



Pervasive Health

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Pervasive Health 2015

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The 9th International ACM/IEEE Conference on Pervasive Computing Technologies for Healthcare (Pervasive Health 2015) was held from 20–23 May at the scenic Boğaziçi University in Istanbul, Turkey. It had a total of 106 registrations, with 25 full papers and five short papers from around the world (see Figure 1).

The conference showcased a wide variety of technology applications, methods, and studies aimed at understanding how computing applications can help improve healthcare and the general well-being of individuals. Researchers presented applications of wearable and sensing technologies, as well as explorations focused on understanding how pervasive technology can be incorporated into healthcare domains. As with previous years, the researchers demonstrated the importance of pervasive computing technology in healthcare in managing and improving healthcare outcomes.

KEYNOTES

Pervasive Health had three keynote talks from researchers and healthcare practitioners.

Wearables

Oliver Amft, the Chair of Sensor Technology and the ACTLab research group at the University of Passau in Germany, opened up the Pervasive Health conference with his talk, “What Smart Eyeglasses and other Wearables Will Soon Know about Our Body.” His talk brought to bear the important shifts from current wearable technology as merely an accessory for accessing information, toward

a means to sense what we perceive and encounter in our daily activities. In particular, Amft discussed his group’s work in the development of smart eyeglasses that provide access to physiological and activity data.

The Practitioner Perspective

The second keynote was presented by Gulustu Kaptanoglu (see Figure 2), a practitioner who directs the Behavioral Neurology, Dementia and Movement Disorders Clinic and an instructor at Boğaziçi University in Istanbul, Turkey. She represented the medical perspective at the conference with her talk, “In Sickness and in Health,” during the afternoon session on the opening day.

Kaptanoglu focused on how currently available pervasive technologies can be integrated into the clinical workspace—for example, to diagnose and monitor a patient’s unique development, treatment, and side effects, or to provide clinicians with contextual information about the patient’s life. She gave a brief overview of her team’s development of wearable devices to help understand tremors from patients living with Parkinson’s disease. Finally, she pointed out possible game changers of the future such as advancements in tracking REM sleep reliably or the functions of the autonomous nervous system.

Sensing

Paul Lukowicz from DFKI and Kaiserslautern University of Technology in Germany presented the third keynote, “Sensing Trends for Pervasive Healthcare.” Lukowicz spoke about the emerging world of wearables and

applications for the healthcare community (see Figure 3). He also presented his current research focused on the development of textile sensor arrays and capacitive textile sensors.

WORKSHOPS

On the first day of the conference, Pervasive Health 2015 hosted four workshops. The Workshop on Adaptive Treatments and Therapies (WATT) focused on the development of dynamically customized interventions, treatments, and therapies for changing patient needs. Next, HomeSHARE 2015 focused on issues of geographically distributed, home-based testbeds for pervasive health research. The Workshop on Personal Health Systems for Chronic Diseases (PHSCD) centered on systems for diseases, while the Workshop on Process-Oriented Approach For Patient-Centered Care Delivery (ProCare) focused on the development and introduction of efficient and effective processes for patient-centered care delivery in the complex ecosystem of stakeholders with different goals, backgrounds, and perspectives.

DOCTORAL COLLOQUIUM

In parallel to the workshops, there was a doctoral colloquium, run by Katie Siek, Rosa Arriaga, and Kay Connelly. The students presented their research on a range of topics, from stress management for older adults to the influence of personality on the use and non-use of personal informatics. The presentations inspired interesting discussions on the operationalization of stress and the differences between acceptable subject numbers in different

research communities. The faculty advisors shared personal experiences and best practices to plan and conduct interdisciplinary studies and introduced the students to researchers with a similar focus within the community.

POSTERS

Located on the roof of Perkins Hall, participants had the chance to both enjoy a stunning view of the Bosphorus strait and the Asian side of Istanbul, and to view 14 posters, three demos, and one medical perspective (see Figure 4). Trending topics at this year's poster session included the communication and interpretation of wearable health data, clinical applications of unobtrusive eye-tracking, predicting perceived stress levels in the workplace, and game-based rehabilitation systems such as a tablet game for rehabilitative progress of hemispatial neglect patients presented by Hendrik Knoche from Aalborg University, Denmark.

