

E-Inclusion Innovation for Rural India: Mobile Voice and Tablet Based Educational Services

Mikko Ruohonen, *mikko.j.ruohonen@uta.fi*

Markku Turunen, *markku.turunen@sis.uta.fi*

Juhani Linna, *juhani.linna@uta.fi*

Jaakko Hakulinen, *jaakko.hakulinen@uta.fi*

University of Tampere, Finland

Amit A. Nanavati, *namit@in.ibm.com*

Nitendra Rajput, *rnitendra@in.ibm.com*

IBM India Research Laboratory, New Delhi, India

Abstract

The needs of the lowest income segments of the population in developing economies (bottom of the pyramid, BoP) are enormous. Therefore organizations should create significant economic value by innovating the design of products and services to more effectively serve BoP. Normally we discuss e-inclusion or digital divide in the context where efforts to close the gap between developed and less developed countries is seen through the possibilities of the use of World Wide Web and text-based services. Voice-based services offer major opportunities in developing areas such as India and Africa. They provide the only possible way to create viable services for rural areas, where people are mostly illiterate and need to access the information in their local language.

The usage of mobile phones is increasing all the time in rural areas. In this paper we study the deployment of voice-based mobile educational services for developing countries, especially in India. Our research is mainly based on a Spoken Web technology developed by IBM Research Labs.

In a program level we study how in agriculture, primary healthcare, education, banking and microfinance and entertainment these services can be deployed. In this paper we focus on educational services. The results of the project can be applied for similar market areas, such as Africa and Latin America. It also provides a platform for the reverse innovation system building, especially in speech and symbol interface based applications for focused areas in developed countries.

Keywords

e-inclusion, education, BoP, voice-based services

INDIAN BOP MARKET FOR MOBILE SERVICES

Organisations, both companies and public authorities, should create significant economic value by innovating the design of products and services to more effectively serve the needs of the lowest income segments of the population in developing economies. This is especially true in the growing economies in such as India, Latin America and in many countries of Africa. It has been noted that a large market opportunity also exists for businesses to tap at the bottom of the pyramid (BoP) (Pra-

halad and Hart, 2002). In addition to that mobile phone based services have opened up new opportunities (Parikh & Lazowska 2006).

The total population of India is roughly 1.2 billion people, from which over 800 million live in rural and 400 million in urban India. Poverty continues to be a significant issue in India despite the high growth of the economy in the last years. The Government of India defines Below the Poverty Line (BPL) as an economic benchmark and poverty threshold to indicate economic disadvantage, and to identify individuals and households in need of government assistance and aid. The total BPL population of India is some 300 million with a break up of 220 million from rural India and 80 million from urban India. Expressed as a percentage of the total population, the BPL population is 25% on an all India basis, 27% in rural India, and 21% in urban India.

The poor are vulnerable by virtue of lack of education, lack of information, and economic, cultural, and social deprivations (Karnani 2007). Accessibility to this large rural BoP market is a huge challenge, also for education. The distribution channels for products have been established with large investments by some of the large consumer product companies but services have been quite unexplored. One exception is telecom services, while the amount of phone connections has grown from 37m to over 900m in a period of 10 years 2001-2011 (Jeffrey & Doron 2013). According to Telecom Regulatory Authority of India (<http://www.trai.gov.in>) the total number of mobile phone connections in India will reach 1 billion 2013 with over 600 million in urban India and over 300 million in rural India. While service prices have dropped drastically the market in rural India has now opened up and that is where the growth is much higher in rural areas than that in urban India. The national mobile connection teledensity is 72.12 with an urban teledensity of 157.76 and a rural teledensity of 35.20. What appears to be a comparatively low rural teledensity for mobile connections is very misleading in terms of a measure of the power of the mobile phones for accessing the rural market. In rural India the mobile phone is not a personal device like in urban India but a shared device across the entire family. This makes the addressable market size using mobile phones larger than that suggested by the teledensity figures.

