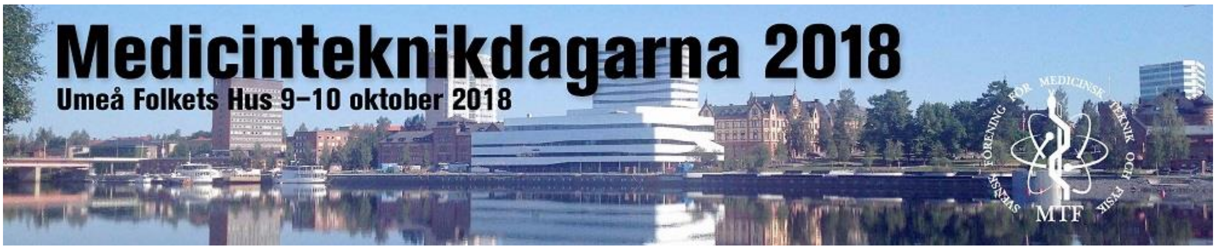


VÅRD PÅ DISTANS

Tisdag 9 oktober 11.20 – 12.20

Abstract: 81

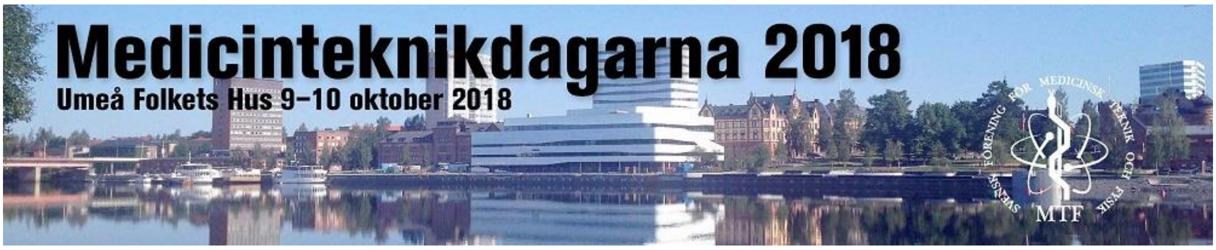
Inbyggda Sensorsystem för hälsa - teknik som stödjer trendmonitorering i hemmet

**M. Lindén*1, M. Björkman2; 1Mälardalens högsko.a, Inbyggda Sensorsystem för hälsa, Västerås, 2Mälardalen University, Division of Networked and Embedded Systems, Västerås*

Inbyggda Sensor System för hälsa (Embedded Sensor Systems for Health, ESS-H) är en forskningsprofil vid Mälardalens högskola som startade 2013. Inom ESS-H samverkar forskare inom inbyggda system med såväl offentlig som privat sektor med syftet att ta fram nya sensorsystem som bland annat ska möjliggöra sensormonitorering i hemmet för att följa hälsotrender, hälsomonitorering på arbetsplatsen och säker och integritetsskyddad kommunikation och infrastruktur för fysiologisk datahantering inom dessa områden.

Ett av de övergripande målen för hälsomonitorering i hemmet är att kunna följa hälsotrender i hemmet och på så sätt tidigt kunna identifiera en hälsoförsämring. Sensorsystem, signalbehandling och beslutsstödsalgoritmer för utvalda användarexempel har utvecklats. Exempel utgörs av Intelligent hjärtljudsövervakning, Realtidsmonitorering av arbetsminnet med EEG, Kontinuerlig övervakning av KOL-patienter, Mikrovågsteknik för att monitorera bröst- och hjärninhomogeniteter, Trådlös monitorering och automatisk falldetektion, Teknik för att uppmuntra till fysisk aktivitet, Signalbehandling av inbyggda rörelseanalyssytem, samt Yt-EMG signalbehandling för avkodning av handrörelse.

Inom området sensorsystem för hälsa på arbetsplatsen har system för Analys av andningsalkohol i fordon, Detektion av människor med Ultra Wide Band radar och Trådlös bärbart mätsystem för pedobarografi utvecklats. Säker och integritetsskyddad infrastruktur är viktig vid utvecklingen av inbyggda sensorsystem. Även mjukvaran i det inbyggda systemet måste vara säker och patientdata som skickas och tas emot måste vara integritetsskyddad.