PERVASIVE HEALTH TECHNICAL SESSIONS

The technical sessions showcased the breadth of applications for pervasive technology in the healthcare domain. These sessions also let researchers exploring similar themes present and discuss their work while forming new collaborative efforts, helping them move forward to address similar problems and application areas.

Session 1: Supporting Personalized Healthcare Delivery

In the opening session of the main conference, Rosa Arriaga presented her group's recent work on behavioral support for individuals with autism. In particular, their paper, "Towards Designing Social Question-and-Answer Systems for Behavioral Support of Individuals with Autism," identified the potential of social media to help individuals with autism cope with daily challenges. By analyzing 1,277 threads of Web forums for people with autism, the researchers found that such forums



Figure 1. Participants at Pervasive Health 2015, located at Boğaziçi University in Istanbul, Turkey.

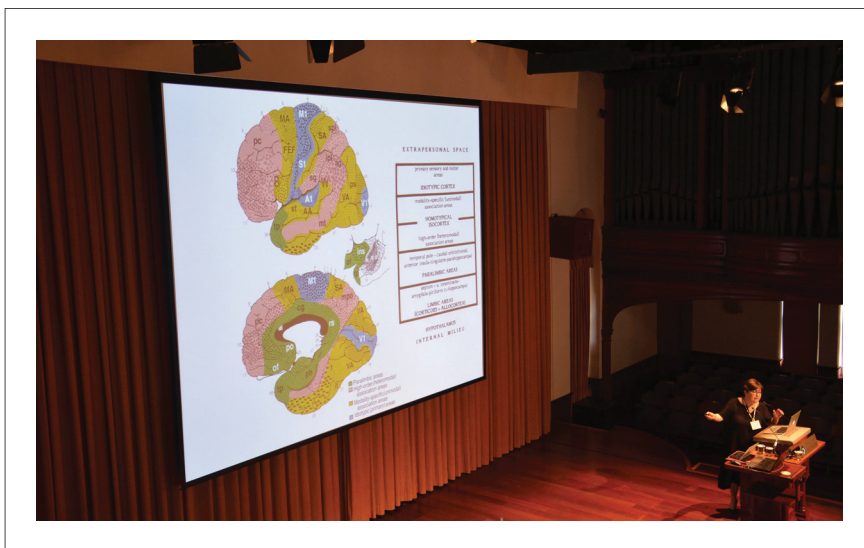


Figure 2. Gulustu Kaptanoglu, a practitioner who directs the Behavioral Neurology, Dementia and Movement Disorders Clinic and an instructor at Boğaziçi University in Istanbul, Turkey, representing the medical perspective at the conference with her keynote talk, "In Sickness and in Health."

lack the insights of non-autistic individuals. Most questions sought advice about socially appropriate behavior that the dominant user base is not familiar enough with to answer.

Lixin Gao presented her group's work, titled "Supporting Drug Prescription via Predictive and Personalized Query System," which applied graph theory to help healthcare providers prescribe drugs based on a variety of factors, including drug interactions, side effects, and patient profiles. Results from this method showed an improvement in the

Area under Receiver Operating Characteristic (AUROC) by up to 40 percent compared to baseline.

Other talks in this session presented a coach-supported form of Web-based depression treatment and a framework for personalized health and well-being support.

Session 2: Supporting Impairments and Disabilities with Wearables

The first talk of the second session was given by Karen Anne Cochrane.



Figure 3. Paul Lukowicz, from DFKI and Kaiserslautern University of Technology in Germany, presenting the third keynote, “Sensing Trends for Pervasive Healthcare.”

Improving Hand Sensation in Persons with Spinal Cord Injury Using Passive Haptic Rehabilitation.” This research focused on the design and evaluation of a wearable vibration glove used to teach participants passively to play the piano by stimulating the finger playing the next note. Participants using the wearable glove experienced a significant increase in hand sensation compared to the control group.

Session 3: Persuasive Technology Design

The third session of the conference highlighted one talk presented by Geerte Paradies, titled, “Lost in Persuasion: A Multidisciplinary Approach for Developing Usable, Effective, and Reproducible Persuasive Technology for Health Promotion.” Paradies’s talk centered on an approach and guideline for the development of persuasive technology for healthcare. The purpose of this work is to address current problems in making effective, reproducible, and usable persuasive technology, promoting a sound design rationale. Overall, her talk provided highly useful insights for the design and development of persuasive technology in healthcare moving forward.