MOBILE PHONE BASED SERVICES FOR BOP ILLITERATES

Typically value added services through mobile phones have been delivered through text and web platforms. Both of these require the service consumer to be literate. Whereas literacy is a given in developed markets for mobile value added services, it is not necessarily the case in the rural India bottom of the pyramid market segment. The illiteracy rate in India is 26%, with 31% illiteracy in rural India and 15% illiteracy in urban India. It is no coincidence that the illiteracy rate in rural India (31%) and the BPL population in rural India (25%) are similar in numbers. In this rural India BPL segment poverty and illiteracy go hand in hand. It is, therefore, safe to assume that essentially the entire 221 million rural India bottom of the pyramid population is illiterate.

This problem is likely to persist, since elementary education is not targeted to adults, and children's drop-out rates are high; 28 % in primary and 50 % in upper primary level in 2004-2005 (SES 2007). Illiteracy makes text based and web based service delivery platforms unusable. This creates a need for services that can be delivered on other platforms than text or web, e.g., a voice or tablet platforms. In addition to service needs for these BoP markets it also provides a platform to create and develop first in developing countries context and then "reverse" the innovation to developed countries (Govindarajan & Trimble 2010).

Spoken services

Spoken services have been used successfully in many areas in many countries. Typical examples of speech applications include transport information services,

such as automated train and bus timetable services. The first speech applications were telephone-based interactive voice response (IVR) systems, which used speech outputs and telephone keys for interaction. These applications are still popular and possibly the most important examples of widely used commercial speech applications. Typically, these applications are designed to replace human operators. Problems with these systems include that the DTMF (colloq. touch-tone) interface may be awkward and user satisfaction poor, if the service does not match the quality offered by human operators. On the other hand, these applications can be very useful for users if they introduce new services which are not possible or affordable with human operators (or in any other way). This is exactly the case in our target area, where human-operated services are not viable or too costly in many cases.

The current trend is that DTMF inputs are replaced by speech inputs. This may promote both greater user satisfaction and cost savings in some application areas. In addition to IVR applications, many other forms of telephony applications have dominated the field. These include information services, such as timetable, weather forecasting and banking services, e-mail applications and voice portals. When these applications are collected together, we can create voice portals which integrate several applications into a unified speech interface. However, conventional voice portals have several problems in our target area, while they do not support user created content, which makes many services impossible.

IBM Research Labs have developed the Spoken Web to deliver data and information to illiterate people (Kumar et al. 2008, Kumar et al. 2009, Agarwal et al. 2010). It is being built as a service that runs on the normal telecom infrastructure differing from WWW that runs as a service on the Internet infrastructure. Spoken Web proposes to build an alternate web for the underprivileged population that is yet untouched by the enormous benefits of Internet and WWW. Service and content offered over Spoken Web can be accessed through lowest end phones and the interface presented to people is in their local language.

In a nutshell, Spoken Web content is stored in the form of voice-sites instead of text based web-sites. The content is in local dialects, making it much easier for illiterate people to access this information. It has been observed that IT systems with a voice-based feedback have much more appeal for the illiterate and semiliterate population of these regions as compared to graphical user interface (GUI)-based systems such as Internet Kiosks.

Voice-links allow for navigation between voice-sites using voice commands from a limited permissible vocabulary set. The interconnection of voice-sites leads to a WWTW or World Wide Telecom Web on the lines of the well-known World Wide Web. Voice-sites can be accessed by dialing a phone number. The much higher access to mobile phone connections, therefore, makes access to voice sites much easier.

Tablet based services

Another promising approach for Indian BoP market is tablet based computing. Tablet computers, tablet PCs or simply tablets are mobile computing devices typically incorporating multitouch touchscreen input, wireless connectivity (3G+ and Wi-Fi), and processing power and graphics hardware comparable to lower segment laptop PCs with nearly instant-on boot times. IDC defines tablets as "devices with 7 – 12 inch color displays" running "lightweight operating systems such as Apple's iPhone OS and Google's Android OS", distinguishing them from x86 based portable tablet form factor PCs and laptops that run full PC operating systems. According to IDC, while tablets are primarily marketed as "multifunction entertainment devices", applications providing productivity and business features for consumers and enterprise users will eventually be available.

The history of tablet computers dates back to the 19th century, with early prototypes being introduced in the later part of the 20th century (e.g. Alan Kay's Dyna-

book concept from 1968). However, the real advent of tablet devices began with the introduction of the Apple Newton in 1993 and subsequently the Microsoft Tablet PC in 2000. These early platforms were more business oriented, marketed as personal digital assistants (PDA) and relied on external devices (styluses) for data input on the touch screen. Although commercially unsuccessful, they paved way for products such as smaller form factor PDAs, smartphones and ultraportable PCs.

