Project title
Implicit situation awareness of a wireless sensor network utilising channel quality estimations

Interaction with the supervisor
My supervisor at NII is Prof. Yusheng Ji. Professor Ji is organising weekly group meetings to which I regularly attend. Additionally, Professor Ji has greatly supported me in my search for an apartment in Tokyo and is anxious to help me in every respect. A Laptop computer, monitor, mouse and keyboard was ordered and available at my arrival in Tokyo.

Regarding the project, we have started a scientific discussion on the general focus of my studies and possible collaborations.

Visit of Japanese institutions
At January, 17th 2011 I have attended a talk of Dr. Jiannong Cao from Hong Kong Polytechnic University on 'Distributed Algorithms for Mobile Wireless Networks'. The talk was given at Tsukuba University.

Participation in workshops and seminars
I will organise the 2nd workshop on Context Systems Design and Evaluation (CoSDEO 2011) at February, 23rd 2011. The CoSDEO workshop will take place in conjunction with the fifth conference on Architecture for Computing Systems (ARCS 2011) in Como, Italy. At the workshop I will also present a paper titled 'Context awareness through the RF-channel'.

From March, 8th 2011 to March 11th 2011 I will participate in the 17th Conference on Communication in Distributed Systems (KIVS 2011) which will take place in Kiel, Germany. At the conference, I will present a paper titled 'An adaptive protocol for distributed beamforming'.

Publications and progress report
The research on the project 'Implicit situation awareness of a wireless sensor network utilising channel quality estimations' was officially started in December 2010. Preliminary studies were undertaken since about autumn 2010. The first work package in this project is focused on context classification based on channel measurements. In the project proposal it is proposed to utilise channel measurements as inputs to a graph based in-network context classification.

Currently, studies related to the utilisation of channel measurements for the classification of situations are conducted and a vector-based context representation is developed that enables arbitrary composition of subcomputations in a network of distributed nodes. Additionally, an unobtrusive mechanism to establish a secure channel among devices in an ad-hoc manner based on ambient audio is considered.
Situation awareness based on channel measurements

Studies on the general feasibility of classifying situations based on channel measurements have been conducted. In particular, with the help of software defined radios\footnote{http://www.ettus.com}, channel fluctuations could be visualised and analysed. The noise figure, the signal amplitude, the frequency and variance of amplitude changes over a fixed time window as well as the energy on predefined frequency bands have been considered as features for situation classification. With these features it was possible to detect ongoing phone calls, presence of individuals and movement in a room. Furthermore, estimations on the position of people in a room, the person count and also detect simple activities such as walking, sitting or standing could be made.

These results have been submitted to the following two events:


Vector-based representation of situation classifications

Complementary to this line of thought also alternative representations of situational context which are well suited in order to allow the aggregation of partial representations of context classifications in arbitrary order have been considered.

A vector based representation of context was proposed in which the rotation of a vector represents the current measurement value. Distinct types (e.g. light intensity, humidity, temperature) are represented by multiples of unique rotations of a vector. The rotations that represent distinct feature classes are required to be no multiple of each other and no multiple of a full rotation so that, after combining rotations of distinct vectors, the resulting rotation still uniquely represents a valid and unique representation of the combined measurements.

This representation already enables a distributed aggregation of measurements in a network. The order in which rotations are applied can be arbitrary and combination of only a subset of vectors represents a partial computation that can be combined with partial computation of other parts of the network. This approach was published in


Building on this development currently additional operations for combining vectors and the contained information are considered. For instance, the length of a vector could represent a confidence value on the (combined) measurement which would necessitate a more advanced operation for vector combination.

Establishing of ad-hoc secure communication channels based on context

Finally, a first study on the possibility to utilise context information in order to establish a secure channel among nodes in close proximity without the requirement of any additional input data was considered.

A first study on this method was submitted to Mobisys 2011 at December 11. 2010.

4. Dominik Schulmann, Stephan Sigg: Ad hoc secure mobile communication based on ambient audio, Ninth international conference on mobile systems, applications and services (MobiSys), 2001 (submitted 11.12.2010)
The possibility to secure the inter-node communication in a mostly unobtrusive way is not considered in the current proposal. However, in a network of nodes that rely on communication for the computation achieved, we consider it critical that an adversary node is prevented from witnessing the actual computation that is undertaken and to further prevent it from biasing the computation by inserting false data.

**Additional information and comments**

None.