Session 4: Walk, Interact, Rehabilitate

Mark Dunlop and colleagues demonstrated the effectiveness of degrading a user’s music experience to motivate the person to pick up his or her walking pace in their paper, “Using Degraded Music Quality to Encourage a Health Improving Walking Pace: BeatClear-Walker.” Currently, the feedback that persuasive running applications provide users about their pace consists of voice messages in fixed intervals. Dunlop and his colleagues’ work aims to promote an effective walking cadence by altering the sound quality of music being played based on the individual’s pace. Results showed a degradation of music quality helped decrease the number of below-cadence steps in a series of controlled experiments.



Figure 4. The posters session took place on the roof of Perkins Hall. Participants could enjoy a stunning view of the Bosphorus strait and the Asian side of Istanbul, while viewing 14 posters, three demos, and one medical perspective.

Her paper, “Developing Design Considerations for Mobile and Wearable Technology m-Health Applications that Can Support Recovery in Mental Health Disorders,” provided a survey

of the literature for different mobile and wearable technology for individuals with mental health disorders. In the second talk, Tanya Estes presented “A Wearable Vibration Glove for

Other talks during the session featured a multisensor system capable of helping individuals adhere to physical rehabilitation exercises for fall prevention, a wearable haptic gait rehabilitation system for patients who are recovering from hemiparetic stroke, as well as an analysis of input methods for wearable smartwatches for the Borg Rating of Perceived Exertion (RPE) Scale.

Session 5: Physiological Signals and Patient-Centered Care

Samantha Kleinberg and colleagues presented their approach to automatically sense when an individual is eating using Google Glass. The researchers analyzed the head movements of participants while eating and performing various other tasks. Their approach yielded promising results, demonstrating that head motion data from Google Glass was sufficient to support recognition of eating with high precision.

Duygu Karaoglan Altop's talk, "Towards Using Physiological Signals as Cryptographic Keys in Body Area Networks," stood out among the talks due to its technical perspective. In her talk, Altop argued that blood pressure signals, together with the electrocardiogram and photoplethysmogram signals, are suitable candidates of physiological parameters as cryptographic keys in body area networks.

The session also included a presentation by David Mohr from Northwestern University. His talk "MedLink: A Mobile Intervention to Address Failure Points in the Treatment of Depression in General Medicine," presented the results of a four-week pilot that showed his and his colleagues' tool, MedLink, was effective in promoting medication adherence for individuals with depression. Mohr and his colleagues received the best paper award for their work on MedLink.

Other work presented in this session included a method for assessing stress through human-smartphone interaction analysis.

Session 6: Designing for Older Adults

Session 6 was dedicated to the challenges presented by demographic change. Kay Connelly presented the results of a needs analysis of older adults from low socio-economic backgrounds derived from contextual observations, semistructured interviews, and questionnaires. Connelly and her colleagues found that health satisfaction, coping mechanisms, and forced limited choices played key roles in the participants' experience of aging in place. While their investigations yielded a plentitude of design considerations, Connelly pointed out some key observations. For example, health satisfaction was judged in comparison to peers, and coping mechanisms (such as offering a ride to a friend who doesn't feel comfortable driving) helped participants deal with a variety of limitations. However, health, environmental, and financial limitations were found to strongly influence the participants' choices in daily life (for example, a reliance on low-cost but carb-heavy food offered by Meals on Wheels).

Julie Doyle and colleagues investigated older adults' interest in smart-home sensor data and attitudes toward living with such sensors. In her paper, "Older Adults' Attitudes to Self-Management of Health and Wellness through Smart Home Data," Doyle found that older adults did not consider sensor technology to be obtrusive. In particular, older adults were interested in seeing the time they spent walking, sleeping, and being active (both within and outside of the home); their blood pressure; and their weight.

Focusing on the effect of context-specific health and well-being-related recommendations for older adults, Thomas Rist presented "CARE—Extending a Digital Picture Frame with a Recommender Mode to Enhance Well-Being of Elderly People." This work explored the use of sensors embedded in the user's environment, which helped in presenting users with recommendations of the

most sensible activities for their general well-being. Following a successful evaluation in a senior's home, the researchers found important considerations for moving forward with such a device, including giving users more control, improving the general usability of the device, and using persuasive technology to help motivate users.

