IfM | Distributed Information and Automation Laboratory

UNIVERSITY OF CAMBRIDGE

DIAL Quarterly October 2014: Visit to YH Global China, Developments in the Automation Lab, Updates from Conferences, Innovation in warehouses from Cambridge Auto-ID Lab and much more.

Meet DIAL's visitor:

Gokcen Yilmaz

Gokcen is a PhD candidate and a research assistant at the Middle East Technical University (METU) in Turkey. She joined the DIAL group as a visiting PhD student in October 2014. Gokcen completed her BSc degree in Industrial and Systems Engineering at Yeditepe University and her MSc degree in Information Systems at the METU in Turkey. She is a certified COSMIC software functional size measurer and completed her MSc studies on improving the reliability of software functional size measurements.

During her 10-month stay in DIAL, she will be working on two projects. The first one is the Information Futureproofing for Infrastructure,

Introduction from Professor Duncan McFarlane:

Welcome to the Autumn 2014 edition of the DIAL Newsletter

The role of the customer in the industrial supply chain is foremost in my mind today as I have just been chastised by my daughter for ordering a dress online which failed to arrive in time for the party she wanted it for! The domestic situation would be a lot easier if I had been able to expedite the delivery a few days ago. Over the last few months I have had the opportunity to present our work on *product intelligence* to industrial and academic audiences which just might give me that expediting opportunity in the future.

Product Intelligence refers to the process of appending a physical object - or often a collection of objects in an order - the ability a) to gather and store information about themselves and b) to influence the way the product is made or delivered while the process is taking place. One aspect of this work is now very strongly focussed on the business rationale for such an odd sounding development.

Our recent research work in logistics, in conjunction with local company James & James Fulfilment, has identified that the product intelligence model is an ideal way to encapsulate a

which is part of the Centre for Smart Infrastructure and Construction. As part of the project her responsibility is to develop an information futureproofing approach which can be used in the industry and easily turned into a software program.

The second one is the logistics project Itali, which is funded by YH Global China.

Philip Woodall at the INDIN 2014

Philip Woodall attended the International Conference on Industrial Informatics (INDIN), in Porto Alegre, Brazil, in August 2014. Philip presented a paper, resulting from DIAL's Boeing-Aladdin project, on how to reduce the time it takes to transfer industrial data from one system to another. This is a common problem in many industrial organisations as one information system rarely meets all the processing and reporting needs of various business units and users; therefore, data must be transferred between systems—mostly using the well-known technique of Extract, Transform and Load (ETL). The key problem for many industries is that because of the large volume of data, the data transfer can take in excess of 12 hours to complete and must therefore be done overnight or

customer's requirements and to allow the customer an automated involvement in, for example, the expediting of a delayed delivery, or the addition of items to a production order. Especially in today's booming e-commerce environments, the ability to offer the customer the possibility of intervening with her order seems to be very attractive.

Of course, such a development might play havoc with the logistic providers operations and further work is underway to understand how to develop warehouse management systems [WMSs] which are resilient and adaptive to such interventions. We have just launched a new programme with Chinese logistics provider YH Global which will examine some of these issues.

A further activity working this time with Boeing, Omron, Fanuc and DIAL start up RedBite in the manufacturing domain is allowing us to investigate how most effectively to develop and integrate intelligent product software into production control environments. If you would like to know more please contact me. Meanwhile enjoy the newsletter.

Developments in the Automation Lab

Over the last six months the DIAL Automation lab has gone through significant changes, customising it to meet the needs of the Boeing's DisTAL research project (Disruption Tolerant Automated Lean Factories). The research project has two key areas of investigation. Firstly, examining how enhanced information from process parameters, part inspection and tracking systems can be used to predict and better cater for production disruptions. Secondly, identifying limits that should be considered during the implementation of production leaning activities to ensure resilient operations are maintained in the face of ongoing disruptions. This is especially important when you are dealing with fast-changing composite-type products with variable stability characteristics.

Formech Vacuum Forming Machine

Domino printer used for printing QR codes

at weekends. If the process spills over into the working day, then users must wait for the data or risk using out-of-date data for their decisions. The approach to address this problem—which is likely to be able to address other issues as well as speeding up data transfer—is to identify only the data that is required for a decision, and to transfer only this data rather than data that is not needed.

Other papers presented at the INDIN conference, by academics from all over the globe, were from a variety of topic areas including: Wireless Communication in Industrial Automation, Recent Advances and Trends of Cyber-Physical Systems and Big Data Analytics in Industrial Informatics Systems, Factory Automation, Human-Machine interfaces, Real-time and Embedded Computing, Industrial Applications for Internet-of-Things Technology, Semantic Technologies for Knowledge-based Industrial Applications, and Mechatronics and Robotics.