The tablet computer market recently grew into a significant and interesting segment of mobile computing thanks to the introduction of the Apple iPad in 2010, featuring its iOS operating system, and the subsequent release of Google's Android OS, RIM's Blackberry OS and HP's webOS powered devices. The current tablet ecosystem is dominated by the Apple iOS line and the multi-vendor Google Android product family. IDC forecasts that worldwide shipments will grow to 46 million units in 2014.

Tablet user interfaces are based on more natural interaction style than the Windows-Icons-Mouse-Pointer paradigm of desktop PCs, including multi-finger gestures for navigating and manipulating applications (e.g. swipes, pinch, flick etc.) and virtual keyboards or handwriting recognition for data entry. Tablets also generally include other sensor devices beyond the touchscreen that allow for advanced interaction styles, such as accelerometer, microphone, proximity and ambient light sensors, back and front facing cameras and GPS.

When compared to laptop PCs, tablets have several advantages and disadvantages. Due to the form factor, tablets are more ergonomic to use in mobile environments (e.g. standing, one handed use), have lighter weight and longer operating time. Touchscreen input and multitouch gestures are also more conducive to certain types of application scenarios and make for a more fluent navigation experience in the user interface.

Tablets are still somewhat expensive -- higher end models easily rival the price of powerful laptop PCs. Also the smaller screen and lack of a physical keyboard can be a problem for some usage scenarios. Also, as the operation of the tablet is centered around the screen (display, input), creating a single point of failure that will render the whole device inoperable.

Affordable tablets based on the Android OS have been launched recently by many Chinese and Taiwanese manufacturers, which provide an entry point to the markets in developing countries. The low hardware requirements and the intuitive touch operation of the device make tablets an appealing alternative to full scale laptop PCs running desktop operating systems. For example, in India the Ministry of Education has invested in the production of an affordable internet ready tablet Akash based on Android OS for university students at a price level of approximately \$45 per device. The proliferation of tablets in developing markets creates exciting possibilities for the implementation of both public service/governmental, commercial and educational services leveraging the strengths of the platforms, such as low power requirements, touch screen input combined with symbolic user interfaces (for illiterate/semiliterate users from low-technology background) and wireless connectivity through mobile networks that diminishes the reliance on wired internet.

Tablets and speech technologies create together a great promise for BoP services. Most importantly, spoken and symbol-based interfaces make services available for illiterate people, and studying these interaction techniques both in mobile phones and tablets makes numerous novel service scenarios possible.

BACKGROUND STUDIES

Spoken Web technology is currently ready to be deployed commercially and several cases reported by IBM Research have been executed (see Ruohonen et al. 2013 forthcoming). Our base study started 2011 with developing agricultural information and continuing education application. First prototype included information on 3 crops, Now, the newest version of application includes information on over 20

crops farmed in Northern Karnataka area. At the end we also present how the spoken and multimodal technology development carried out at UTA can make advanced multimodal services possible.

Farmers' Voice application

Farmer's Voice is a Kannada language voice site created for the purpose of field study. Kannada is one of the official and classical languages in India. This field study was carried out in close collaboration with University of Agricultural Sciences (UAS), Dharwad, IBM Research Lab, India and University of Tampere (UTA).

The Department of Extension, University of Agricultural Sciences works to transform the best agricultural practices, research work and agricultural technologies created by its staff to the farming community. In order to accomplish this goal, they have adopted several modern communication media such as Television, Krishi (Farming) Community Radio Station. Even though adopting all new mediums for communication, they are still not reaching entire farming community. In recent times most of the farmers in Rural India own mobile phones. Thus now the University is willing to propagate services through mobile phone medium. Their objective is to find ways to propagate agricultural information services through mobile phones using spoken web as a platform.

Farmers' Voice (Raitarinda Raitara Dhvani) – voice site application was developed with farmer users during late 2011 and 2012. Most of the participants were illiterate or having very little formal school education. The content of this voice site was provided by the Krishi (Farming) Community Radio Station. The content is in local Kannada language, spoken throughout Karnataka state. There were total five sections in the voice site, like Krishi Chintana (Farming Information), Pakshika Salahegalu – (Tips to the farmers), Weather forecast, Market Forecast and Varada Basanna (Talk by veterinary doctor in colloquial Kannada language).

