TechBridgeWorld

M. Bernardine Dias

Fall 2007

Carnegie Mellon

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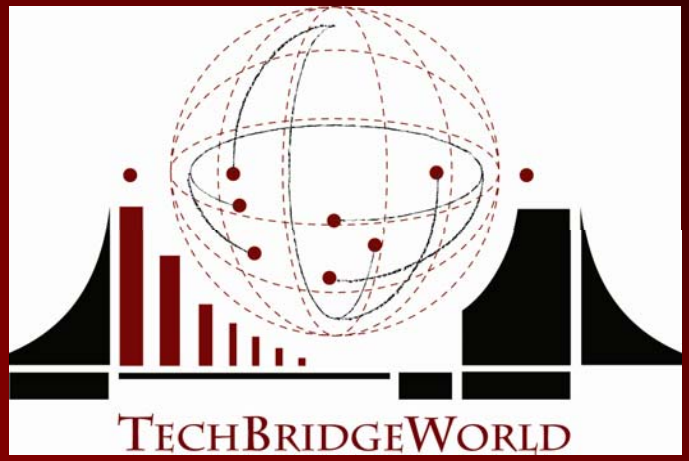

We are a multidisciplinary team embedded within Carnegie Mellon University, spanning education, research, development, deployment, and outreach, dedicated to defining the role of technology in sustainable global development.

www.TechBridgeWorld.org

Some day…

By knowing them, we will learn to create technology of impact to them…

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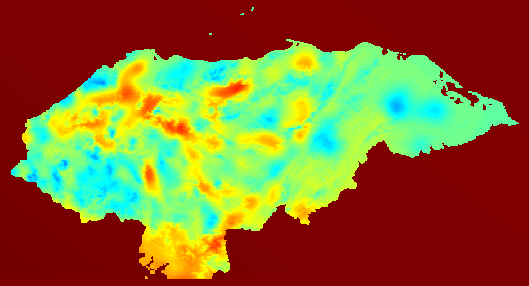
Some day…



The technology we create will help in the battle against poverty…

Some day…

Some of them will become technologists…
our students and colleagues

Because today…



We give students non-traditional educational opportunities!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Building Technology Bridges…

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Technology Consulting in the Community (TCinC)

- *Department:* Computer Science Department
- *Prerequisites:* typically 3rd or 4th year standing
- *Offered:* Fall and Spring since 1998
- *Role:* Satisfies "other computer science" requirement
- *Units:* currently 9, considering going to 12 (equivalent to 3, going to 4 credits at other schools)
- *Typical majors:* CS, IS, ECE
- *Students per class:* typically 12-25

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Partnerships

- Each student is partnered with a leader in a non-profit organization
  - E.g. Executive director, program director, technology coordinator
  - Student works one-on-one with that community partner (and key staff people they designate)
  - On site at the non-profit
  - For 3 hours every week

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Technology Consulting in the Global Community (TCinGC)

TC in GC

www.TechBridgeWorld.org/tcingc

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Technology Consulting in the Global Community

- Summer 10 week program
- Students travel to consult with governments and non-profits in developing communities abroad
- Uses the same consulting model as TCinC course
- Financial break-even deal for student consultants
- Program pays for travel
- Community partner provides accommodations and a small stipend to cover local transportation, food, and incidental expenses

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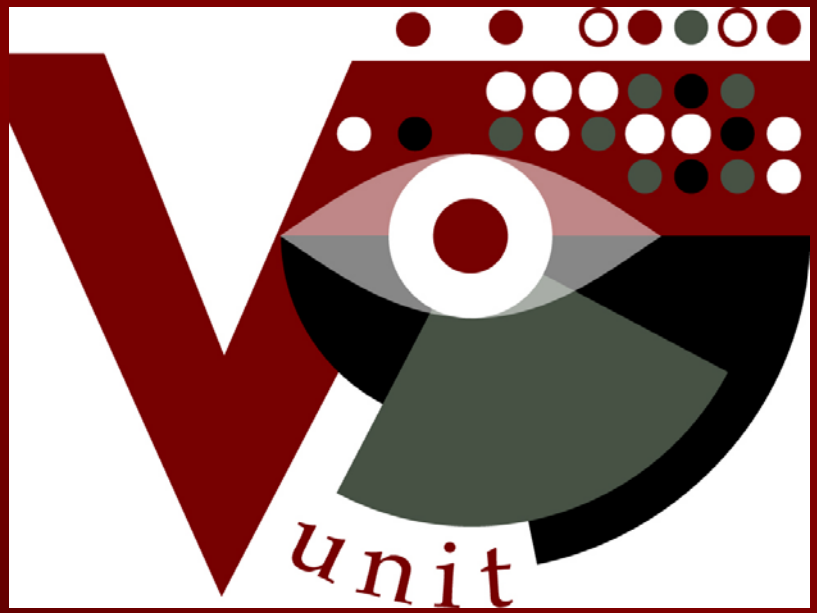
The V-Unit

