Quality-of-Life Technologies

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As we embrace personal digital health technology applications, computing power is increasingly exploited for its capacity to improve our quality of life (QoL). Beyond wearables that capture and transmit our vitals, QoL technologies present a variety of opportunities for extending the human health span—not just how long we live, but how well we are.

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Powerful, personalized, and miniaturized computing technologies and their applications have markedly improved our quality of life (QoL). Yet, even as they enhance the understanding of and ability to improve our everyday physical and psychological health, social interactions, environmental conditions, and decision making, the causality between the technologies and individual QoL gains is not straightforward. In addition, as is often the case, these new innovations raise many new social, design, economic, and legal challenges that must be addressed before the emerging QoL-enabled and -driven computing paradigm can become efficient, effective, and widely adopted.

Emerging Internet technologies and computing services are now an indispensable part of our lives, supporting our need for information, communication, and entertainment—anywhere, anytime, and anyhow. We have observed a shift in use of these services and technologies from a passive style to one that is more mobile, interactive, and real-time. These services have significantly improved our capacity to make informed decisions about our everyday activities, which has a particular impact on our physical and psychological health, social interactions, and environment.

Overall, the ways we use and experience these services on a growing scale contribute to our QoL. According to the World Health Organization (WHO), QoL refers to “individual[s’] perception[s] of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns” (www.who.int/healthinfo/survey/whoqol-qualityoflife/en; 1995). The WHO has also defined an assessment scale called WHOQOL that assesses an individual’s QoL across four domains: physical health, psychological health, social relationships, and environment, as well as 24 subdomains (see Table 1).

The QoL subdomains cover both subjective and objective aspects of life. They are collectively exhaustive, mutually nonexclusive, and potentially correlated; for example, there is an influence of noise—an environmental aspect—on an individual’s sleep and rest, which is a physical health aspect. Of course, overall health is an aspect of the individual’s life that spans all QoL domains.

We define QoL technology research—the focus of this special issue—as fundamental information and communication technologies (ICT) research that leverages methods, models, algorithms, and services. To that end, research enables the identification of a specific individual’s QoL needs as well as the design of ICT-based solutions to address a range of challenges, thus improving the individual’s QoL across multiple domains. Delivery of QoL technologies to users can be in fixed services, but is increasingly mobile.

However, the effectiveness of ICT relies on heterogeneous technologies and computing services, as well as our understanding of the implications of various decisions made by Internet technologies, service architects, designers, and developers on users’ QoL. Although some QoL technologies improve mobility and support the everyday activities of those with disabilities or sensory impairment, the impact of these technologies on the general population is less well known. As a result, research challenges and opportunities continue to be identified and studied, including in this special issue.

In “Can Fitness Trackers Help Diabetic and Obese Users Make and Sustain Lifestyle Changes?,” Mirana Randriambelono, Yu Chen, and Pearl Pu used longitudinal research methods to assess individuals’ physical activity levels and whether the use of tracking devices led to sustainable behavior changes. The research presented expands our understanding of how environmental factors influence our level of physical activity—in this case, users’ activity levels increase as a result of the device presenting information in a playful manner. The article represents QoL research within the “physical health” domain and the “activities of daily living” and “mobility” subdomains.
In “The Science of Sweet Dreams: Predicting Sleep Efficiency from Wearable Device Data,” Aarti Sathyanarayana, Jaideep Srivastava, and Luis Fernandez-Luque present hardware and software solutions that help generate an accurate sleep-quality assessment. With a wide array of sleep-monitoring applications and devices, our ability to collect data on sleep patterns using wearables is relatively well established. However, the data these technologies accumulate and how best to analyze them is still an area for exploration. The authors describe advanced modeling techniques and examine ways to benefit users in terms of interventions that could improve sleep efficacy through these QoL technologies. These results offer additional opportunities to improve QoL technologies in the “physical health” domain and the “sleep and rest” subdomain.

