



Scientific Report

First name / Family name

CAI LUO

Nationality

CHINA

Name of the *Host Organisation*

VTT Technical Research Centre of
Finland

First Name / family name
of the *Scientific Coordinator*

JUHA ZIDBECK

Period of the fellowship

01/05/2012 to 30/04/2013



I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

Using my background in robotics pertaining to localization and navigation as well as robotic control, I give my support to the VTT's research team of Intelligent Networks, which is focusing on development of positioning methods as well as planning and modelling of radio networks performance. The work is mainly done in the framework of the EU Artemis project R3COP (Robust & Safe Mobile Co-operative Autonomous Systems) and the internally funded project ITSE (Intelligent telecommunication systems with enhanced cognitive processing).

I designed and implement modular software for support of quadrotor helicopter platform control via different network node interface. Explored the ways to improve reliable real-time messaging between network entities for more robust and cost-efficient control of the quadrotor helicopter in its application environment. Evaluated the interoperability and performance of overall integrated system components and respective work interface utilized in quadrotor helicopter control to support the collection of pose-specific image and sensor data for various positioning and navigation applications.

I also participate in technical project meetings in order to promote further collaboration and knowledge exchange.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. European Navigation Conference 2013, April 23-25, 2013 in Vienna, Austria. (Accepted)

Title: 3D Virtual Urban planning based on PTAMM

Main Author: Cai Luo and Juha Zidbeck

Abstract: This paper presents our latest achievement towards the target of providing support to architecture construction, inspection and renovation via a UAV-based mobile platform. The platform use augmented reality technology to add virtual computer-generated information to the surrounding real world. As UAV is a flying mobile system, the workers do not need move their position in order to inspect the constructions. In our system they only need to send the position they interested to the UAV then the UAV will fly to the place/places autonomously and shows the inspection results.

Reference:

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- [2] M. Fiala, ARTag, An Improved Marker System Based on ARToolkit. National Research Council Canada, Publication Number: NRC: 47419, 2004
- [3] G. A. Lee, G. J. Kim, and M. Billinghurst, "Immersive authoring: What You eXperience Is What You Get (WYXIWYG)," Commun. ACM, vol. 48, no. 7, pp. 76-81, 2005.
- [4] M.J. Wang, C.H. Tseng, and C. Y. Shen, An Easy to Use Augmented Reality



Authoring Tool for Use in Examination Purpose, IFIP Advances in Information and Communication Technology, Springer Boston, 2010

[5] H. Seichter, J. Looser, and M. Billingham, “ComposAR: An intuitive tool for authoring AR applications,” in Proceedings of the 7th IEEE/ACM International Symposium on Mixed and Augmented Reality, pp. 177-178, 2008.

[6] P. Grimm, M. Haller, V. Paelke, S. Reinhold, C. Reimann, and R. Zauner, “AMIRE - authoring mixed reality,” in Augmented Reality Toolkit, The First IEEE International Workshop, p. 2 pp., 2002.

[7] J. Zauner and M. Haller, “Authoring of Mixed Reality Applications Including Multi-Marker Calibration for Mobile Devices,” Proc. 10th Eurographics Symp. Virtual Environments (EGVE 2004), pp. 87-90, June 2004.

[8] Kostas Anagnostou, Panagiotis Vlamos, ‘square AR: using augmented reality for urban planning’, 3rd international conference on games and virtual world for serious application

[9] Robert Castle, Georg Klein, David W.Murray, ‘video-rate localization in multiple maps for wearable augmented reality’, 12th IEEE International Symposium on Wearable Computers, 2008

[10] Amir H.Behzadan, Vineet R.Kamat, ‘visualization of construction graphics in outdoor augmented reality’, proceedings of the 2005 winter simulation conference

[11] Kim Kirchbach, Christoph Runde, ‘augmented reality for construction control’, 16th international conference on information visualisation

[12] Kazuo Tanaka et al., ‘wireless vision-based stabilization of indoor microhelicopter’, IEEE/ASME transactions on mechatronics, vol.17, no.3, June 2012

[13] Markus Achtelik et al., ‘onboard IMU and monocular vision based control for MAVs in unknown in- and outdoor environments’, 2011 IEEE International Conference on Robotics and Automation (ICRA)

[14] Georg Klein, David Murray, ‘parallel tracking and mapping for small AR workspace’, 6th IEEE and ACM International Symposium on Mixed and Augmented Reality, 2007

[15] Randal W.Beard, ‘Quadrotor dynamic and control’, February 19, 2008

[16] Cai Luo et al., ‘Air-ground multi-agent robot team coordination’, Proceedings of the 2011 IEEE International Conference on Robotics and Automation May 9-13, 2011, Shanghai, China

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. Ubiquitous Positioning Indoor Navigation and Location Based Service
3-4 October 2012, Helsinki
2. European Navigation Conference 2013, April 23-25, 2013 in Vienna, Austria.



IV – RESEARCH EXCHANGE PROGRAMME (REP)

1. 17/Sep/2012 to 28/Sep/2012 ETH Zurich, Swiss
Autonomous Systems Lab (ASL), Prof. Roland Siegwart
Computer Vision Laboratory (CVL), Prof. Luc Van Gool

I got support from ASL on how to create robots and intelligent systems that are able to autonomously operate in complex and diverse environments.

And CVL give support on computer-based interpretation of 2D and 3D image data sets from conventional and non-conventional image sources.

2. 18/Feb/2013 to 24/Feb/2013 NTNU, Trondheim, Norway
ROBOTNOR robotics research centre, Prof. Kristin Y. Pettersen and Dr. Ingrid Schjølberg

I got the support from Robotnor on how to use the recent technologies to develop the next generation robotics technologies and concepts, promoting education and industrial innovation.