Next year, on 22-24 July, INDIN will be held in Cambridge at Robinson College: http://www.anglia.ac.uk/ruskin/en/home/microsites/indin_2015.html

Innovation in Warehouses from the Cambridge Auto-ID Lab

To achieve this in the lab demonstrator, a small gear box assembly has been updated to include a waterproof cover that seals to a precise fit-on gasket. The water proof cover is made from HIPS plastic and is formed using a vacuum forming process.

The addition of this production capability to the lab is key, it provides a production process that can produce parts with dimensional variability depending on production process parameters. e.g. temperature, vacuum time, cooling times, material types and material thickness.

The tracking system within the lab has also been enhanced to provide part level tracking. A RedEdge tracking system from RedBite has been installed making use of both RFID and QR identifiers.

Handheld Scanner

QR provides a good, unique part marking solution that can be easily applied to products during the production process, with an additional benefit of being readable on many different types of devices. We are currently using handheld scanners for logistic processes and small dedicated QR readers that can be integrated directly into robot end effectors to enable robust assembly operations. We are currently exploring how aerospace part marking schemes can be encoded within QR identifiers.

QR Reader on the robot end effector

Essential to the tracking system is having a robust method for applying the QR codes to parts. This part marking capability is provided by a Domino inkjet printer. Parts marking is achieved on the fly. A robot passes the part in front of a print head at a constant speed and a unique QR code is printed directly on to

Vaggelis Giannikas, a Research Assistant in DIAL, was invited to talk about the latest research activities of the Cambridge Auto-ID Lab in the GS1 Global Standards Event in Rome. Vaggelis presented the group's work to industrial companies' representatives, solutions providers and GS1 members in the annual GS1 Transport & Logistics Workshop. In his talk, Vaggelis discussed DIAL's and Auto ID Lab's research on planning and management of warehouse operations covering:

a) adaptive solutions for the storage location assignment problem,

b) customer intervention and

c) the development of IT systems for logistics integration.

Nipat Rasmekomen presented at the IFAC 2014

IFAC 2014 (The 19th World Congress of the International Federation of Automatic Control) was held in Cape Town, South Africa from 24 to 29 August 2014. The conference is the biggest conference in the field of the Automatic Control in terms of number of works which are presented.

Nipat Rasmekomen, a PhD candidate from DIAL, attended the conference to present his

the part. Reusable assets used within the lab for transporting multiple parts such as conveyor trolleys and manual part transport trolleys are tracked using HF and UHF RFID tags.

Another big step forward for the lab is the introduction of part inspection. With plastic parts being produced with dimensional variability depending on process parameters, it is key to have a reliable and accurate method for inspecting parts. Two inspection stations have been developed using Omron 2D Laser Scanners.

Omron 2D laser scanner controller

Omron 2D laser scanner head

These inspection systems allow us to un-intrusively measure several key dimensions on the plastic formed parts, allowing the quality of the vacuum forming process to be determined. Inspection data is captured and recorded within the tracking system.

The gear box production is split across three cells with each cell having an Omron CJ2H PLC. The PLCs are networked together using industrial Ethernet and reconfigurable lower level production resources such as conveyor and assembly modules make use of Device Net.

In the future, the vacuum forming machine will be automated and will have the capability to track the process parameters, which will then be linked to each individual parts. Combining process parameters with inspection data will enable better understanding of the relationship between the process parameter and the part quality.

PLC from Omron

work under the supervision of Dr Ajith Parlikad. Nipat presented a paper titled "Condition-Based Maintenance Optimisation for Multi-Component Systems with Degradation Interactions" in a session on 'Promoting Sustainable Operations through Advanced Maintenance Engineering, Services and Technology'. This work represents a core part of Nipat's PhD research which focuses on how interactions between degradation processes of components in a multi-component system would affect its condition-based maintenance plan. An industrial case study was used in this study to demonstrate the benefits of modelling degradation interactions. Nipat presented how an improvement in condition-based maintenance of a cold-box unit system in a petrochemical plant can be achieved with modelling degradation interactions. Nipat's presentation in the conference along with the completed proceedings is available at http://www.ifac-papersonline.net/

Recent Research Publications:

J. Gao, R. Mead, A. Koronios, P. Woodall, and A. Parlikad, "Assessing Data Quality In Computerized Maintenance Management Systems; A Holistic Approach," in proceedings of the World Congress on Engineering Asset Management (WCEAM), 2014.

P. Woodall, A. Borek, J. Gao, M. Oberhofer, and A. Koronios, "An investigation of how data

This will also enhance the ability of the tracking system for root cause analysis and also for making effective operational decisions.

One of the main research aspects of the project is to examine the balance between lean and resilience of production systems. The lab will be equipped to have variable buffers between cells and different processes within the production system. These buffers will allow the lab to conduct various experiments in trying to find the optimum location of the buffer and the number of parts within each buffer so that the production operations are lean and at the same time resilient to disruptions.