There were also two prototypes of this voice site, one is with background music and another one without background music. We went to total 5 villages near by University of Agricultural Sciences. The prototype was installed on mobile phone (Nokia C6 touch screen phone). More about findings of the use and evaluation of this application prototype is reported in Ruohonen et al. (2013, forthcoming).

Future development

University of Tampere (UTA) has worked with spoken and multimodal mobile services over ten years (Turunen et al. 2005, Turunen & Hakulinen 2007). Its existing research prototypes include numerous applications which have been piloted in large-scale pilots with real users in Finland. For example, the publicly available TravelMate application offers spoken and multimodal public transport guidance for mobile users, and the MobiDic application was developed for mobile dictation and notetaking needs. Currently, UTA is developing spoken mobile applications for medicine and healthcare environment. Another recent work includes speech and symbol based tablet applications for illiterate people. In these applications (and many others), UTA has applied the technology for special user groups, such as visually-impaired people, who share many issues with illiterate people. Most importantly, the work done with these systems completes the work of IBM Spoken Web in many ways. First UTA is one of the key players in the world in the area of spoken mobile applications, and is thus in an excellent position for helping to deploy the Spoken Web technology with IBM and Finnish SMEs. Second, UTA has developed multimodal technologies which can be applied for future applications of Spoken Web and tablets. In particular, UTA and IBM have planned to apply novel auditory, haptic, gestural and symbol based technologies for Spoken Web.

TARGET SERVICE DOMAINS

Opportunities in five verticals

The commercial infrastructure and ecosystem for BoP markets is driven by the following four drivers: creating buying power, shaping aspirations, improving access and tailoring local solutions (Figure 1, Prahalad & Hart 2002). The other drivers after this phase are reverting innovation back to developed countries (Govindarajan & Trimble 2010) and building an institutional innovation system through creation nets (Hagel & Seely Brown 2006).

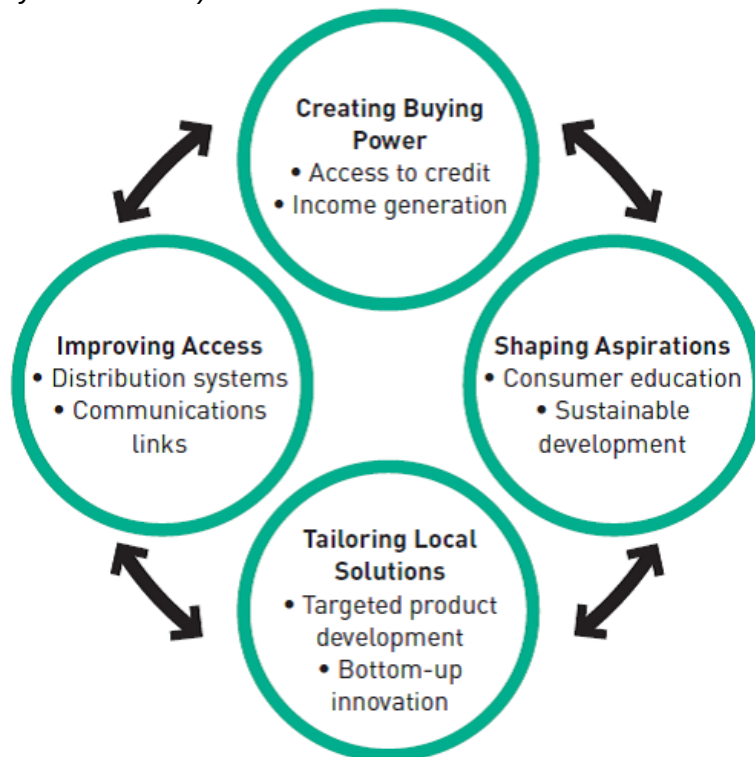


Figure 1: The commercial infrastructure at the Bottom of the Pyramid

Based on our studies (Das et al. 2013) and strategic documents, we have identified the people at India's BoP markets require services in the following five areas: i) Agriculture, ii) Primary Healthcare, iii) Education, iv) Entertainment, v) Banking and Microfinance. These areas and their relations to the research concept are illustrated in Figure 2.

