5th Int. Workshop on Human Activity Sensing Corpus and Applications (HASCA): Towards Open-Ended Context Awareness

Nobuo Kawaguchi
Nagoya University, Japan
kawaguti@nagoya-u.jp

Nobuhiko Nishio
Ritsumeikan University, Japan
nishio@cs.ritsumei.ac.jp

Daniel Roggen
University of Sussex, UK
daniel.roggen@ieee.org

Sozo Inoue
Kyushu Inst. of Technology, Japan
sozo@acm.org

Susanna Pirttikangas
University of Oulu, Finland
susanna.pirttikangas@oulu.fi

Kristof Van Laerhoven
University of Siegen, Germany
kvl@eti.uni-siegen.de

Abstract

Technological advances enable the inclusion of miniature sensors (e.g., accelerometers, gyroscopes) on a variety of wearable/portable information devices. Most current devices utilize these sensors for simple orientation and gesture recognition only. However, in the future the recognition of more complex and subtle human behaviors from these sensors will enable next-generation human-oriented computing in scenarios of high societal value (e.g., dementia care). This will require large-scale human activity corpuses and much improved methods to recognize activities and the context in which they occur. This workshop deals with the challenges of designing reproducible experimental setups, running large-scale dataset collection campaigns, designing activity and context recognition methods that are robust and adaptive, and evaluating systems in the real world. As a special topic this year, we wish to reflect on the challenges and possible approaches to recognize situations, events or activities outside of a statically pre-defined pool, which is the current state of the art, and instead adopt an open-ended view on activity and context awareness. Following the huge success of previous years, we are further planning to share these experiences of current research on human activity corpus and their applications among the researchers and the practitioners and to have a deep discussion on the future of activity sensing, in particular towards open-ended contextual intelligence.

Author Keywords

Large Scale Human Activity Sensing Corpus, Activity Recognition, Wearable Computing, Open-Ended Activity/Context Recognition; Mobile Sensors; Participatory Sensing.

Rationale and Objective of the Workshop

The objective of the workshop is to bring together researchers and practitioners both from academia and industries with the goal to discuss, identify and share experiences surrounding the construction of human activity sensing corpuses and their applications. Similarly to other human-related information processing areas, such as speech recognition and image recognition, real-world activity recognition requires large-scale

corpuses of data. Some initiatives set reference datasets for the use by the community, such as OPPORTUNITY [1] and HASC [2], but more work on larger scale and richer datasets are clearly required. Scenarios of high societal value - such as a memory prosthesis for people with dementia - are likely to require a more complete and subtle understanding of the user's activities and the context in which they occur, beyond what is currently available in "off the shelf" datasets. Similarly, activity recognition methods will have to be further improved to tackle real-world challenges. This year, we wish to give a special consideration on how to address a common limitation faced by most activity recognition systems: by the nature of using supervised machine learning they are limited to recognizing a narrowly pre-defined "closed" set of activities/context for which training data is available. In practice the rich complexity of activities and context in which a person may engage is unbounded and it is not possible to foresee it entirely at design-time. The action-motor strategies of a person may evolve (e.g. due to injuries, changing preferences), new activities may be performed, or old ones lost (e.g. changing job). In a scenario of high societal value it may not be feasible to enumerate every single activity that is potentially relevant at design time to collect training data, or it may be too costly or time consuming to do so. In this workshop we are interested in recent advances that may allow - in isolation or combination - to pave the way towards "open-ended contextual intelligence". In other words, we believe that next generation recognition system may well be "seeded" with some pre-defined activities or contexts, but that they will then have to be able to expand their repertoire of activities and contexts as they encounter new situations. Some approaches illustrate how this may be envisioned. Online data sources can be used to avoid the data collection phase [12, 13]. Transfer learning supports dataset reuse by adapting datasets to different but related modalities [8,10]. The cost of acquiring precise annotations can be reduced algorithmically [16] or using crowd-sourcing platforms [18,19]. Pattern recognition can be made more robust to boundary jitter [11] and boundaries may be detected by structure discovery [21]. Social media can provide implicit information about activities [22]. Mobile phone experience sampling can be used to self-report activities [15, 17]. Recent wearables (e.g. smartwatches, Google Glass) further support this through micro-interactions [6]. This can be used to collect minimalistic feedback, as even a binary feedback is sufficient to learn multi-class problems [14]. Semi-supervised learning [20] or self-taught learning [7] can exploit partially labelled data which is easily collected to improve accuracy. These approaches could combine in a framework allowing open-ended learning [9].