Other work presented in this session included the design of novel screening environments for individuals with mild cognitive impairments.

Session 7: Technology Integration

This session focused on the various benefits and challenges that researchers encounter when integrating technology into the healthcare space. In particular, researchers provided insight into the ways technology is viewed, and where challenges arise in its use, across a wide variety of healthcare situations.

The session opened with a presentation by Florian Gldenpfennig on his group's research paper, "ProxyCare: Integrating Informal Care into Formal Settings." In particular, Gldenpfennig presented his group's approach to the development of informal sensing technology for patients with dementia. ProxyCare was successfully integrated into a formal nursing-home-care setting for a patient suffering from dementia, and researchers used the technology to detect when an individual was leaving her bed (in order to prevent falls). Overall, the research presented was successful in capturing 72 such events and was positively received by both the family and nursing-care staff.

Michael J. Gonzales presented his group's work, "Designing Collaborative Healthcare Technology for the Acute Care Workflow." This research focused primarily on an ethnographic study that took place across three different institutions, aimed at uncovering the many challenges clinicians face during emergency code situations. In particular, the researchers found that documentation in these situations takes place commonly on napkins, and



Figure 5. The gala dinner, held on a yacht, provided local Turkish cuisine and music.

that there is a wide range in environmental constraints affecting clinicians and variances in the ways clinicians approach code situations as they occur.

Other talks during this session provided an assessment and understanding of tools in healthcare management and monitoring. Bert Vandenberghe provided an analysis and design recommendations for the use of sleep-monitoring tools for both in and out of the hospital. Other work focused on understanding the roles of personal health informatics and wearables for self-management and monitoring of chronic pain.

Session 8: Wearable and Pervasive Technology

The last session of the conference had a particular focus on wearable and pervasive technology and its use in healthcare monitoring, tracking, and physical rehabilitation.

Javier Hernandez opened up the session with the paper “BioWatch: Estimation of Heart and Breathing Rates from Wrist Motions,” which was also a best paper nominee. Hernandez presented his group’s methods for extracting cardiac and respiratory parameters using accelerometers and gyroscope sensors on a smartwatch. These methods were assessed through a series of controlled experiments involving individuals in different positions (standing up, sitting down, and lying down), with comparable

results to a state-of-the-art heartrate monitor.

Kim Oakes from The University of Indiana, Bloomington presented “MuscleMemory: Identifying the Scope of Wearable Technology in High Intensity Exercise Communities,” which was another best paper nominee. In this study, researchers developed a novel, wearable knee brace capable of measuring a user’s squat depth for high-intensity exercise communities, like CrossFit. Researchers conducted a qualitative study with individuals in a high-intensity exercise community to understand their needs, the usability and effectiveness of the device, as well as to inform future design of the device.

Other papers during this session provided an overview of a robust architecture for wearable heart-rate monitoring and a modular system for balance rehabilitation for individuals recovering from a stroke.

Pervasive Health 2015 brought together researchers across the globe to share their experiences and approaches to solving complex problems in healthcare using pervasive technology. Researchers were highly engaged in conversations about current problems in the healthcare field, including challenges with current health systems (such as electronic health records) and

patient data accessibility and considerations for the usability and design of health-centric applications. They also were interested in exploring various wearables and their applications, improving healthcare delivery, and developing best practices for presenting this information to patients. The conference provided a positive and engaging environment for researchers to share ideas, form new collaborations, and engage in thoughtful discussions about finding new ways to tackle the problems of the ever-changing healthcare field.

Boğaziçi University and the city of Istanbul provided a beautiful and diverse setting for the conference. The poster session, reception, and lunches for the conference took place on the rooftop of Perkins Engineering Hall, providing a gorgeous overview of the Bosphorus strait that cuts through central Turkey and separates Europe and Asia. A gala dinner, which was held on a yacht for attendees, provided local Turkish cuisine, music, and some impromptu karaoke (see Figure 5). The environment of the conference, and overall experience as a whole, was thoroughly enjoyable and engaging. ■

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