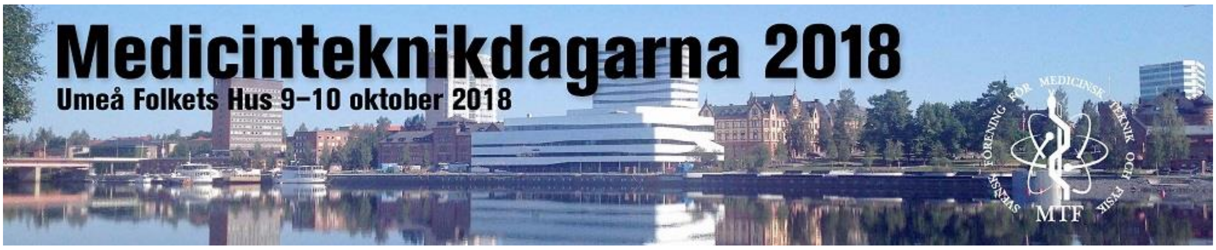
Abstract: 53

IPv6 connectivity in eHealth IoT networks

*H. Fotouhi*1, M. Vahabi1, I. Tomasic2, N. Petrovic2, M. Björkman1, M. Lindén2; 1Mälardalen University, Division of Networked and Embedded Systems, Västerås, 2Mälardalen Univeristy, IFT, Västerås*

The Internet of Things (IoT) is exponentially growing by interconnecting billions of smart objects. Internet Protocol version 6 (IPv6) is scaling up the Internet to huge number of addresses globally reachable [1]. Low-power wireless devices are the key enablers of IoT networks by providing wireless connectivity through cheap and low-power radio technologies [2]. Running IPv6 for low-power wireless networks is challenging as it imposes large overhead with header size of 40 bytes. We are focusing on designing and evaluating algorithms of IPv6 connectivity for IoT networks, such as IEEE 802.15.4 and Bluetooth low energy (BLE) [3]. The IEEE 802.15.4 is a reference standard for home and industries, while BLE standard is widely used by various vendors, especially for medical devices. It is common to employ both environmental sensors equipped with 802.15.4 radio and medical sensors equipped with BLE or Bluetooth classic radio for remote health monitoring. Combining various types of sensors can result in a more accurate diagnosis. BLE employs frequency hopping over 37 channels for communication and 3 channels for advertising with a bitrate of 1 Mbps and 27 bytes packet size. BLE forms a star network with a master node communicating with several slaves. 802.15.4 features a total of 27 non-overlapping channels with 16 channels in 2.4 GHz, while supporting 250 kbps bitrate with maximum packet size of 127 bytes. It is important to consider two main implementations of 6LoWPAN (IPv6 over low-power personal area networks) [4] and 6LoBTLE (IPv6 over Bluetooth low energy) [5] that are the key enablers of supporting IPv6 traffic in IoT networks. These adaptation layers provide a compressed IPv6 addressing by shortening the IPv6 header. In our study, we are considering the IPv6 protocol stacks implemented for BLE and 802.15.4. There are various algorithms and protocols from the physical layer to the application layer that support IPv6 for data communication. These protocols are namely RPL as a routing protocol for low-power and lossy networks and CoAP as a constrained application protocol. We are also aiming to investigate network connectivity in heterogeneous networks, consisting of BLE, 802.15.4 and WiFi. This involves extensive radio survey on various channels while running IPv6 protocols for connectivity purposes.