Topics of the Workshop

The objective of this workshop is to share the experiences among current researchers around the challenges of real-world activity recognition, the role of datasets and tools, and breakthrough approaches towards open-ended contextual intelligence. We expect the following domains to be relevant contributions to this workshop (but not limited to):

1.Data collection / Corpus construction:
Experiences or reports from data collection and/or corpus construction projects, such as papers describing the formats, styles or methodologies for data collection. Cloud-sourcing data collection or participatory sensing also could be included in this topic.

2.Effectiveness of Data / Data Centric Research:
There is a field of research based on the collected corpus, which is called “Data Centric Research”. Also, we solicit of the experience of using large-scale human activity sensing corpus. Using large-scape corpus with machine learning, there will be a large space for improving the performance of recognition results.

3.Tools and Algorithms for Activity Recognition:
If we have appropriate and suitable tools for management of sensor data, activity recognition researchers could be more focused on their research theme. However, development of tools or

algorithms for sharing among the research community is not much appreciated. In this workshop, we solicit development reports of tools and algorithms for forwarding the community.

4.Real World Application and Experiences:
Activity recognition “in the Lab” usually works well. However, it is not true in the real world. In this workshop, we also solicit the experiences from real world applications. There is a huge gap/valley between “Lab Environment” and “Real World Environment”. Large scale human activity sensing corpus will help to overcome this gap/valley.

5. Sensing Devices and Systems:
Data collection is not only performed by the “off the shelf” sensors. There is a requirement to develop some special devices to obtain some sort of information. There is also a research area about the development or evaluate the system or technologies for data collection.

In light of this year's special emphasis on open-ended contextual awareness, we wish cover these topics as well:

6. Mobile experience sampling, experience sampling
strategies: Advances in experience sampling approaches, for instance intelligently querying the user or using novel devices (e.g. smartwatches) are likely to play an important role to provide user-contributed annotations of their own activities.

7. Unsupervised pattern discovery:
Discovering meaningful repeating patterns in sensor data can be fundamental in informing other elements of a system generating an activity corpus, such as inquiring user or triggering annotation crowd sourcing.

8. Dataset acquisition and annotation through crowd-sourcing, web-mining:
A wide abundance of sensor data is potentially in reach with users instrumented with their mobile phones and other wearables. Capitalizing on crowd-sourcing to create larger datasets in a cost effective manner may be critical to open-ended activity recognition. Online datasets could also be used to bootstrap recognition models.

9. Transfer learning, semi-supervised learning, lifelong learning:
The ability to translate recognition models across modalities or to use minimal supervision would allow to reuse datasets across domains and reduce the costs of acquiring annotations. These topics can be described with the following

Keywords:
- Human Activity Sensing Corpus
- Large Scale Data Collection
- Data Validation
- Data Tagging / Labeling
- Efficient Data Collection
- Data Mining from Corpus
- Automatic Segmentation
- Performance Evaluation
- Man-machine Interaction
- Noise Robustness
- Non Supervised Machine Learning
- Sensor Data Fusion
- Tools for Human Activity Corpus/Sensing
- Participatory Sensing
- Feature Extraction and Selection
- Context Awareness
- Pedestrian Navigation

−Social Activities Analysis/Detection
−Compressive Sensing
−Sensing Devices
−Lifelog Systems
−Route Recognition/Detection
−Wearable Application
−Gait Analysis
−Health-care Monitoring/Recommendation
−Daily-life Worker Suppor

Workshop Format

There will be a keynote talk by a practitioner in the field who can provide their opinion of successes and failures in the field of human activity recognition, in order to set the tone for the workshop. There will be a discussion sessions after the all presentations. The aim is to avoid being a mini-conference but instead provide a forum within which to explore the issues in human activity sensing corpus, and begin setting a road map for future research and collaboration in data collections and tools development. The theme of the discussion session will be to identify existing and new approaches that offer some promise for improving the state of the art in human activity recognition based on sensing corpus. The intention of this discussion session is to provide early feedback to the presenters on their ideas, and primarily to engender discussion of what approaches in general the participants consider promising. We plan for three technical paper sessions in the workshop, one for long papers, and two for short papers.

Estimate of expected participants

We expect to bring together 40-50 participants from academia and industries who are working on or having interest with human activity sensing corpus and its applications (last year's participant count was over 40 [3-5], see also: http://hasca2016.hasc.jp/entry-14.html). We will not the limit the participants because it is very important to share the experience and the information of the corpus in this field for the real-world practical applications.

