Annex 3 – EMJD ICE III Cohort Research Projects

Project N° 1 - Multi-sensor Surveillance
Dynamic positioning of mobile sensors for scene understanding

The autonomous and active observation of wide areas is a challenging task, especially in highly dynamic environments. Mobile and pan-tilt-zoom cameras are still manned by personnel who need to observe large amounts of information in order to isolate situations that need special attention. Future sensors on mobile platforms such as mobile robots and unmanned aerial vehicles shall be able to automatically identify and appropriately place themselves to maximise coverage of important events and behaviours. For optimal-sensor placement, a system shall be aware of the environment in which the sensors are employed. In addition to the knowledge about the environment, individual sensors need to know about their location related to that of other sensors. This project will study and design multi-sensor control strategies that self-adjust and place themselves according to the context of the scene under surveillance; that detect changes in the parameters defining the area of interest and adjust according to these changes; and that select a subset of available sensors that is optimal for the task at hand (e.g. minimum number of sensors to be used while maintaining the maximum coverage of the scene).

Project N° 2 - Multi-sensor Surveillance
Multi-sensor data fusion and scene analysis

Large infrastructure sites such as rail stations, ports and airportsare monitored by an increasing number of sensors (e.g. cameras, RFIDs, Infrared). Due to the large amounts of data generated by these networks of sensors, efficient information filtering steps are required to detect important or unusual events. Instances that need further attention have to be identified to appropriately allocate the available resources to the task at hand when there is a limitation on the number of available sensors, on the locations at which these sensors can be placed and on other resources such as communication bandwidth, storage capacity as well as operator attention. The framework to be developed in this project will highlight context-dependent situations with the required priority to separate those that require immediate attention from those that require later scrutiny or are unimportant. The proposed research program will focus on the automatic detection and tracking of events across networks of heterogeneous sensors, potentially wirelessly connected. The analysis and fusion of the collected data shall allow - on the long term - to redesign the built environment to optimize its use by different categories of users**.**

Project N° 3 - Network Embedded Systems
Networking of Small Autonomous Aerial Robots

Small flying robots are used for many interesting applications, such as outdoor aerial imaging (e.g. for police and fire rescue) and indoor rescue operations. Such robots carry payloads - cameras and sensors - fly in the air, sense the environment, and communicate with ground stations and other robots. Current research addresses networks of multiple robots that communicate and coordinate themselves over the wireless channel in an autonomous manner.
This PhD project should investigate communication and networking aspects of networked UAVs, in particular protocols and connectivity-coverage issues. The project builds upon existing expertise at the University of Klagenfurt in this domain [1-3] and complements ongoing work of another ICE PhD student in Klagenfurt. Based on a comprehensive state-of-the-art analysis and identification of major problems, the goal is to evaluate solutions and implement them on real robots.
References
[1] M. Quaritsch, E. Stojanovski, C. Bettstetter, G. Friedrich, H. Hellwagner, B. Rinner, M. Hofbaur, M. Shah. Collaborative Microdrones: Applications and Research Challenges. In Proc. International Conference on Autonomic Computing and Communication Systems, Juli 2008.
[2] E. Yanmaz, C. Costanzo, C. Bettstetter, W. Elmenreich. A Discrete Stochastic Process for Coverage Analysis of Autonomous UAV Networks. In Proc. Intern. Workshop on Wireless Networking for Unmanned Aerial Vehicles, Miami, FL, USA, December 2010.
[3] E. Yanmaz, R. Kuschnig, C. Bettstetter. Channel Measurements over 802.11a-based UAV-to-Ground Links. In Proc. Intern. Workshop on Wireless Networking for Unmanned Autonomous Vehicles, Houston, TX, USA, December 2011.

Project N° 4 - Network Embedded Systems
Positioning and Navigation of Small Autonomous Aerial Robots

Small flying robots are used for many interesting applications in outdoor and indoor environments. Such robots carry payloads - cameras and sensors - fly in the air, sense the environment, and communicate with ground stations and other robots. Current research addresses networks of multiple robots that communicate and coordinate themselves over the wireless channel in an autonomous manner.
This PhD project should investigate positioning and navigation aspects within groups of networked UAVs. The goal of this research is to improve the derived position information of the individual robots in real time by fusing data of on-board sensors (GPS, IMU etc.) and position data of remote robots. The accurate position data enables improved navigation methods for the networked robots. The project builds upon existing expertise at the University of Klagenfurt in this domain and complements ongoing work of another ICE PhD student in Klagenfurt. Based on a comprehensive state-of-the-art analysis and identification of major problems, the goal is to evaluate solutions and implement them on real robots.