Learning to Build a Vision



www.cs.cmu.edu/~vunit

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Key Elements

- Focus
  - Technology for non-traditional applications
- Strong support network
  - V-Unit coordinators
  - Project advisors
  - Community partners
  - Department, School, and University
- Dissemination
  - Public oral presentation
  - Written report

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Other Activities

- Poverty simulation
- Seminar series
- Robotics course in Ghana
- E-Village (online community)
- Wish list
- Individually catered opportunities (internships, partners, funding, introductions, projects, etc.)

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TFDC Examples II

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Categories of TFDC Apps

- Education
- Agriculture
- Health
- E-Government
- Employment
- Assistive Technology
- Safety
- Others

Education: Challenges

- Lack of resources
- Lack of access to experts
- Professional and intellectual isolation
- Lack of support for research
- Mistrust of technology (often due to inappropriate transfers of technology)
- Lack of access to professional organizations, literary works, academic journals, etc.
- Notion that education and technology are for the rich
- Traditional and cultural barriers

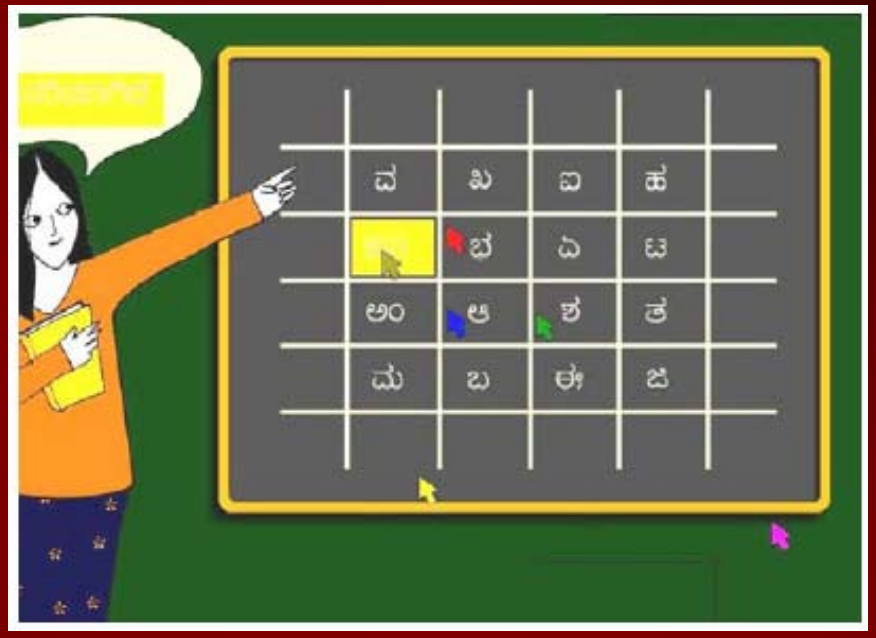
Technology Enhanced Education

- Automated tutors
- Web-based tools
- Distance education
- Teaching/learning tools for the physically and mentally challenged
- Computing infrastructure
- Robots
- Teacher training resources
- Resources and tools for teachers
- Multimedia displays
- Virtual experiences

Technology Education

- Technology courses
- Hands-on labs
- Trade/Job skills
- Technology teacher-training
- Research opportunities
- Web resources
- Exchange/Study Abroad programs

Multiple Mice



Udai Singh Pawar, Joyojeet Pal and Kentaro Toyama, Multiple Mice for Computers in Education in Developing Countries, ICTD 2006
http://tier.cs.berkeley.edu/docs/ict4d06/multiple_mice-jp.pdf

Introduction

- Addresses the challenge of lack of resources
- Computers can be expensive but mice aren’t
- Often many children use one computer in developing communities
- Group engagement can be a positive element in the learning process
- Should allow several children to share a single computer with multiple mice
- Needs relevant software applications

Results & Challenges

- Developed several educational games
- A cursor with a unique color is “attached” to each mouse
- Games were implemented in English, Hindi, and Kannada
- Preliminary field trials were conducted

- Questions answered:
  - Can children understand and use the multiple-mouse paradigm when the number of mice is as many as five?
  - How do children interact with each other with respect to multiple mice? How do they share or not share?
  - Does the multiple mouse paradigm increase interest and engagement?
- Observations:
  - Gender difference in sharing
  - One child didn’t like competitive element

Future Work

- Build more educational applications
- More extensive field tests
- Evaluate tangible learning outcomes
- Adaptive software for simultaneous multiple users
- Joint decision making mechanism
- Collaborative applications