Publication

All contributions will be included in the ACM Digital Library and supplemental proceedings of the conference. A website at http://hasca2017.hasc.jp/ is a permanent record for the workshop.

Estimated outcomes

We hope that the workshop will contribute in establishing a research community in the human activity sensing corpus area. Expected outcomes are:
1. Survey of the state of the art of "Human Activity Sensing Corpus." This includes an overview of the data collection methods, tools and algorithms.

2. Practical knowledge of the data collection methodologies for human activity sensing.

3. Recognition of the potential and the importance of the large-scale corpus for human activity recognition.

These outcomes also will be shown on the workshop
website.

Pre-Workshop activities

Most of organizers / TPC members are from the OPPORTUNITY [1] and HASC [2] groups. We already have a community about human activity sensing corpus. HASC Challenge was a data-collection challenge. Through the HASC Challenge, we have collected more than 500 subjects' activities through

various types of smartphones. We already have more than 150 registered users at this time, so we can ask them to submit and attend the workshop.

Post-Workshop activities

On the workshop website, the list of the current data collection activities and the information of the public corpora will be presented. If we can successfully form a new research community for the human activity recognition, we will provide a mailing list for the community.

Organizers

The most of the organizers are from OPPORTUNITY and HASC group. We already have experiences of collecting human activity sensing corpus. And deeply understand the importance and difficulty of them. So we would like to form a research community to share the experiences and discuss about the future direction.

Nobuo Kawaguchi is a professor of Institutes for Innovation for Future Society, Nagoya University since 2014. He received Ph.D. in Computer Science from Nagoya University, Japan, in 1997. He founded a NPO named Location Information Service Research Agency(Lisra) in 2012. His research interest is in the areas of Human Activity Recognition and Ubiquitous Communication Systems. He is now serving a chairperson of the Human Activity Sensing Consortium (HASC), Japan.

Nobuhiko Nishio is a professor of the College of Information Science and Engineering, Ritsumeikan University. He got his PhD at Keio University in 2000. Since 1993 till 2003, he had worked at Keio University SFC. His current research interests are ubiquitous computing and long term human activity recognition. He is was a general chair of HASC Challenge 2013.

Daniel Roggen is Associate Professor (Reader) in Sensor Technology at the University of Sussex. He received his MSc in microengineering in 2000 from the EPFL (Swiss Federal Institute of Technology) in Lausanne, Switzerland. He received his PhD degree from EPFL in 2005. Since then his activities include context recognition algorithms, embedded wearable systems, sensor fusion, and learning and adaptivity in wearable systems. He has coordinated the EU-funded FP7 project OPPORTUNITY on opportunistic activity recognition. He is leading the UK EPSRC-funded project "Lifelearn: Unbounded activity and context awareness" (2016-2018).

Sozo INOUE is an associate professor in Kyushu Institute of Technology, Japan. His research interests include human activity recognition with smart-phones, and healthcare application of web/pervasive/ubiquitous systems. Currently he has gathered 40,000 activity information of 250 people with accelerometer data using smart phones and servers. Inoue has a Ph.D of Engineering from Kyushu University. He is a member of the IEEE Computer Society, the ACM, the Information Processing Society of Japan (IPSJ), the Institute of Electronics, Information and Communication Engineers (IEICE), and the Database Society of Japan (DBSJ).

Susanna Pirttikangas is a Senior Research Fellow and adjunct professor on data science at the Center for Ubiquitous Computing, University of Oulu. Her expertise is on data mining and pattern recognition research enabling situation awareness. Her research interests include data management systems, AI systems, edge analytics and data science for context recognition and routine learning.

Kristof Van Laerhoven is Professor for Ubiquitous Computing at the University of Siegen, Germany. His

research activities include (wearable) sensing systems, activity recognition, wireless sensor networks, machine learning, signal processing. He was technical program commitee chair of the International Symposium on Wearable Computers in 2013. Previously he was Professor for Embedded Systems at the University of Freiburg, and an Emmy Noether Research Group (DFG) Leader of Embedded Sensing Systems at the Technical University of Darmstadt, Germany.

