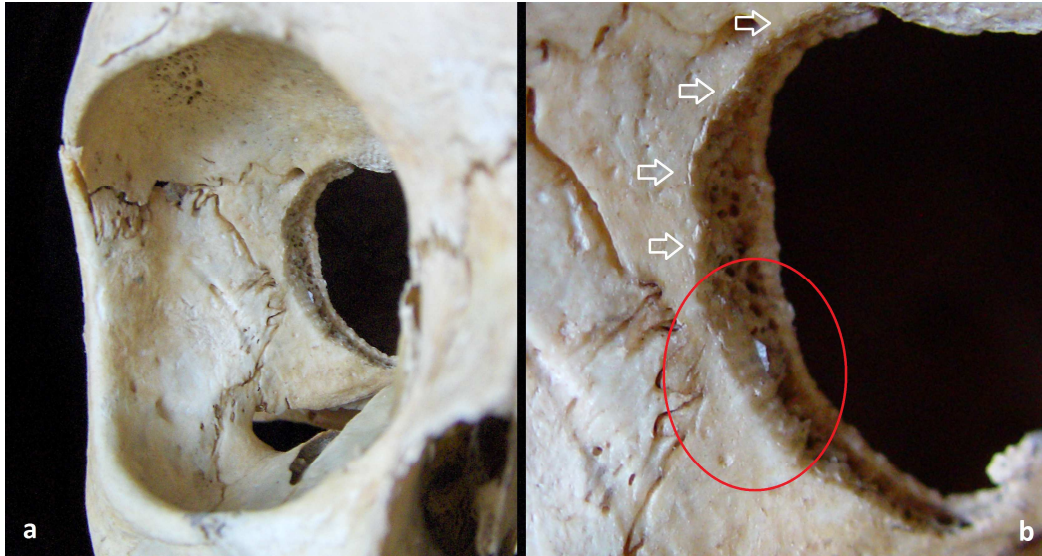


APPLICATIONS of CT MICROSTRUCTURE ANALYSIS in PALEOANTHROPOLOGY with the Institute of Experimental Morphology, Pathology and Anthropology with Museum – Bulgarian Academy of Sciences

The co-occurrence of bregmatic bone and metopism is an extremely rare finding. In the present study we investigated, compared and described this uncommon combination in two skulls belonged to infant and adult male individuals. The objects of the study were obtained after archaeological excavations of two medieval necropoles located in the northern Black Sea coast of Bulgaria. The samples were macroscopically observed and measured. A CT scanning was performed in order to investigate the internal microstructure and the relation between the calvarial bones.

Another studied case describes a survived surgical intervention on the orbit with an excision of part of the orbital apex on a skull from the medieval town of Kabyle, Southeastern Bulgaria (12th - 14th century). The orbital defect was observed macroscopically and analyzed in detail by micro CT imaging. The most probable causes for orbital trepanation in the case could be an urgent orbitocranial trauma or serious symptoms of some orbital pathological condition. The traces of remodelling on the defect margin indicate that the individual survived for a certain period of time after the operation. The images below show:

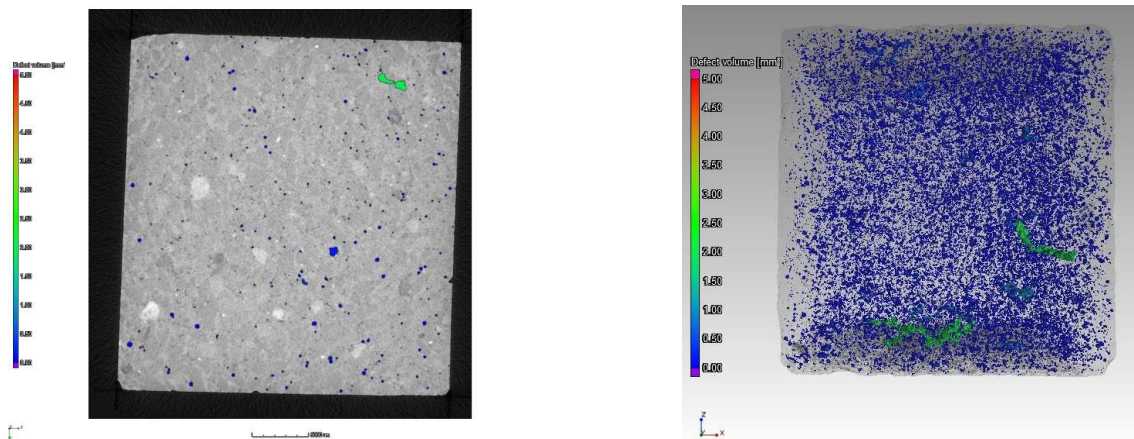
- Right orbit with orbital defect: (a) a closer view of the defect; (b) the arrows indicate the smoothed outer edge; the circle encloses the coverage of the diploë by a thin layer of compact bone tissue;
- CT-images of the orbital defect: (a-c) a 3D volumetric representation with illustrated coronal, transversal and sagittal plane at the level of the defect; (d-f) the corresponding coronal, transversal and sagittal section at the same level.