In “Are They Paying Attention? A Model-Based Method to Identify Individuals’ Mental States,” Tongda Zhang, Renate Fruchter, and Maria Frank describe a Mental Motion State Model that advances our ability to determine an individual’s mental state. The application of the described technique centers on fatigue, cognition, and engagement levels when study subjects are engaged in specific activities. The research falls under the domain area of “psychological health” and the “thinking, learning, memory, and concentration” QoL subdomain.

In “Using Multimodal Wearable Technology to Detect Conflict among Couples,” Adela C. Timmons, Theodora Chaspari, Sohyun C. Han, Laura Perrone, Shrikanth S. Narayanan, and Gayla Margolin present some initial results from a field study that utilizes mobile computing, sensing

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<tr>
<th>QoL domain</th>
<th>Facets incorporated within QoL domain</th>
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<tr>
<td>Physical health</td>
<td>Activities of daily living&lt;br&gt;Dependence on medicinal substances and medical aids&lt;br&gt;Energy and fatigue&lt;br&gt;Mobility&lt;br&gt;Pain and discomfort&lt;br&gt;Sleep and rest&lt;br&gt;Work capacity</td>
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<tr>
<td>Psychological health</td>
<td>Bodily image and appearance&lt;br&gt;Negative feelings&lt;br&gt;Positive feelings&lt;br&gt;Self-esteem&lt;br&gt;Spirituality/religion/personal beliefs&lt;br&gt;Thinking, learning, memory, and concentration</td>
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<tr>
<td>Social relationships</td>
<td>Personal relationships&lt;br&gt;Social support&lt;br&gt;Sexual activity</td>
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<td>Environment</td>
<td>Financial resources&lt;br&gt;Freedom, physical safety, and security&lt;br&gt;Health and social care: accessibility and quality&lt;br&gt;Home environment&lt;br&gt;Opportunities for acquiring new information and skills&lt;br&gt;Participation in and opportunities for recreation/leisure activities&lt;br&gt;Physical environment (pollution, noise, traffic, and climate)&lt;br&gt;Transport</td>
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*Table is reprinted from K. Wac et al., “Quality of Life Technologies: Experiences from the Field and Key Challenges,” IEEE Internet Computing, vol. 19, no. 4, 2015, pp. 28–35; doi:10.1109/MIC.2015.52.*
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technologies, and real-time systems to determine an accurate assessment of individuals’ psychological state, specifically in the context of romantic couples and the level of tension or conflict between partners. The authors collected data from wearable physiological sensors as well as individual self-reports on emotional state and reflections on recent interactions with their partners. The analysis of the data identifies some patterns in couples that could reveal opportunities to improve communication or mitigate conflicts. Such technologies contribute to the QoL research in the “social relationships” domain and the “personal relationships” subdomain in particular.

The research methods covered within these articles are nearly all quantitative—focusing on the technical requirements and speed, accuracy, dependability, and computational modeling complexity these QoL technologies offer in terms of reliable and timely individual state assessments. Additionally, Mirana Randriambe- lonoro and her colleagues describe qualitative methods through focus groups and interviews that enable data collection regarding an individual’s perception and user experience while using QoL technologies for behavior change.

The articles in this special issue shed light on diverse challenges and opportunities in QoL technologies research and applications, and they help advance the QoL-driven computing paradigm in terms of improving efficiency, effectiveness, and efficaciousness. As QoL technologies are in their nascent stage, and as our understanding of their impact

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continues to improve, we expect that their use will expand into many areas of everyday human activity.

Thus, to succeed, future QoL technology research requires interdisciplinary efforts to ensure user-centric, holistic applications—including improvements in physical, psychological, social, and environmental aspects. As researchers better address challenges relating to infrastructure; human–computer interaction; ethics; privacy; trust; behavior economics; and the organizational, financial, environmental, and legal facets of developing, deploying, and using these technologies to the maximal benefit of individuals, the potential depth and breadth of QoL technologies’ benefit to humanity will be astounding. For that reason, we see QoL technology research as a long-term endeavor, rather than one that is short-term or self-contained. Additionally, as these technologies advance and become widely adopted, our needs and expectations for their use will continue to change.