Information and Communication Technologies for Development

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Information and Communication Technologies for Development (ICTD) is an emerging field within computer science that focuses on the design, implementation, deployment, and evaluation of innovative technologies for social and economic development. The ICTD research agenda is driven by a desire to bridge the digital divide and make computing useful to the significant fraction of the world's population that lives in underdeveloped areas with limited resources.

Bridging the Digital Divide

Computer science, as a field, has largely focused on problems relevant to the developed world. The Internet and World Wide Web have remained largely urban phenomena. A significant fraction of the people living in developing countries, especially in rural and underdeveloped regions, remains disconnected from the rest of the world.

Conventional computing solutions are often inappropriate in these emerging contexts due to various factors, such as the lack of infrastructure, limited purchasing power, poor connectivity, limited power, language and literacy issues, and the lack of local expertise for managing systems. These unique infrastructure, cost, power, and connectivity constraints create new research challenges that often require a fundamental rethinking of the way we design computing solutions.

The Role of Pervasive Technologies

Pervasive computing and communication technologies have the potential to radically transform millions of lives in the developing world due to their low cost and broad availability. One of the fundamental challenges in the ICTD space is extending Internet connectivity to increase the availability, reliability, and usability of the Web in underdeveloped areas. Enabling low-cost access to communication and information is a powerful tool in providing new information services for poor communities.

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ICTD Research Areas

Some challenging computing-centric research themes in the field of Information and Communication Technologies for Development include

- designing cost-effective and high-bandwidth network connectivity solutions for developing regions,
- enabling information access under poor and intermittent network connectivity,
- designing new mobile applications and services to address specific developmental problems,
- designing power-efficient and low-cost computing devices,
- designing appropriate and accessible user interfaces for low-literate populations using low-cost computing devices,
- addressing multilingual computing challenges and adapting content and applications for local language settings and education levels,
- developing participatory methods and designing user-centered applications for specific domains such as healthcare and education,
- using machine learning techniques for large-scale data mining and analysis in development contexts,
- developing speech interfaces and speech recognition for low-resource languages, and
- understanding social relationships and information flows in disadvantaged societies.

In the past decade, we've witnessed a phenomenal growth in the penetration of mobile devices and services in emerging regions. This growth has also led to the large-scale adoption of new mobile services related to banking, healthcare, and market information systems. Mobile banking systems, such as M-Pesa and GCash, are revolutionizing the way banking is performed in the developing world, supporting millions of transactions every day. By combining appropriate ICTD solutions with an effective social entrepreneurship model, emerging regions could leapfrog the developed world in terms of adopting new technological solutions to address challenging societal problems.

Understanding the Context

Conducting practical ICTD research often requires significant field work to understand the ground realities. The main challenge in this research space is problem discovery, and the key metric for success is the ability to have a real-world impact on society. The ground realities dictate the problem requirements and constraints; any ICTD solution should satisfy the various technical, economic, social, and other contextual constraints imposed by the problem.

Often, technological solutions designed for first-world contexts are a poor fit for these other settings. Most highly regarded ICTD projects—especially those resulting in real-world deployments in developing regions—conduct rigorous evaluation studies to demonstrate large-scale effectiveness and societal impact.

Taking an Interdisciplinary Approach

ICTD is, by nature, an interdisciplinary endeavor that brings together researchers from different backgrounds to carry out a common dialogue around the central question of how technology can impact social and economic development. The International Conference on Information and Communication Technologies and Development (http://ictd2012.org) and the ACM Symposium on Computing for Development (http://dev2012.org), two of the premier publication venues in this space, attract a large audience from numerous disciplines outside of computer science, including anthropology, electrical engineering, economics, political science, public health, and sociology. The "ICTD Research Areas" sidebar lists some of the challenging computing-centric research themes in this space.

In This Issue

This special issue of *IEEE Pervasive Computing* features three articles that address numerous ICTD themes.

First, in "Sensors and Smartphones: Tracking Water Collection in Rural Ethiopia," the authors present their efforts to quantify how much time people in rural areas of Ethiopia spend gathering water. Residents in these areas regularly must venture far from home to access clean water. This work involved attaching low-power motion sensors to household water containers and using smartphones to wirelessly retrieve data from the sensors. The data is later uploaded to a computer for analysis. Nontechnical researchers in the field were able to use the system. The authors' goal is to better understand the economic and social impact of water locations and policies.

Second, in "Monitoring Vaccine Cold Chains in Developing Countries," the authors describe their deployment of a low-cost system to monitor the temperature at which vaccines are stored throughout their distribution chain. To remain effective, vaccines must be kept within a prescribed temperature range until they're administered. The authors used temperature sensors attached to cell phones to send data summaries to a central location via SMS messages, a communication medium that's widely available in developing nations. Their system has already helped diagnose problems in the vaccine cold chain in Albania.

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Finally, in "Cost-Aware Mobile Web Browsing," the authors propose an approach for reducing the costs incurred by mobile Web users who are subject to usage-based pricing. The prevalence of such pricing in developing regions, together with the increasing size and complexity of webpages, can place even nominal Web usage beyond the financial reach of many people. The authors' approach computes a cost quota for each Web request and adapts the content of the resulting webpages to fit within the quota. They show that their techniques can significantly reduce costs while producing the best possible version of a page given the cost constraints.

We hope you find these articles as stimulating as we have. ICTD holds tremendous promise to help people in developing regions improve their lives. As exemplified by the work presented in this special issue, pervasive computing and communication technologies are slated to be a key driver of this transformation.

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