Project N° 5 - Assistive Technologies
User independent movement disorders detection

Parkinson's disease is a neurological disease which provokes movement disorders able to be sensed through inertial sensors. The PhD will continue a previous thesis were different symptoms, like On-off periods, falls, dyskinesia, tremor and gait parameters, are detected through preliminary algorithms. Those algorithms are usually user-dependent and must be adapted to each patient. The work of the PhD will consist of understanding Parkinson's disease symptoms, the way algorithms detect them and propose, develop and test machine learning methods to convert them into user-independent symptoms-detection algorithms.
In order to develop the PhD project, it will be available a database of ambulatory movement of 90 Parkinson's patients with the record of the signals provided by two inertial sensors (waist and wrist) for seven movement parameters previously defined, and the correct labelling process of each movement by comparison with golden standards. The database will be constructed under an FP7 European project named REMPARK (Personal Health Device for the Remote and Autonomous Management of Parkinson's Disease. 2011-2014).

Project N° 7 - People Inspired Technologies
Supporting social networking and serious gaming for mobility

Social networks and serious games are becoming of ever increasing importance as new key communication, entertainment and education tools.
The objective of this PhD project is to develop a social mobility platform, which is quite different than simply producing data/games for Facebook, Twitter, Google+ or LinkedIn. The platform will rely on ad-hoc modules for messaging, tagging, community building, ad-hocmobility gamification, ad-hoc Human-Machine Interaction in order not to overload the cognitive functions of the user. This does not mean developing another Facebook, but providing a new enabling platform for a specific context (mobility), with a critical mass of users, with a great potential for entertainment, learning/coaching and community building.
The project will be performed in the context of European industrial research project collaborations.

Project N° 8 - People Inspired Technologies
Multi-Sensor Signal Processing Algorithm for Context-Aware Smartphone Services

Combining the functions of mobile phones and PDAs, smartphones can be considered versatile devices and offer a wide range of possible uses. The technological evolution of smartphones, combined with their increasing diffusion, gives mobile network providers the opportunity to come up with more advanced and innovative services. Among these are the context-aware ones, highly customizable services tailored to the user's preferences and needs and relying on the real-time knowledge of the smartphone's surroundings, without requiring complex configuration on the user's part. Examples of context-aware services

are profile changes as a result of context changes, proximity-based advertising or media content tagging, etc.
During the project activity, several methods to extract context information, by employing a smartphone, based on Digital Signal Processing and Pattern Recognition approaches, will be studied, developed and the related performance will be investigated. The nature of the considered signals is "multi-sensor". In facts, the studied algorithmic solutions will depend on the numerous sensors available on-board the smartphones: audio, video, inertial, and radio signals.
The final aim of the activity is to answer to the following questions about the smartphone user's surroundings: What, Who, Where, When, Why and How. It represents a fundamental part of the overall process needed to provide a complete context-aware service whose employment may find applications in several fields such as e-health, surveillance and security, commercial advertisement, and forensics.

Project N° 9 - Design for Social Interaction
Multi-user Interaction in Experiential Landscape Design

Experiential Design Landscapes (EDL's) are test-beds for the design of interactive and cognitive environments (ICE) with multiple-user-centric perspective by integrating multi-modal pervasive and interactive technologies. An EDL takes the physical form of an environment where rich interaction takes place between the intelligent systems and the users. In such an EDL the emerging interaction of systems and users can be thoroughly observed to provide new type of services. Such an EDL could be an open lab for the design and experiment: e.g. the GLOW festival, smart city district, business fairs, etc.
This PhD project will be working on collecting multi-user information from multiple cameras in such EDL's, providing input for, and also contributing to, experiential landscape designs. These designs will not only be the means to meet a users' demand but also be used as experimental ICE's to understand the behavior of the users and to enable new behavior in the interaction.

Project N° 10 - Design for Social Interaction
Collective Satisfaction Modeling and Monitoring

Cameras are nowadays virtually pervasive and can be used for collecting information about collective satisfaction levels in offices, shops, stations, streets and other public spaces. On a larger scale videos from a virtual space or a social network can be analyzed in a similar manner. The results, possibly in combination with input from other sensors and user input, can provide valuable collective satisfaction information about jobs, products, systems and services, for adapting and improving the structure, the management, and the behavior.
The PhD project will use the department of Industrial Design at TU/e (TU/e-ID) as the experimental environment. TU/e-ID is practicing a competency-based and self-directed education model, in which the students are responsible for their own development whereas the researchers and teachers provide the support instead of traditional curriculum based teaching. Many activities are organized and conducted bottom-up instead of top-down. The environment is much more dynamic than the ones with a fixed curriculum. The analysis of the collective satisfaction with the changes and the dynamics in the system is expected to gain insights and provide feedback for adaptation with a shorter term and even real time adaptation.