Furthermore, the lab is currently exploring various tracking and control architectures, which will allow the lab to be flexible and reconfigurable for research and teaching purposes.

DIAL visits YH Global in China

DIAL has recently launched a new research project on Information Technology Architectures for Logistics Integration (ITALI) in collaboration with YH Global, a large, third-party logistics provider in China. The ITALI project will focus on the development of the next generation Information Technology (IT) systems capable of integrating different operations and value-added services of logistics providers. Moreover, within ITALI DIAL will research how different information systems architectures can support customised information reporting to several stakeholders within and outside the boundaries of a logistics organisation.

In October, Philip Woodall, Vaggelis Giannikas and Wenrong Lu from DIAL (see photo) visited YH Global's warehouses and headquarters in Suzhou and Shenzhen. During the visit, the team had the opportunity to observe and study logistics operations as well as identify factors that cause disruptions to these operations. In the company's headquarters, DIAL had discussions with the CEO to understand current needs and future developments of IT systems and the strategic vision of the company in the changing business landscape in China.

YH Global's office in Shenzhen. From left to right: Zhu Zhang (Project manager, YH Global), Philip Woodall (Senior Research Associate, DIAL), Wenrong Lu (Doctoral Researcher, DIAL) and Vaggelis Giannikas (Research Assistant, DIAL)

quality is affected by dataset size in the context of Big Data analytics," in Proceedings of the International Conference on Information Quality, 2014.

P. Woodall, T. Jess, M. Harrison, D. McFarlane, A. Shah, W. Krechel, and E. Nicks, "A Framework for Detecting Unnecessary Industrial Data in ETL Processes," in Proceedings of the International Conference on Industrial Informatics (INDIN), Porto Alegre, Brazil, 2014.

P. Woodall and M. Trzcinski, "Balancing Big Data with Data Quality in Industrial Decision-Making," in Proceedings of the International Data and Information Management Conference, Loughborough, 2014.

P. Woodall and A. Wainman, "Re-purposing Manufacturing Data: A Survey," in Proceedings of the International Data and Information Management Conference, Loughborough, 2014.

T. Jess, P. Woodall, and D. McFarlane, "A framework for identifying suitable cases for using market based approaches in industrial data acquisition," in Proceedings of the International Data and Information Management Conference, Loughborough, 2014.

Masood, T., McFarlane, D., Schooling, J. and Parlikad, A. (2014): The role of future proofing in the management of infrastructural assets, International Symposium for Next Generation Infrastructure, Vienna, 30 Sep - 1 Oct, 2014.

Farewell to Mark Harrison

After 12 years, Mark Harrison is leaving DIAL and the Cambridge Auto-ID Lab. He joined the group in May 2002 initially to develop some software for the Auto-ID demonstrator in the DIAL automation lab, as part of the Auto-ID Center project. The initial focus was on the web interface for placing customised orders in a holonic manufacturing system and for real-time data-driven visualisation of the location of shuttles and parts and work-in-progress, derived from RFID observations at various locations around the conveyor track. This led to his involvement in the Software Action Group within the Auto-ID Center and EPCglobal and contribution to the development of the GS1 EPC Information Services standard.

He contributed to the development of EPC Information Services (EPCIS) and has co-chaired work groups on Discovery Services and Event-Based Traceability, as well as participating in the GS1 EPCglobal Architecture Review Committee and GS1 Architecture Group.

Over the years he has been involved in a number of research projects in DIAL, including the EU BRIDGE project, Aerospace ID Technologies, Airport Operations, Drug Security Network and more recently the SAHNE and ALADDIN projects for Boeing.

More recently, Mark has become more involved with Linked Data technology and provides technical leadership in the GS1 Digital work group 'GTIN+ on the Web', which is developing a web vocabulary and technical recommendations and cookbook examples to help companies make use of Linked Data technology to make their information about products and services more readily available on the web in a machine-interpretable format that can be consumed by search engines and smartphone applications (apps). In connection with the GS1 Digital work on Linked Data, Mark is also participating in the W3C 'Data on the Web Best Practices' work group.

After leaving DIAL, Mark will spend five months travelling in New Zealand and Australia, enjoying some hiking and photography of landscapes and wildlife. When he returns to Cambridge at the end of April, he will continue his technical work with GS1, directly, as a part-time technical consultant. He is also planning to develop a number of ideas related to his travel photography interests. Mark would like to thank his colleagues, past and present, both within DIAL and across our industry partners, as well as our research visitors - many of you have also become good friends of his.

An extended version of this article is available here.

If you are interested in anything that has been featured in the newsletter or would like further information about DIAL, then please do not hesitate to contact us on dial-enquiries@eng.cam.ac.uk or call Petra Kasmanova on +44 (0) 1223 764306.