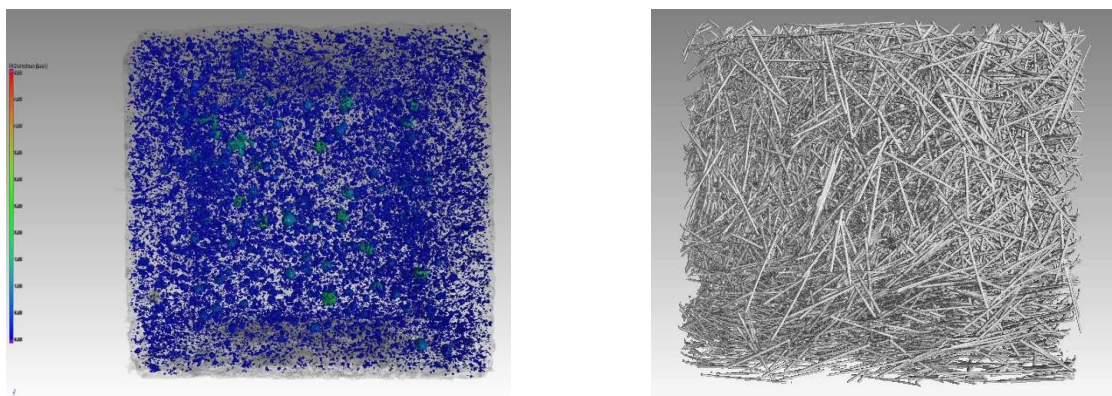
ADVANCED STRUCTURE CHARACTERISATION of FIBER REINFORCED CONCRETE with the INSTITUTE OF MECHANICS – BULGARIAN ACADEMY OF SCIENCES

Incorporation in concrete composition of steel macro and micro fiber reinforcement with structural function increases the degree of ductility of typically brittle cement-containing composites, which in some cases can replace completely or partially conventional steel reinforcement in the form of rods and meshes. Thus, that can reduce manufacturing, detailing and placement of conventional reinforcement, which enhances productivity and economic efficiency of the building process.

In this study, six fiber-reinforced with different amounts of steel fiber cement-containing self-compacting compositions were investigated. Advance approach for the study of structural and material properties of these type composites is proposed by using the methods of industrial computed tomography. The obtained original CT microstructure results and characterisation of individual structural components make it possible to analyze the effective macro characteristics of the studied composites. The first obtained results in this topic concerns porosity distribution analysis with respect to the amount of the included steel fibers.



Porosity distribution (in mm³): 2D intersection (left) and volume distribution (right)



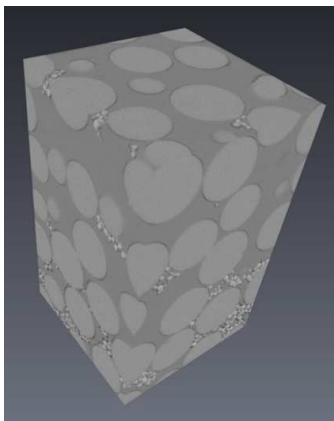
Porosity (left) and fiber (right) distribution for composition

5.4 International Collaboration

RUHR-UNIVERSITY OF BOCHUM (GERMANY)

In a joint project involving the Ruhr-University and the Institute of Mechanics – Bulgarian Academy of Sciences, we carried out investigations and a micro structural analysis of geological materials by scanning with the 3D industrial tomography XTH 225 and processing the resulting 3D images as follows:

- Infiltration of the bentonite suspension in a medium of glass spheres and plastic granules;
- Hydration of the rock salt by the introduction of water into radially limited samples (narrow pipes);
- Scanning the internal structure of sedimentary rocks and hard clays;
- Micro-structural analysis of samples of sand containing undersized fractions.



