TOPIC: <STINT - South Korea>
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Introduction

This memo is intended to provide an overview of activities at the Artificial Intelligence and Integrated Computer Systems Division (AIICS) at the Department of Computer and Information Science (IDA), Linköping University (LiU), Sweden and to propose a number of avenues for concrete collaboration under the STINT-KOSEF Project.

Unfortunately, I was unable to make it to the initial meeting in Sweden, although my student Mariusz Wzorek was present at that meeting.

Let me first focus on the research venues that would be involved in cooperation, at least in the initial stages of any collaboration. LiU is one of the leading universities in Sweden and has the largest computer science institute (IDA) in Sweden. IDA is one of the leading Computer Science Departments in Europe. Within IDA, there are five divisions, one of which is AIICS, which I lead. There is of course much more to say about LiU and IDA, but the focus here will be on AIICS and its activities.

The Artificial Intelligence and Integrated Computer Systems Division (AIICS) has circa 34 members. The main focus of interest for the AIICS division is artificial intelligence and its application to intelligent artifacts. Intelligent artifacts are defined as man-made physical systems containing computational equipment and software that provide them with capabilities for receiving and comprehending sensory data, for reasoning, and for rational action in their environment. Examples of such artifacts range from PDAs and software agents to ground and aerial mobile robots.

Some of the primary areas where we have great competence and international reputations are:

- Hybrid System Architectures - These are complex distributed software architectures which include both hard/soft real-time processes and combinations of control, reactive and deliberative capabilities which must operate seamlessly and robustly. They are often used on complex robotic systems, but much of the work here can equally be applied to the development of software agents or softbots which operate pro-actively on the WWW. A very sophisticated CORBA-based software architecture has been developed in our group and is deployed on both ground and aerial robotic systems.

- Automated Planning Techniques - We have developed both task-based planners and motion planners for robotics systems and as stand-alone planners for other applications. TALplanner is a temporal logic based award winning planner and is currently one of the fastest Task planners in existence. It won the ICAPS 2000 automated planning competition. We have also developed a number of different motion planners for aerial robotic systems based on Probabilistic Roadmap and Rapidly Evolving Random Tree techniques. These planners are reconfigurable in real-time and are deployed on our robotic systems. They may also be used for agents in computer games and other non-robotic applications. We are also developing a number of other planners and techniques. Internationally, we are one of the leading groups in this area.

- Knowledge Representation - This group has worked with knowledge representation techniques for

several decades and is also one of the leading internationally in this area. I have been program and conference chair for KR 2006/2008, respectively, which is the most prestigious KR conference around. Our interest in Knowledge representation focuses on formal KR where logic is the main representation tool. We have developed a number of temporal action logics for reasoning about dynamic behavior and specifying software and robotic agent behaviors. TAL (Temporal Action Logic), developed by us, will have its own chapter in a new KR handbook to be published in 2007.

We have are also leading internationally in work which attempts to combine traditional knowledge representation techniques with rough/fuzzy techniques. We have recently published a new book in this area. One of our activities has been the development of rough relational database technologies. This is essentially a generalization of deductive database technology where standard crisp relations are generalized to rough relations. We are also experts in the area of non-monotonic reasoning in all its forms.

- Robotics (UAVs) – We have been involved in the development of autonomous unmanned aerial vehicle systems since 1997. We use Yamaha RMAXs as our research platforms and have developed a fully deployed autonomous aerial vehicle capable of executing highly complex push-button missions in the areas of surveillance, emergency services assistance, vehicle tracking, photogrammetry, etc. The system uses the hybrid architecture mentioned above and many of the planning technologies also. We are internationally leading in this area also with contacts in the USA with leading groups such as Georgia Tech and NASA. We also develop our own hardware, for instance, a flight control board about the size of a credit card and weighing 16-33 grams. We have developed a micro-UAV under 500 grams that recently won an international competition in the fall of 2005. We are currently doing some work with image processing for UAVs and have recently integrated a stereo camera and infrared camera. So, there is much work with sensors and sensor fusion too.

  We are moving heavily into the area of cooperative robotics. In particular, large-scale network centric systems where both aerial and ground robots are involved in additional to mixed-initiative and multi-modal operator interfaces to interact with such systems.

The above topics are intended to provide a feel for what our group does in terms of research and where it is ranked internationally. Of course, we do much more and if one widens the perspective to activities at IDA and to our collaborations with the mechanical engineering and electrical engineering departments at LiU, it is safe to say that this is one of the most interesting and dynamic research environments in all of Europe.

