The International Association for Automation and Robotics in Construction

Newsletter 2008 · Issue 1

A Word from the President:

I would like to welcome all the participants of the 25th Jubilee of the International Symposium on Automation & Robotics in Construction (ISARC). When the whole thing started – in 1984 in Carnegie Mellon University, Pittsburgh, Pennsylvania (US) – by some visionaries from the US, Japan & Israel, no one could have imagined that there would be a conference on an **annual basis**! I have attended most of the conferences since 1989 & believe me, my friends, this is a very high quality conference, which is so successful thanks to your enthusiasm & the contribution of such high quality papers.

Another reason for the success is the Organization behind all the ISARCs – the International Association for Automation & Robotics in Construction (IAARC). Many of the participants know IAARC, but I am sure that many others know very little, or even nothing. All 25 ISARCs were not only officially sponsored by IAARC, but actually would have not been realized without IAARC (ask all local organizers, they'll tell you) – this is why it is important to say a few words about IAARC.
I do not want to bore you, my friends, with too many details or historical information, hence I'll just describe the present organizational structure. IAARC is run by a Board of Directors (BOD), which draws its policies, decides about future ISARCs, maintains the growth of its membership, controls the quality of the symposia, etc. The BOD normally meets during ISARCs & conducts virtual meetings during the year. There is also an executive BOD (past president, current president, vice president and the secretariat) which prepares the BOD meetings & deals with many issues that cannot wait for BOD meetings. The body that deals with everyday issues and supports the president with all her/his activities is the Secretariat, which is lead by two BOD members from Eindhoven University of Technology, The Netherlands.

An additional reason why I am telling you all the above is that **we need young, enthusiastic new BOD members**. You don't have to be involved in this area for many years – all that matters is that you are interested in the broad area of construction automation & that you are prepared **to be committed** to the organization. Both men & women (we only had one woman on the BOD for a short while) are encouraged to turn to me personally, or to any other BOD member & present themselves, during the symposium or after it.

I wish you all a very fruitful & enjoyable symposium.

Ronie Navon,
President

News:

- **Tucker-Hasegewa Award to Prof. Miroslaw Skibniewski:** During the 24th ISARC held in Kochi, India (19-21 September 2007), the Richard Tucker-Yukio Hasegewa Award, IAARC's highest honor awarded to a researcher in construction automation and robotics, was presented to Professor Miroslaw J. Skibniewski from the University of Maryland at College Park, USA. Prof. Skibniewski holds the A. James Clark Endowed Chair in Construction Engineering and Management, serves as a faculty leader of the e-Construction Group at his University, and is the Editor-in-Chief of Automation in Construction, an international research journal constituting the official publication outlet for IAARC. Prof. Skibniewski served as the President of IAARC during the 2000-2001 term.

- **Special Issue on Robotics and Automation Technologies in Construction:** The International Journal of Advanced Robotic Systems published a Special Issue on Robotics and Automation Technologies in Construction in their Volume 4, Number 4 December 2007 issue.

- **On-line ISARC 2007 Proceedings CD:** The complete and unaltered content of the official Proceedings of the 24th International Symposium on Automation and Robotics in Construction (ISARC) CD-ROM is available online at http://www.iaarc.org.

Upcoming Event:

25th ISARC 2008

Vilnius, Lithuania
June 27-28, 2008

The International Symposium on Automation and Robotics in Construction (ISARC 2008) will be the 25th jubilee symposium. The 25th ISARC (ISARC 2008) will be held in Vilnius, Lithuania, from June 27th to 29th of 2008. The first symposium was held in June 1984 at Carnegie Mellon University in Pittsburgh, Pennsylvania, USA. Later symposia from this series were organized and held in France, Israel, Japan (multiple times), USA (multiple times), United Kingdom (multiple times), Germany (multiple times), Poland (multiple times), Spain, Taiwan, The Netherlands, South Korea, Italy and India.