Potential for Educational Services

Agricultural extension education. In the area of agriculture, the problem is that of information and knowledge asymmetry where people at the BoP do not have access to information on agri-commodity prices, weather, seeds, pesticides, fertilizers, and agricultural equipment. They need real time information access and educational services to improve their productivity and increase their well-being. Some of the needed information and educational services are agri-commodity prices for small farm management, weather information for maintaining production in fields, seeds information for improving total output, how to use pesticides and fertilizers in different situations and use of agricultural equipment. There are three phases in agriculture i.e., production, processing and marketing of the crops. Farmers are in need of guidance and consultation for their problems during all these phases. So, continuing education is very vital for the farmers.

Health information and education for the whole healthcare chain. For primary healthcare, the condition of health care in the BoP is very poor. Doctors are not pre-

sent, even nurses visit physically the villages couple of times per week, and access to any kind of modern health care is virtually non-existent. People in many villages have no option but to go to “village quack” and often face life threatening consequences. These people need genuine medical advice and access to consultation facilities. With voice and tablet based systems you can i) improve the access of healthcare information, ii) develop the healthcare chain (for example by tablet systems either networked or standalone, iii) arrange doctoral consultations when needed from far distances, iv) develop the medicine delivery system with SMS-based prescriptions to pharmacies and finally v) follow up and even predict the diseases burst in certain rural areas.

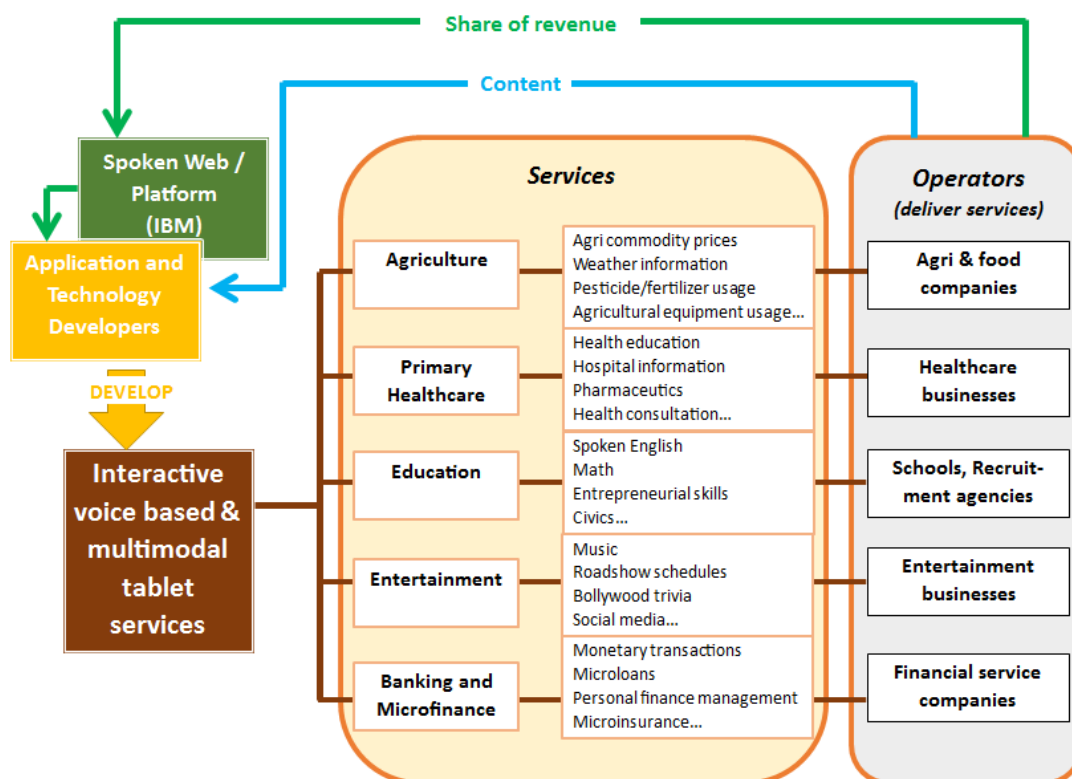


Figure 2: Delivering Interactive Voice Based Mobile Phone Services and Multimodal Tablet Services to India's BoP