References: *[1] Gubbi, Jayavardhana, Rajkumar Buyya, Slaven Marusic, and Marimuthu Palaniswami. "Internet of Things (IoT): A vision, architectural elements, and future directions." Future generation computer systems 29, no. 7 (2013): 1645-1660. [2] Kovatsch, Matthias, Simon Duquennoy, and Adam Dunkels. "A low-power CoAP for Contiki." In Mobile Adhoc and Sensor Systems (MASS), 2011 IEEE 8th International Conference on, pp. 855-860. IEEE, 2011. [3] Narendra, PrithviRaj, Simon Duquennoy, and Thiemo Voigt. "BLE and IEEE 802.15. 4 in the IoT: Evaluation and Interoperability Considerations." In International Internet of Things Summit, pp. 427-438. Springer, Cham, 2015. [4] Mulligan, Geoff. "The 6LoWPAN architecture." In Proceedings of the 4th workshop on Embedded networked sensors, pp. 78-82. ACM, 2007. [5] Decuir, Joseph. "Bluetooth Smart Support for 6LoBTLE: Applications and connection questions." IEEE Consumer Electronics Magazine 4, no. 2 (2015): 67-70.*



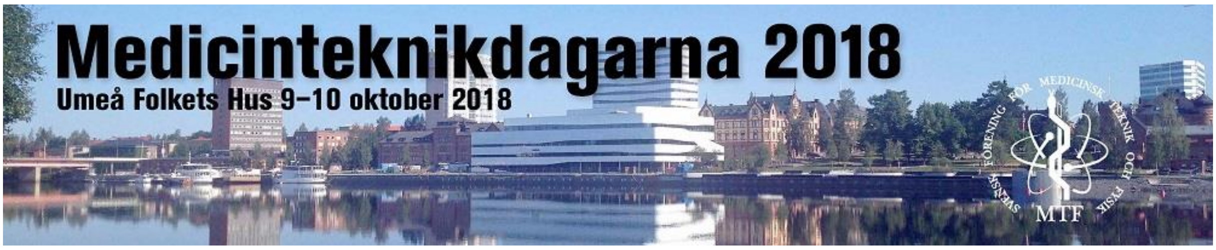
Abstract: 38

IoT enabled monitoring of patients' environmental parameters supported by OpenWSN, OpenMote, and relational databases

**I. Tomasic*1, N. Petrovic1, H. Fotouhi2, M. Björkman2, M. Lindén3; 1Mälardalen Univeristy, IFT, Västerås, 2Mälardalen University, Division of Networked and Embedded Systems, Västerås, 3Mälardalens högskola, Inbyggda Sensorsystem för hälsa, Västerås*

Remote health monitoring (RHM) has a potential to provide better care and reduce healthcare costs. The RHM should be continuous, real-time, enabling decision support and prediction, and improve quality of life through smart environments, controlled medication and wellbeing services [1]. The Internet of things (IoT) combined with Cloud and Fog, is one of the key technologies enabling RHM. Recently in the IoT world, the IEEE 802.15.4e standard has been proposed as a MAC amendment to the existing IEEE 802.15.4-2011 standard. The specific mode in this standard, called Time Synchronized Channel Hopping (TSCH), significantly increases robustness against external interference and multipath fading. TSCH is particularly efficient in providing ultra-low-power operation. Defining IPv6 over the TSCH mode of IEEE 802.15.4e (6TiSCH) is a key to enable further adoption of IPv6 in both industrial and healthcare IoT domains [2]. The OpenWSN is a recently released open-source implementation of a fully standard-based protocol stack for IoT capillary networks, rooted in the TSCH standard. The OpenMote device is a representative of new generation open-hardware platforms [3]. The OpenMote-CC2538 is based on TI CC2538 SoC functionalities, thus combining the 32-bit ARM Cortex-M3 MCU with the IEEE 802.15.4 transceiver. OpenMote has 4 sensors (temperature, humidity, light, accelerometer). It can be battery powered. The OpenMote indoor transmission range is around 50 m, and in outdoor environments is around 200 m. In our previous work we have proposed a RHM system architecture [4]. Here we focus on the usage of an IoT platform based on OpenMote hardware devices and OpenWSN operating system, for the RHM system. In our RHM system the OpenMotes running OpenWSN sends the data to a Relational Database Management System (RDBMS). The RHM system was developed for the needs of ESS-H research profile [5] at Mälardalen University, Sweden. The system has a data acquisition layer (C#.NET or a LabVIEW program) as well as the web service that prepares the data for a web interface. The web service and a web interface are both written in PHP and are running on the Apache HTTP Server. The end-user is able to observe either real-time data (i.e. with insignificant delay) or processed historical data on any web browser. The advantage of using the web interface instead of a desktop application is that it makes the presentation layer easily accessible and platform independent.