The researchers involved in AIICS have diverse competences and work closely together. We have aeronautical engineers, signal processing engineers, mechanical engineers, computer scientists, part time employees from Saab aerosystems, and software engineers. You may find out more about this group and our projects at the following site: `http://www.ida.liu.se/~patdo/aiicssite1/index.html`

Let me mention two more collaborations AIICS is involved in which should be of some interest to KOSEF:

- LINKLAB – Linklab is an excellence center for Future Aviation Systems established in December 2004. It is a collaborative endeavor between LiU and Saab Aerosystems. The idea is to do research and develop key technologies in the area of UAVs. This involves control theory, software systems, artificial intelligence, etc. The intention is to promote the area and to create a research environment beneficial to both Saab and LiU in this area. Other companies and institutes can get involved in this center in the future. I am one of the two program directors for this center. You may read about this center at the following site: `http://www.linklab.se/`

- MOVIII – This is a new research center for Decision Support in Complex Systems with a focus on modelling, visualization and information integration. Five internationally renowned professors are

involved in this new center, myself included. It will be in place for at least 6 years and we are open to collaboration and exchange of students and senior researchers. You may read about this center at the following site: `http://www.moviii.liu.se/`

After this short introduction, I'll now comment on the 4 points you requested to be covered in the short white paper.

Identification of topics for possible research collaboration or joint research

Both AIICS, LINKLAB and MOVIII together offer a number of possibilities for research collaboration. The topics mentioned above are certainly at the top of the list for collaboration or joint research. One point that should be emphasized is the fact that many of our research endeavors are demonstration driven. By this we mean that we try to the extent possible to bring basic research results into the applied arena by actually integrating and deploying technologies on our UAV and robotic systems. Because these are CORBA-based, this eases the possibility for collaboration since technologies developed elsewhere can be easily wrapped and integrated in our existing systems. We also have a very rich hardware in-the-loop environment for other types of hands on experimentation.

We are open to student and senior research exchange in the above areas and possibly other areas.

Exchange of students, postdocs, and professors

As stated in the previous section, we are certainly open for this activity and encourage it. Of course, the proper economic incentives have to be provided for this to work. We have a research agenda in the area of Autonomous UAV systems and related technologies that is rich in opportunity. Integration with our group would also be relatively straightforward since we are use to multi-disciplinary activity and have had experience with Saab visitors in this respect.

We are open to exchange of students, postdocs, and professors. Our preference is for postdocs and professors, but if coupled with them, students would also work.

Identification of methods for collaboration in teaching/training

In any engineering curriculum, it is essential that students get hands on experience with real systems. It is not often the case that one has access to such systems. In our case, we have a portfolio of complex robotic systems and simulation environments. It would certainly be interesting to investigate how to provide student access to such systems in the educational development.

Currently, the courses we teach are in the areas of programming languages, knowledge representation, artificial intelligence, and robotics. We will be developing a new masters program in intelligent autonomous systems and there are opportunities here for experimentation in novel forms of education.

It is feasible to collaborate in this area. We do have the possibility of teaching compressed courses in AI, logic,

KR, and other areas in a South Korean venue. We would be open to the same here at LiU at the doctoral level in one of our graduate schools in theoretical computer science (CUGS). This can be arranged within a 6 month planning horizon.

Organization of joint events such as international competitions, seminars/workshops, symposiums, etc.

This is also an area where collaboration might be interesting. We have of course entered (and won) several international competitions and have experience with these. Recently, we just concluded the 1st LINKLAB forum in which Saab and university employees were invited to a two day forum. We had guests from NASA and Georgia Tech, USA. We intend to do this each year and are open for cooperation here. MOVII has as a goal one workshop per year in their area of interest. Again, we are open for collaboration and guest speakers here.

In general, if the topic areas are of mutual interest, we are open to cooperating in establishing joint events across the board either here in Sweden or in South Korea.

Conclusions

Since I was unable to attend the first KOSEF meeting, I am not sure how aware you are of the activities mentioned above and whether there is a great deal of intersection relative to your activities. I do hope this summary and my view of cooperation in the four areas you propose is of constructive use to you. I would be happy to provide additional details at our meeting in november.

Bottom line is, we are quite positive to collaboration across the board provided the intellectual and economic incentives are in place and the collaboration is mutually beneficial to both parts.