

Evaluation of EIS: Embedded and Intelligent Systems Research Environment at Högskolan in Halmstad

This document represents the final report for the evaluation of the Embedded and Intelligent Systems research environment at Högskolan in Halmstad (HH) that was formed during the summer of 2008 out of four research groups at HH. The report provides the answers of the evaluation panel to the following three key questions:

- A. The Quality of the Research
- B. The Direction and Profile of the Research
- C. The Doctoral Program

The report is partly based on written material covering:

- A report on the formation of EIS
- Key figures on research production, economy and research education
- Detailed account of Research Education
- Detailed account of Master Education
- Concentrated CVs for all personnel at EIS with PhD.

In addition – and most importantly – the report is based on three days of evaluation (November 24-26, 2008) during which the evaluation panel was given extensive presentations on the EIS research environment and research education based on meetings and interviews with a large and representative collection of researchers, administrative personnel as well as students at all levels of the organization. These included:

- Overview presentation of EIS
- Presentation of a number of Application areas
- Meeting with the University Leadership
- Meeting with EIS Professors
- Meeting with EIS Lektors
- Meeting with EIS Post-Docs
- Presentation of Doctoral Education at EIS
- Meeting with EIS PhD Students (pre- and post licentiat)
- Meeting with External Partners
- Meeting with Former PhD Students
- Meeting with Representatives for Study Boards

Extensive minutes of the discussions taking place at the above presentations and meetings have been made and are available as an Appendix to this Report.

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A.

The quality of the research

Comments on the research quality within intelligent embedded systems HH versus other similar research in an international and national perspective. Identification of particular parts found to very strong. Strengths and weaknesses.

Overall we find that the research conducted by the groups in EIS is very good. The research has such high quality that it attracts national attention and performs at an international level.

Certain subgroups perform at excellent level. The research is of excellent quality, with publications normally having great impact, also internationally. Without doubt, the research has a leading position in its field in Sweden. Also, certain other subgroups have the potential to become excellent.

Furthermore the long-standing collaboration with industry demonstrated by most of the research within EIS should serve as an excellent platform for future, high quality research and publications.

Below follows our comments on some of the research leaders based on the presented material, presentations and interviews:

We find that excellent research quality is performed by the subgroups Signal Analysis and in Real-time Systems (Wireless Communication). This is witnessed by their extensive services to the international research community.

We further find that the research on Artificial Neural Networks has a similar high level of quality within his special area.

We recognize the collective and committed effort in the creation of EIS as a combination of several existing strong research laboratories and groups.

Among the group of lektors we find significant contributions to the research and research management in the areas "Healthcare Technology" and "Software Engineering". Also this group play a major role in the current coverage of Computer Science, and with notable responsibility for the management of the research education.

The group of Post-docs constitutes a strong group of researchers with high potential. For both Lektors and Post-docs there must be a clear strategy for future careers.

B.

The direction and profile of the research

Opinions on the research profile of EIS, the directions taken in research, the mix of applied and basic research, and the choice of partners. Opportunities and possible threats?

We find that the research competences within EIS cover nearly all essential aspects of intelligent embedded systems. This includes core competences in hardware and execution platforms, sensor, networks and communication, hard real-time, control theory, signal processing, machine learning as well as supporting competences within biometry, nano-technology, sensor networks.

Also the research competences have significant impact on a number of applications in important areas such as health, radar- and telecommunication systems, identification, guidance and tracking, paper and print, intelligent vehicles and transport systems. In fact, a particular strength is the excellent and extensive collaboration with local and national industry within embedded and intelligent systems. We highly recommend that this strong interaction with industry is maintained as well as capitalized in future national and European projects.

We find that this rather new formation of EIS has a very high potential provided the cooperation between the different competences can be fully exploited and completed with proposed, additional competences from and chairs in Computer Science, including high-level programming languages, compiler technology and software engineering.

We find that it is important that the core competences within EIS are supported by competences in mathematics. However, the material and presentations only cover marginally the role of mathematics, and we can therefore not evaluate this aspect.

We find that the research conducted within the different applications areas serves as focal points for research among groups and provides an excellent platform for future high quality research:

- *Intelligent Vehicles and Transport Systems.* This area exhibits an excellent combination of basic research and applications and with high national and international impact.
- *Sensor Networks.* *The activities on wireless sensor networks provide challenging applications of the EIS competences on real-time communication. The activities within nano-technology seem currently less connected.*
- *Biometry and Signal Analysis.* The research conducted within this area has high international visibility and impact despite the relatively small size of the group.
- *Health Technology.* The direction on adaptable prostheses/orthoses and power assisted techniques provides a high quality focussed research activity with connections to Mechatronics. The direction on safe and secure home

environments with focus on health-care and elderly is of strategic importance. The research conducted has extensive regional impact and good international connections.

- *Radar and Telecommunication.* Within this area important work is done on developing computational models and programming languages suited for parallel and distributed architectures (DSP, FPGA). As well as being a core CS area, the trend towards multi-core and network-on-chips everywhere makes this research highly strategic.
- *Paper and Print.* This research has very significant impact on the extensive number of regional and national companies within the paper and printing sector, and has generated excellent research.

C.

The doctoral program

EIS as a future (and present) environment for doctoral education. Has it worked well in the past? Are the competences coherent but still sufficiently broad to provide a creative, inspiring and high research quality environment for doctoral students in this field? Should we offer a more narrow set of subjects or a wider? Does it have attraction (if not, why)? What advice can you give to us in our work towards achieving the right to offer a doctoral program in our particular areas of strength?

The strength of the current doctoral program is based on an extensively developed network with several other institutions (Örebro, Chalmers, Lund) resulting in high quality programs for the individual PhD students.

- *Courses.* The majority of the graduate/PhD-level courses are given at HH. These are complemented by courses at the partner institutions. There is also a willingness to seek, and use courses given within international PhD schools.
- *Supervision.* The supervision provided by HH is highly appreciated as witnessed by current and former doctoral students. The co-supervision provided by the partner institutions generally seems to be more formal and only plays a role during the annual meetings within the PhD committees.
- *Infrastructure.* There is a good research culture developed within EIS. Both PhD students and senior researchers meet in joint weekly seminars. The cooperation between members from different groups within EIS provides critical mass that benefits the research and gives the doctoral students opportunities to discuss their work with different senior members of the institute.
- *Financing.* So far, the EIS has shown an excellent track record in gaining (co-) financing for their research students.
- *Applicability of topics.* The topic of intelligent embedded systems provides an internationally established research area with high potential for research education, several open and challenging problems, as well as obvious industrial applications.

Overall, we find that the implementation of the PhD education and environment is excellent.

Provided the existing network and collaboration with other Swedish Universities is maintained, and that the planned completion of the competence in Computer Science is fulfilled, we support without hesitation that HH is granted the privileges to examine PhD-students and grant PhD-degrees within the area of intelligent embedded systems.