Major substance opportunities in e-learning through voice. In the area of education, a key contributor to India's growth story in a globalized economy has been the English speaking skills of the educated population. Now the illiterate population, who also do not know spoken English, have missed out on the opportunities that knowledge of the English language provides. Even without having requisite literacy levels for other jobs, knowledge of spoken English opens up several employment avenues that currently do not exist for the rural BoP. The focus on inbound tourism opens up possibilities in the hospitality industry where spoken English becomes a boon. This includes jobs as drivers, hotel housekeeping staff, tour guides, etc. In addition, knowledge of spoken English also opens up doors for employment for these people in urban centers for cleaning staff and errand runner jobs in MNC offices as well as expatriate managers' residences. These people in the rural BoP would like access to spoken English courses that do not need basic literacy as a prerequisite. In addition to English language education, there is a need for entrepreneurial and small business education which supports the opportunities of poor people and growth of small businesses in rural India.

Developing educational services with edutainment content. Music is the prime source of entertainment for the BoP. Generally they listen to music on the radio.

Local music preferences change over geographical distances with preference for different folk songs and dialects. Radio stations typically play standard music from the Indian movie industry with not too many local flavors. People, therefore, don't have the option to listen to the songs of their preference but are forced to listen to the songs that are played by the radio station. They would ideally like to be able to listen to the music of their choice.

Improved training of banking and finance opportunities. Regarding banking and microfinance, the BoP faces two fundamental problems. One is getting accessibility to banks and the other is that the amount of money that needs to be transacted is often small. The accessibility problem stems from the fact that there are over 600 000 villages in India and it is, therefore, not feasible for banks to have their branches in all of the villages. The small transaction size makes it infeasible for banks to carry out these transactions profitably. The rural BoP segment needs access to banks and micro finance institutions (MFI) with an ability to conduct small transactions.

RESEARCH PARTNERS AND PROPOSED RESULTS

Our network consists of the technology provider IBM Research Lab India, Finnish application/service developers, Finnish and Indian research organizations University of Tampere (UTA), International Management Institute, University of Agricultural Sciences and Finnish internationalization experts Finpro and Finnnode. The project is carried out by UTA, while the companies involved should carry out the focused development work in vertical service deployment projects.

To summarize, the proposed results of the project on education will be:

- Models for voice and tablet based educational services for the Indian BoP target areas
- Improved use of multimodal Spoken Web and tablet technology in education
- Several deployed Spoken Web and tablet based educational prototypes
- Localized field studies conducted in India, Karnataka area.
- Analysis for transferring to other contexts and reversing innovation

We will work in close collaboration of the network partners to apply the results into real world services. In this way, the results of this project can also make commercial products possible in the company driven actions which run after and in parallel with the proposed base project. In addition to the Indian BoP market, the results of the project can be applied for similar market areas, such as Latin American or African countries, with similar processes.

REFERENCES

- Agarwal, S.K., Jain, A., Kumar, A., Nanavati, A.A. & Rajput, N. (2010). The Spoken Web : A Web for the Underprivileged. *SIGWEB Newsletter Summer 2010*. DOI: 10.1145/1796390.1796391 <http://doi.acm.org/10.1145/1796390.1796391>
- Das, H., Ruohonen, M.J. & Mahajan, G. (to be published 2013). Delivering Interactive Voice based Services through Mobile Phones to Rural India's Bottom of the Pyramid. Ström, P., Dolles, H., Alvstam, C., & Middel, R. (Eds), *Proceedings of the 28th Euro-Asia Management Studies Association Conference 2011* Palgrave-MacMillan.
- Govindarajan, V. & Trimble, C. (2010). *The Other Side of Innovation: Solving the Execution Challenge*. Harvard Business School Press.
- Hagel, J. and Seely Brown, J. (2006). *Creation nets: Harnessing the Potential of Open Innovation*. <https://www.johnhagel.com/creationnets.pdf> (checked 12.1.13)
- Jeffrey, R. & Doron, A. (2013). *The Great Indian Phone Book - How Cheap Mobile Phones Change Business, Politics and Daily Life*. C. Hurst & Co Publishers, London.