PAVIA UNIVERSITY (ITALY)

As a collaborative activity with the University we performed tasks in connection with an accompanying event of EXPO 2015, Milan, Italy - the Exhibition “The Battle of Pavia” at the Visconti Castle in Pavia. The joint activities concerned the restoration of historic events:

- Preparation and completing of 3D models of historical figures taken from the Tapestries of the Battle of Pavia,
- development of 3D models with 3D software, parameterization of the 3D models, processing of the received data, analysis, design and visualization of 3D models and testing new models in the field of 3D printing,
- 3D printing of the models of historical figures from the Tapestries of the Battle of Pavia by using the AComIn 3D Printer Pro Jet 460+,
- 3D printing of 3D models of historical figures from the Tapestries Battle of Pavia for the visually impaired people by using the SmartLab 3D Printer Pro Jet 460+.





5.5 Others

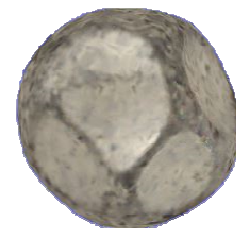
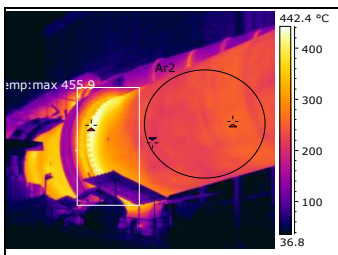
In this section we present recently established contacts with potential Users, mostly subsidiaries of large international industry, who are potential collaborators in future joint activities. It is our strategy to establish prior relationships with partners (sometimes personal relationships), to look for tasks of joint interest and to identify further the right external funding opportunity for eventual joint projects.

CEMENT HOLDING HOLCIM - VRATZA, BULGARIA

The cement factory in the village Beli Izvor, near Vratsa, produces a milling material for the cement production by grinding the materials in large ball mills and the baking of the cement in large furnaces. Vulnerable points by the process are the uniformity in the particle size of the cement of different brands (which besides its composition determines also the quality), and the location and cooling of the large bearings that support the rotating parts of the mills and furnaces (which can result in damage and accidents due to an overheating or an overloading).

We offered the company for the optimization of these processes, after some conversations, the following:

- Research and development of models for the distribution of particles with a size of 0.01 - 2000 μm in samples of bulk materials to determine the size distribution and particle uniformity of various ingredients in a particular cement brand using a laser nano granulomer Analysette 22 Nano Tech + for size and distribution of particles.
- Study of the temperature images of materials and equipment (mills and furnaces) in the range -40°C - $+2000^{\circ}\text{C}$ for diagnostic and optimization of the layout of the cooling elements and control of the condition of the bearing camps using a thermal camera FLIR P640.
- Study of the movement and interaction of multiple objects and particles by modeling the size, shape and number of bodies and particle simulation by bulk and grinding materials, analysis of results needed for the energy efficiency and optimization of digestive processes in different types of grinding material, different types of grinding bodies and different levels of amortization of grinding bodies with the EDEM Software, simulating them in bulk materials and ab analysis of the results.



CHELOPETCH MINING (SUBSIDIARY OF DUNDEE PRECIOUS – CANADA)

In the mine, 600 meters underground, is carried out and crushed ore, which is transported to the surface and then ground to the size of 80 microns, followed by an enrichment of the concentrate to 70-80%. In the galleries and tunnels of the mine is needed a good ventilation, which is done with the help of enormous fans (1 megawatt). During the processes of digestion and processing it is important to monitor the size of the particles in the concentrate. In connection with these requirements we had some talks and offered the management of the mine the following:



- Research and development of models for the distribution of particles with a size of 0.01 - 2000 μm in samples of bulk materials to determine the size distribution and particle uniformity of various ingredients in a ore using a laser nano granulometer Analysette 22 Nano Tech + for size and distribution of particles.
- Generation of acoustic images and noise analysis using the Acoustic Camera (Holographic Antenna) and its software.

The Acoustic camera can be very useful in the mine, e.g. for testing defects of the large ventilation bearings without stopping the installation.