The annual ISARC symposia are sponsored by the membership of the International Association of Automation and Robotics in Construction (IAARC). They are a prestigious gathering of researchers, academics and industry practitioners in all specialties related to the construction industry, including civil and building engineering/design and project execution, advanced construction machinery and robotics applications in construction, information technologies for planning, design, logistics, computer-aided project management, environmental protection issues, building systems monitoring and control, safety and recovery operations, and temporary/rapid construction technologies.

Website: http://www.isarc2008.vgtu.lt/

Construction Robotics Laboratory

Prof. Dr.-Ing. Univ./Tokyo Thomas Bock

The chair for “Building Realization and Informatic” had been established in October 1997 at TU Munich, Germany. My first encounter with industrial robots happened during an internship at the Daimler Benz car factory south of Stuttgart in 1980. Based on this inspiration I designed and built a six party apartment house using CNC pre-cut timber technology in 1981 in Freiburg, Germany and a precast 5 storied mixed use building in Barcelona, Spain in 1983. During MSc studies at IIT in Chicago, USA I visited the Detroit car industries and heard of the new challenging Toyota Production System being not only applied to just in time production of cars but also of modular homes. This information triggered a stay in Japan from 1984 till 1989 where I got involved in all major Japanese construction automation and robotics projects. All in all I was involved in the design and development of about 10 off site production -, 50 on site robotic- and 20 automated building construction systems primarily in Japan, France and Germany.

Picture 1 shows the 300 square meter construction robotics laboratory which has an overhead gantry crane for on site rapid assembly testing, 1 industrial and 3 prototypic construction robots. The focus of these activities are the “robot oriented design” (1) and prototyping of building systems (2), construction (3) and personal robots for ambient assisted living. (4).

The construction robotics laboratory is located on main campus of TU Munich downtown Munich in the museums district. Here is also the office of the chair totalling 200 square meters including seminar room.

On the Garching campus of TU Munich between downtown and Munich airport the chair holds a 3000 square meter teleconstruction site (picture 2). Here in the future an infra free modular experimental building with embedded mechatronics and personal service robotics will be built.

Laser supported concrete spraying in tunnels

Pär Åhman

Robotized application of sprayed concrete as rock support in tunnels is a difficult task. The concrete layer should meet high demands on strength, even thickness and adhesion to rock. The tunnel roof and walls are normally distanced 5-10 m from the operator and the sight is damped or in other way limited. It normally takes several months to learn the job properly. The operator must be fully concentrated all the time while spraying, e.g. passes from 30-45 minutes each with pauses of 15 minutes. Wounded back or strained shoulders are common problems for the personnel, and some have to change profession due to such problems after less than ten years of spraying. Not fully skilled operators can cause quality problems and risk for accidents if rock support is not properly installed. The situation also cause high costs for learning new operators.

Laser scanning is widely used to document the rock surface in tunnels. Now there is robot equipment for sprayed concrete that uses laser scanning in order to help the robot operator to install the sprayed concrete correctly. Special contractor BESAB have made a series of tests in a highway tunnel in the Stockholm region under construction.

The results of these tests can be summarized as follows:

- Automatic spraying can significantly reduce wounds of the operators
- Layer thickness will be more even when the technique is used
- Automatic spraying can be installed with high speed and even quality
- The laser scanning system can, due to decreased thickness fluctuation, possibly reduce concrete volume used, however not fully proofed in this limited test series
- The equipment used, were quite sensitive for disturbance in geometry such as bolts and fan tubes
- The equipment also showed a great number of technical problems during this test series
- Over the test period the laser scanning with automatic spraying were used approximately 25 % of the time, while manually manouvered spraying stood for the same volume. The rest of the time were used for moving the equipment, cleaning and waiting for material.
- The technique will not reduce the need for skilled robot operators

Finally it is clear that, after some modifications, laser scanning have the potential to be widely used in the future.