- Karnani, A. (2007). The Mirage of Marketing to the Bottom of the Pyramid: How The Private Sector Can Help Alleviate Poverty. *California Management Review* 49(4), 90-111.
- Kumar, A., Chakraborty, D., Chauhan, H., Agarwal, S.K. & Rajput, N. (2009). Content Creation and Dissemination by-and-for Users in Rural Areas. In *IEEE/ACM International Conference on Information and Communication Technologies and Development (ICTD)*. Doha, Qatar.
- Kumar, A., Rajput, N., Agarwal, S.K., Chakraborty, D., & Nanavati, A.A. (2008). Organizing the Unorganized - Employing IT to Empower the Under-privileged. In *WWW '08: Proceedings of the 17th International World Wide Web Conference*. Beijing, China.
- Parikh, T.S. & Lazowska, E.D. (2006). Designing an Architecture for Delivering Mobile Information Services to the Rural Developing World. In *Proceedings of the International Conference on World Wide Web (WWW)*.
- Prahalad, C.K. & Hart, S.L. (2002). *The Fortune at the Bottom of the Pyramid*. Strategy+Business January 2002 (<http://www.strategy-business.com/article/11518?gko=9a4ba>) (checked 12.1.13).
- Ruohonen, M., Turunen, M., Kumar, V., Linna, J. & Das, H. (2013). Mobile Voice-based Educational Services for Rural India: Project RuralVoice. In Ley, T., Ruohonen, M., Laanpere, M. & Tatnall, A. (Eds), *OST'12, AICT 395, IFIP International Federation of Information Processing* (pp. 3-11). Springer.
- SES (2007). *Selected Education Statistics (SES) of the Ministry of Human Resource Development*. <http://www.educationforallinindia.com/> (checked 12.1.13).
- Turunen, M. & Hakulinen, J. (2007). Spoken and Multimodal Communication Systems in Mobile Settings. *Verbal and Nonverbal Communication Behaviours*, (227-241). Springer-Verlag.
- Turunen, M., Hakulinen, J., Räihä, K.-J., Salonen, E.-P., Kainulainen, A. & Prusi, P. (2005). An architecture and applications for speech-based accessibility systems. *IBM Systems Journal* 44(3), 485-504.

Biographies



Mikko Ruohonen is a Professor at the School of Information Sciences, University of Tampere and the leader of the Information, Customer and Innovation Management (CIRCM) group. Mikko has an extensive expertise about information systems, digital services and business strategies. He has been in a leading position in several national and international research projects and scientific consortiums.



Markku Turunen is a Professor at the School of Information Sciences, University of Tampere and the leader of the Speech-based and Pervasive Interaction group. His expertise includes many aspects of multimodal and spoken user interfaces, including multimodal and spoken dialogue systems, and novel user interfaces for mobile and pervasive computing. He has worked in over 30 national and international research projects.



Juhani Linna is a Researcher at the School of Information Sciences, University of Tampere. He is working in both Speech-based and Pervasive Interaction group and Information, Customer and Innovation Management group. Juhani is interested in digital business, internationalization of knowledge-intensive SME's and inclusive business prospects in the developing areas especially in South and South East Asia.



Jaakko Hakulinen is a Senior Researcher at the School of Information Sciences, University of Tampere. He is working in the Speech-based and Pervasive Interaction group. Jaakko pursues constructive research approach in human-computer interaction. His main fields of interest are speech user interfaces, gesture based interaction, spatial audio and interactive lighting.



Amit A. Nanavati is a Senior Researcher and Master Inventor at IBM India Research Lab. Amit can be described as a Spoken Web evangelist, and he broadly dabbles with speech in mobile and pervasive environments. He is also interested in applying graph theory to various domains. Amit recently authored a book with Nitendra on "Speech in Mobile and Pervasive Environments", published by John Wiley & Sons in 2012.



Nitendra Rajput is a Senior Researcher and a Research Manager at IBM India Research Lab. He likes to build novel interaction systems, especially for mobile devices targeting low-literate users. He has worked on speech recognition and dialog systems for Indian languages in the past. Nitendra is interested in mobile interactions, HCI, statistical signal processing, recommender systems and multimodal search.

Copyright

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/3.0/>