CABLE GONDOLA LIFT – BOROVIETZ

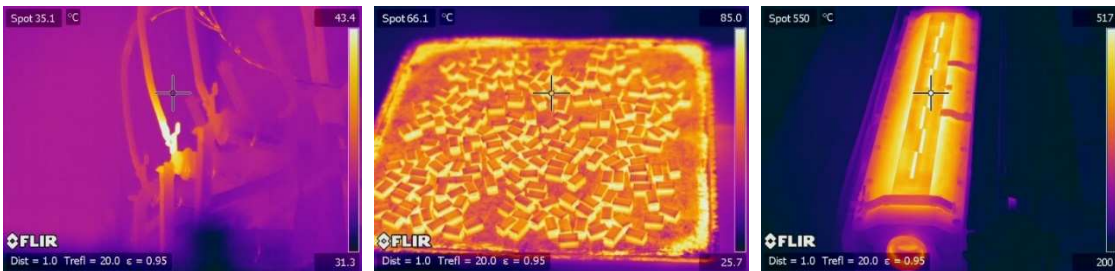
The cable gondola lift uses a ropes line, and the ropes pass through the rollers of supporting pillars. The rollers are coated into special rubber tires, which prevent any deformation and scraping. By the movement of the ropes through the pulleys, the bandages and rolls are heated by friction. Uneven rubbing is a sign of aging or improper disposal of tread, leading to differences in their temperatures and signal for the need of their repair or replacement, before any emergency situation that might endanger the health and lives of passengers occur. For this purpose we performed a study of the thermal image by thermal processes in large mechanical systems - rubber tires to protect the rope and the bearing rollers of the lift, energy efficiency, analysis of thermograms to diagnose the state of the protective bandages, safety in the work of the lift, causes of warming and damages using the thermal camera FLIR P640.



KEMET ELECTRONICS BULGARIA AG, KYUSTENDIL

The company manufactures various types of capacitors. The capacitors are baked in special furnaces, and the temperature regimes during these processes are very important, as well as the uniform heating of the entire area and the volume, which depends on the good location and good work of the heating elements. For the company we performed the following tasks:

- Study of high-speed processes in the formation of corpora by rolling, pressing and soldering of the feet of capacitors using a thermal camera FLIR P640;
- Study of the thermal image by thermal processes in electric furnace and electric heating resistors to measure the uniformity of heating and evaporation of the metal using a thermal camera FLIR P640;
- Study of uniform heating of the pans in the furnace for the heat setting of capacitors using a thermal camera FLIR P640.



6 ASSESSMENT OF THE ADDED VALUE OF THE ACOMIN WP4 ACTIVITIES TO THE STRENGTHENING OF IICT RESEARCH AND INNOVATION CAPACITY

The Added Value of AComIn to the IICT Research and Innovation potential can be assessed from several perspectives.

First, no doubts IICT increased its patent filing capacity via AComIn. In fact the patent activities would be impossible without AComIn especially the more expensive applications to the WIPO which extend respective Bulgarian applications. But it is more important that the modern SmartLab devices, purchased within AComIn, enable to formulate sophisticated and complex claims and in general imply patent applications with better quality.

Second, IICT increased its capacity to carry out contracted research. All developments presented in section 5.2 rely on the SmartLab devices. The potential applications of the modern equipment essentially catalise joint research activities with Users. These active contacts are implemented via various forms of Networking with Users and increase the entrepreneurial activities of IICT seniors. In Reporting period 2 they managed to establish liaisons with the largest industrial clusters and professional organisations – the *Mechatronics and Automation cluster* (http://www.cluster-mechatronics.eu/index.php/en_US/home), the *Srednogorie cluster* (<http://srednogorie.eu/en/>), as well as with the *Association of Business Clusters in Bulgaria* (<http://abclusters.org/en/>). In this way, establishing long-term strategic partnerships with Users, IICT makes steps towards establishment of shared facilities for R&D& innovation.

Last but not least, AComIn helped to (systematically) involve IICT PhD students and young researchers in the cooperative innovation activities, which trains them how to bridge the academia and industry.

7 DEVIATIONS FROM SCHEDULE

There are no deviations from the scheduled Tasks in WP4.

8 CONCLUSION

AComIn run in full speed during the Reporting period 2. The project team had the chance to protect the intellectual property rights of the generated knowledge and technological achievements. Keeping close contacts with different User Communities, IICT seniors test and improve their research results and get precious feedback from the market. In some cases the AComIn researchers suggest to Users new materials, new technologies or new shape and type of industrial bodies or modules. These active developments increase both the theoretical and practical knowledge of IICT staff. On the other hand, the User satisfaction increases the recognition of the role of the public research organisation towards the society. AComIn is famous as innovation driver not only in the Bulgarian Academy of Sciences but also at national level. This recognition enables participation in follow-up projects and obtaining further financial support from public institutions or private organisations.

A challenge that remains to be addressed in the future is the identification of new international partners and expansion of the present User contacts to international collaborative networks.