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Construction Engineering and Management Research Division at KICT (Korea Institute of Construction Technology)

Dr. Moonyoung Cho (Director)

The Construction Engineering and Management Research Division (CEM Research Division) is a multi-disciplinary research department studying the construction industry. The CEM Research Division is dedicated to gaining a comprehensive understanding of the construction industry and to its future competitiveness and advancement in a rapidly changing global environment. Its vision is to have a leading role in changing the Construction Industry with Construction Management (CM), an Information Technology (IT), Automation and Robotics. Main **research topics** of the CEM Research Division are as follows:

- Production and Delivery/Procurement Systems for Construction
- Core Technology for Construction Project Management
- Construction Process/Product Modeling, Computer Integrated
- Construction (CIC), and Project Management Information System (PMIS)
- Performance Measurement/Evaluation and Best Practice Benchmarking
- Quality/Safety Management and Facility Management
- Construction Automation and Robotics
- Policies/Principles and Legal Aspects of Construction Management

Current research efforts at the CEM Research Division developed RFID and WSN (Radio Frequency Identification and Wireless Sensor Network) technology applications for the construction industry. It also has exerting efforts in the field of robotics and automation technology in construction:

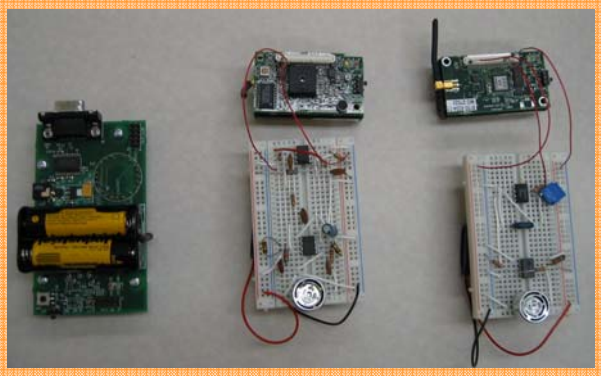
- Wireless Sensor Network Based Bridge Monitoring: 50% of the installation costs of a real-time bridge health monitoring system consist of wiring costs: wires between the sensor and the data loggers; and optical cables between the data logger and the maintenance office. A wireless-sensor-based road/bridge health monitoring system and a u-node (sensor + one-channel ADC + wireless communication module) has been developed. Each u-node is a wireless sensor module and is connected to the u-gateways (a CDMA gateway for the u-nodes).
- The Intelligent Excavation System (IES) is a multimillion dollar project involving the development of an automated excavation system for earth work to address the problems of the lack of skilled excavator operators, having to work in a hazardous environment, indefinite designs, and poor work scheduling. IES has three main research segment: (1) an intelligent task planning system; (2) a work environment recognition and intelligent control system; and (3) intelligent excavation system integration.

- Automatic Tunnel Monitoring System: Tunnel construction is often considered a life-threatening work due to the possibility of the sudden and unpredicted collapse of the tunnel. Therefore an automatic tunnel monitoring system has been developed based on the wireless sensor network system: Zigbee, a low-cost and effective wireless communication module for tunnel sensors. This integrated tunnel monitoring system used wireless and automated data collection, a 3D CAD system and structural analysis technologies.

e-Construction Group at the University of Maryland

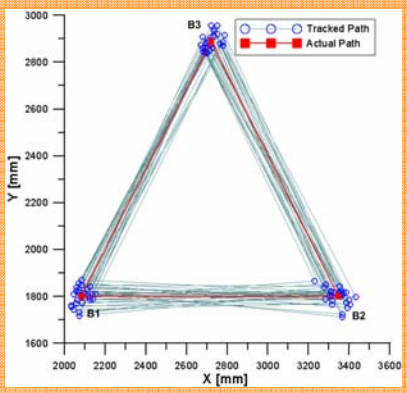
Dr. Mirosław J. Skibniewski

The e-Construction Group at the University of Maryland at College Park led by *A. James Clark Chair* Professor Mirosław J. Skibniewski is a multi-disciplinary research team engaged in cutting-edge research to redefine the principles and practices of the construction industry with state-of-the-art information technology. One of the recently completed projects constituting Ph.D. dissertation research by Dr. Won-Suk Jang focused on *Embedded System for Construction Asset Tracking using RF and Ultrasonic Devices.* This research introduced a new prototype framework for an automated asset tracking system for construction sites. The research effort addressed the needed shift from the time- and labor-intensive legacy systems for construction site asset tracking to sensor- and network-based collaboration and communication systems for an improved conduct of these tasks.