References: *[1] I. Tomasic, N. Tomasic, R. Trobec, M. Krpan, and T. Kelava, "Continuous remote monitoring of COPD patients---justification and explanation of the requirements and a survey of the available technologies," Med. Biol. Eng. Comput., Mar. 2018. [2] IETF Datatracker, "IPv6 over the TSCH mode of IEEE 802.15.4e (6tisch)." [Online]. Available: https://datatracker.ietf.org/wg/6tisch/documents/. [3] "OpenMote platform." [Online]. Available: http://www.openmote.com/. [4] G. Gardašević, H. Fotouhi, I. Tomasic, M. Vahabi, M. Björkman, and M. Lindén, A Heterogeneous IoT-Based Architecture for Remote Monitoring of Physiological and Environmental Parameters, vol. 225. 2018. [5] M. Lindén and M. Björkman, "Center for Embedded Sensor Systems for Health - ESS-H," Trans. Japanese Soc. Med. Biol. Eng., vol. 51, no. Supplement, p. R-65-R-65, 2013.*



Abstract: 65

Methods in an interdisciplinary project within health technology

**A. Åkerberg*; Mälardalen University, School of Innovation, Design and Engineering (IDT), Västerås*

Background
In health research, the interest in combining qualitative and quantitative methods is growing [1]. Mixed methods can be defined as “collecting, analyzing and mixing both quantitative and qualitative data in a single or series of studies” [2], and provides a wider range of tools when addressing a complex or multidimensional question, such as in health research [1]. In a synergy project within health technology, the users contributed with input on how technology could be used to promote physical activity. The aim of this paper is to describe the methods used in this specific research project, and to discuss the strengths and weaknesses of these methods.

Material and Methods
The project includes four studies, and the aim was; based on a user perspective, to develop a first model of an interactive health technology solution that is usable to encourage physically inactive adults to become more physically active. Results The project was initiated by a quantitative phase (study 1 and 2), was followed by a qualitative phase (study 3), and was ended by using a mixed methods phase (study 4). The project consisted of the following designs: Cross sectional comparative design (study 1), cross sectional design (study 2), explorative design (study 3) and mixed methods design based on user-centered design also including the technical development (study 4).

Discussion
To initiate the project by using physical measure and a questionnaire in study 1 and 2, to be able to screen the baseline, is a strength. Study 2 and 3 were complementary, because deeper information was generated by focus group interviews in study 3, which also enriched the result of these studies. Study 1-4 contributed to the technical development in study 4, by generating different user perspectives from user groups on how to develop the technology. In study 4, triangulation was applied, meaning that both qualitative, quantitative and mixed methods have been used to verify the findings, using both workshops, questionnaires and physical measure. The data in study 4 was partly analyzed and presented simultaneously in the usability evaluation. A possible weakness of study 4 can be that it consisted of several parts, was time consuming and difficult to summarize. The strength of study 4 is however a more comprehensive and broader outcome.

Conclusion
To use both quantitative, qualitative and mixed methods in this research project, have contributed to broader and deeper user input. This have in turn generated deeper understanding of this complex health research field, resulting in better outcome of the project.

References *[1] S. Tariq, J. Woodman. Using mixed methods in health research. Journal of the Royal Society of Medicine Short Reports, 2010; 0:1-8. [2] JW. Creswell, CVL. Plano. Designing and Conducting Mixed Methods Research. London: Sage Publications Ltd, 2007.**Acknowledgements This abstract was supported by the research profile Embedded Sensor Systems for Health (ESS-H), Mälardalen University, founded by the Knowledge Foundation (KKS), Sweden.*