Acknowledgements

UK EPSRC First Grant EP/N007816/1 “Lifelearn:
Unbounded activity and context awareness”,
JSPS KAKENHI Grant Number JP 17H01762

REFERENCES

1. D. Roggen, A. Calatroni, M. Rossi, T. Holleczek, G. Tröster, P. Lukowicz, G. Pirkl, D. Bannach, A. Ferscha, J. Doppler, C. Holzmann, M. Kurz, G. Holl, R. Chavarriaga, H. Sagha, H. Bayati, and J. del R. Millán. "Collecting complex activity data sets in highly rich networked sensor environments" In Seventh International Conference on Networked Sensing Systems (INSS’10), Kassel, Germany, 6 2010.
2. N. Kawaguchi, Y. Yang, T. Yang, N. Ogawa, Y. Iwasaki, K. Kaji, T. Terada, K. Murao, S. Inoue, Y. Kawahara, Y. Sumi, N. Nishio, “HASC2011corpus: Towards the Common Ground of Human Activity Recognition”, In Proceedings of the 13th International Conference on Ubiquitous Computing(UbiComp2011) .
3. N. Kawaguchi, N. Nishio, D. Roggen, K. Fujinami, S. Pirttikangas , Chairs' Summary/Proposal for International Workshop on Human Activity Sensing Corpus and Its Application HASCA2013), In UbiComp 2013 Adjunct Publication (UbiComp2013) .
4. N. Kawaguchi, N. Nishio, D. Roggen, S. Inoue, S.Pirttikangas , International Workshop on Human Activity Sensing Corpus and Its Application (HASCA2015), In UbiComp 2015 Adjunct Publication (UbiComp2015) .
5. N. Kawaguchi, N. Nishio, D. Roggen, S. Inoue, S.Pirttikangas, K. Laerhoven, Int. Workshop on Human Activity Sensing Corpus and Its Application (HASCA):Towards Open-ended Context Awareness,In UbiComp 2016 Adjunct Publication (UbiComp2016) .
6. Ashbrook, Enabling mobile microinteractions, PhD Thesis, Georgia Institute of Technology, 2010
7. Amft, Self-Taught Learning for Activity Spotting in On-body Motion Sensor Data. Proc. ISWC, 2011
8. Baños et al., Kinect=IMU? Learning MIMO Signal Mappings to Automatically Translate Activity Recognition Systems Across Sensor Modalities, Proc. ISWC, 2012
9. Calatroni, Villalonga, Roggen, Tröster, Context Cells: Towards Lifelong Learning in Activity Recognition Systems, EuroSSC, 2009
10. Dai et al., Translated learning: Transfer learning across different feature spaces, Proc. NIPS, 2008
11. Nguyen-Dinh, Roggen, Calatroni, Tröster, Improving Online Gesture Recognition with Template Matching Methods in Accelerometer Data, Int Conf on Intelligent Systems Design and Applications, 2012
12. Perkowitz, Philipose, Patterson, Fishkin. Mining models of human activities from the web. Int. World Wide Web Conf, 2004.
13. Rossi et al. Recognizing Daily Life Context using Web-Collected Audio Data, Proc ISWC, 2012
14. Förster, Monteleone, Calatroni, Roggen, Tröster, Incremental kNN classifier exploiting correct - error teacher for activity recognition, Proc. ICMLA, 2010
15. Froehlich, Chen, Consolvo, Harrison, Landay, Myexperience: a system for in situ tracing and capturing of user feedback on mobile phones, Proc. MobiSys, 2007
16. Kirkham, Khan, Bhattacharya, Hammerla, Mellor, Roggen, Ploetz, Automatic Correction of Annotation Boundaries in Activity Datasets by Class Separation Maximization, HASCA Workshop at UbiComp, 2013
17. Scholl, P., Kücükyildiz, N., and Van Laerhoven, K, When do you light a fire?: capturing tobacco use with situated, wearable sensors. Proceedings of the 2013 ACM conference on Pervasive and ubiquitous computing adjunct publication, 2013

18. Lasecki, Song, Kautz, Bigham, Real-time crowd labeling for deployable activity recognition, Proc.Computer supported cooperative work, 2013
19. Nguyen-Dinh, Waldburger, Roggen, Tröster, Tagging Human Activities in Video by Crowdsourcing, Proc of the ACM Int Conf on Multimedia Retrieval, 2011
20. Stikic et al., Weakly Supervised Recognition of Daily Life Activities with Wearable Sensors, IEEE T-PAMI, 2011
21. Huynh, Fritz, Schiele, Discovery of activity patterns using topic models, Proc. Ubiquitous Computing, 2008
22. Zhu et al. Human Activity Recognition Using Social Media Data, Proc Mobile and Ubiquitous Multimedia, 2013.