Software and hardware architecture for the new tracking system was developed with the use of the combination of ultrasound and RF devices. By embedding an external ultrasound device with a MICAZ platform, enhancements to networking flexibility and wireless communication were observed in comparison with older technologies used in construction material tracking systems. Experimental results showed notable improvement of measurement performance, with positioning accuracy means ranging from 4.3 to 4.7 cm among 30 samplings. Distance estimation indicated that the 90th percentile of all measurements among more than 1,000 samplings ranges from 3 to 25 cm up to a ranging distance of 15 meters. Unlike the proximity approach, the trilateration method generates the geographic coordinates of mobile objects with increased accuracy. Positioning accuracy with less than 5 cm resolution has been found to be superior to many GPS-based technologies such as DGPS and RKP. The cost-benefit analysis performed as part of Dr. Jang's research implied that the proposed measurement technology can result in the savings on the cost of material tracking of up to more than 60 percent when compared with the use of traditional tracking technologies in a typical construction project. In addition to cost savings, the use of a sensor-based tracking system can provide additional, less tangible but comprehensive benefits in communication, labor utilization, document- and resource management.

Based on the findings from the initial implementation results, future research will likely focus on enhancements of the signal detection algorithm, improved circuit design for even better performance, and on the scheduling algorithm for multi-dimensional communications for application on large construction sites. Based on the proposed tracking framework, different scenarios of applications will be considered for AR motion tracking systems, labor safety monitoring, construction materials and equipment tracking, and automated structural health monitoring.



More information: www.pm.umd.edu/e-construction

Centre for Pavement and Transportation Technology at the University of Waterloo

Dr. Carl T. Haas

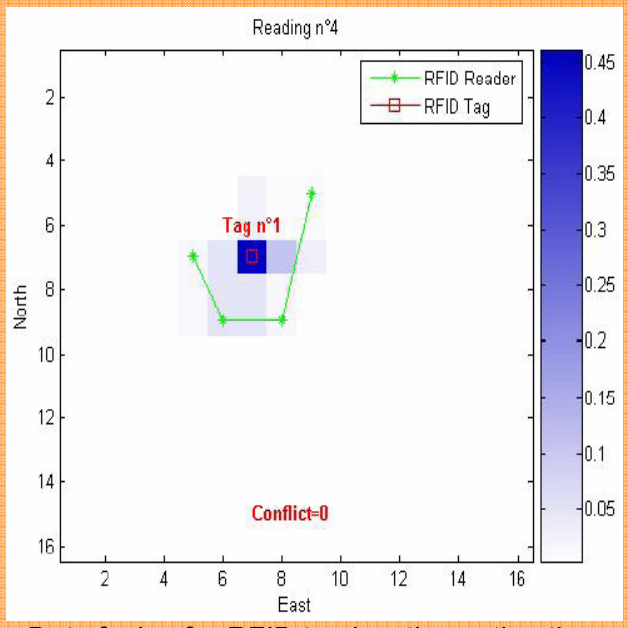
The activities at the Centre for Pavement and Transportation Technology (CPATT) and colleagues in Canada, the US, and France currently falls into roughly three research thrusts.

We work to make advances in construction project state estimating and real time 3D modeling via new sensing, data fusion and modeling methods. These tools will ultimately facilitate improved safety, effortless productivity tracking, real-time decision support, and advanced project knowledge management capabilities. In simple terms, they will help to get better information faster so constructors can make better decisions faster.

A second research thrust involves sustainability. Data indicates that planning for sustainability positively impacts infrastructure capital project performance. CPATT is also involved in a major study of long life sustainable pavements, for which I am contributing sensing network and life cycle economics knowledge. In a study of Remote Weather Information System (RWIS) sensor data we are determining when roads are vulnerable to damage or when conditions are dangerous for drivers. At our field test site here in Waterloo we are also studying "weigh-in-motion" technologies that will provide sensor data input to pavement design and life cycle models. Again, getting better information faster is allowing better decisions to be made. This will result in a more sustainable infrastructure.

A third research thrust involves the sustainability of the human capital that underpins our infrastructure systems. A critical skilled construction labour shortage exists in Canada and in the US. To respond, we are developing strategies such as multi-skilling, more complete human resource management systems, and optimization for return on investment in training.

Pipe spool locations using automated materials tracking



Data fusion for RFID tag location estimation using Dempster-Shafer theory

More information at:
http://www.civil.uwaterloo.ca/CPATT/

Real-time Automated Project Information and Decision Systems (RAPIDS) Laboratory

Dr. Jochen Teizer

Constructability, productivity, safety, budget and schedule planning and executing are critical tasks for construction managers. They often require fast and accurate decision making. Due to the complex nature of construction and transportation projects, in recent years, visualization, modeling, and simulation of construction and transportation infrastructure environments have increased the interest in sensing technologies to solve some of the problems. A research objective of the RAPIDS laboratory is to apply existing and emerging sensing technologies and to assist in their development. Similarly to rapids in the nature, "RAPIDS" quickly transforms the vast flow of "data" into a stable and useful flow of "information" at a controlled level. To tackle some of the existing problems in construction and transportation, research efforts focus on integrating these technologies in the decision process by first identifying and measuring data accurately, then processing the data to useful information, and finally to be able to provide and assist decision making with relevant information values.

Dr. Jochen Teizer heads the Real-time Automated Project Information and Decision Systems (RAPIDS) laboratory which is located in the School of Civil and Environmental Engineering at the Georgia Institute of Technology. The RAPIDS laboratory is supported by various funding sources, including the National Science Foundation (NSF), the Construction Industry Institute (CII), the National Cooperative Highway Research Program (NCHRP), the Georgia Department of Transportation (GDOT), industry sponsors, and others. RAPIDS develops and uses commercial as well as prototype sensing technologies to collect and process construction and transportation data. Presently, the research group concentrates on an inference management framework in the areas of real-time 4D site management and real-time active work zone safety. Current research topics in construction and transportation:

- Inference Management for a Connected and Intelligent Worksite
- Real-time Active Work Zone Safety and Security in Road and Heavy Construction
- Machine Positioning, Guidance, and Control in Real-time
- Real-time Optical and Wireless Sensing, Tracking, and Monitoring of Construction Resources (Workforce, Equipment, Material) to Increase Construction Performance and Productivity
- Technologies for Logistics in Construction

Technologies at RAPIDS include the latest computational hardware and software that enable real-time data processing, a high-definition 3D Laser Scanner and other laser sensors, active and passive radio frequency identification technology (RFID), near-infrared 3D video range cameras (Flash LADAR), Global Positioning System (GPS), Robotic Total Station, video cameras, and more.

Tracking Workers for Work Zone Safety

More information:
http://www.rapids.gatech.edu

R&D within the Swedish Construction Federation

Pär Åhman

The aim of the R&D activities within the Swedish Construction Federation is to manage R&D-issues and present the results in a way that both directly and indirectly will benefit its around 2800 members (contractors). The activities shall create conditions for in-service training and serve to enhance the reputation of the construction industry. The R&D activities shall also support other activities within the Federation.

The activities shall achieve results that the membership companies can realize in practical use. The activities are principally R&D-projects that has a broad support and a clear benefit to the trade. The results from the projects are forewarded to all members in the Federation by conferences, seminars, trade fairs, reports, boklets, newspaper- journal articles, web and so forth.

The Federation is supporting regional R&D-cooperation carried out by regional Committees, geografically covering the entire country. The work is carried out in collaboration with membership companies, universities, institutes, customers and other operaters within the trade.

At the moment priority areas are lean production, industrialization and passive houses/low-energy houses.

Here can be your article!

Please submit your contribution to the next IAARC Newsletter to teizer@gatech.edu.

Impressions from the past 2007 ISARC conference in Kochi, Kerala, India:

Dr. Koshi Varghese and his many helpers made the 2007 ISARC symposium to a great success

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