Project Kané

M. Bernardine Dias, G. Ayorkor Mills-Tettey, and Joseph Mertz, The TechBridgeWorld Initiative: Broadening Perspectives in Computing Technology Education and Research, 2005

http://www.ri.cmu.edu/pub_files/pub4/dias_m_bernardine_2005_4/dias_m_bernardine_2005_4.pdf

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Introduction

- Ghana is seeking means to improve English literacy
- One major shortcoming with available resources is the opportunity for guided reading practice
- Carnegie Mellon's Jack Mostow and group had developed an automated English reading tutor – project LISTEN

Results & Challenges

- Field study designed as TDC class project
- Pilot study was implemented over the following summer with good results
- Searched for follow-on funding and partnership
- UNESCO funding and partnerships secured in 2006 summer

- Many challenges in implementing follow-on study including very limited funding
- Difficulty in ensuring attendance for long-term study
- Initial phase was carried out in Internet café; wasn't possible for follow-on
- Being a remote partner is difficult

Future Work

- Complete on-going field study – comparison to guided practice with an older youth
- Seek creative ways to overcome recent licensing of the tutor
- Seek creative means of funding follow-on work
- Find other partnerships
- Lots of demand!
- English tutors for adults are also in high demand

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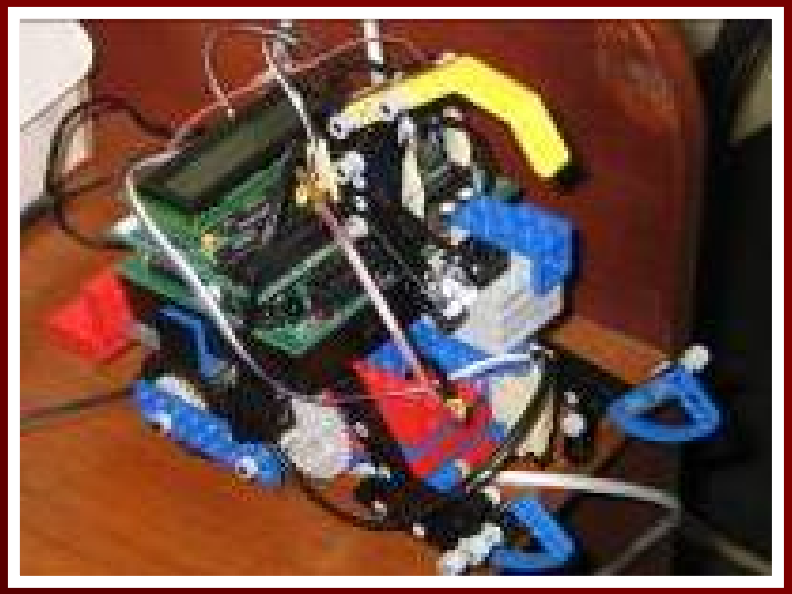
Robotics Course in Ghana



G. Ayorkor Mills-Tettey, M. Bernardine Dias, Brett Browning and Nathan Amanquah, Teaching technical creativity through Robotics: A case study in Ghana, 2007

http://www.ri.cmu.edu/pub_files/pub4/mills_tettey_g_ayorkor_2007_1/mills_tettey_g_ayorkor_2007_1.pdf

Introduction

- Sustainable development requires increased diversity in the creators (and consumers) of technology
- Challenges to successful technology education in developing communities include limited access to infrastructure, equipment, and expertise
- Challenges can be mitigated by creative course design and collaborative partnerships
- Partnership with Ashesi University in Ghana
- Course was designed and co-taught with Nathan Amanquah – head of CS dept.

Results & Challenges

- Design philosophy:
  - Encourage creativity
  - Use local resources
  - Teach technical skills
  - Teach dissemination skills
  - Inspire with examples of state-of-the-art
  - Encourage a broad understanding
  - Impact and involve local community
- Outcomes:
  - Knowledge and technical creativity
  - Technical skills
  - Confidence
  - Awareness of research and professional organizations
  - Impact on other academic endeavors
  - External interest

Future Work

- Find ways to continue to offer the course at Ashesi University
- Disseminate course to other universities
- E-Village: Online educational resource for TFDC
- Find ways to enhance access to professional organizations
- Alum start-up company: e-wallet for mobile-phone banking!

Agriculture: Challenges

- Lack of resources
- Lack of access to experts
- Mistrust of technology
- Challenges with land ownership
- Obtaining good market prices
- Obtaining trustworthy, relevant, and timely information
- Transportation and storage

Technology Enhanced Agriculture

- Information kiosks
- Automated soil mapping
- GM crops
- Agricultural tools
- Online training and educational programs
- Crop protection
- Storage and transportation devices
- Quality control
- Sensing and monitoring systems

aAQUA – Agricultural Portal

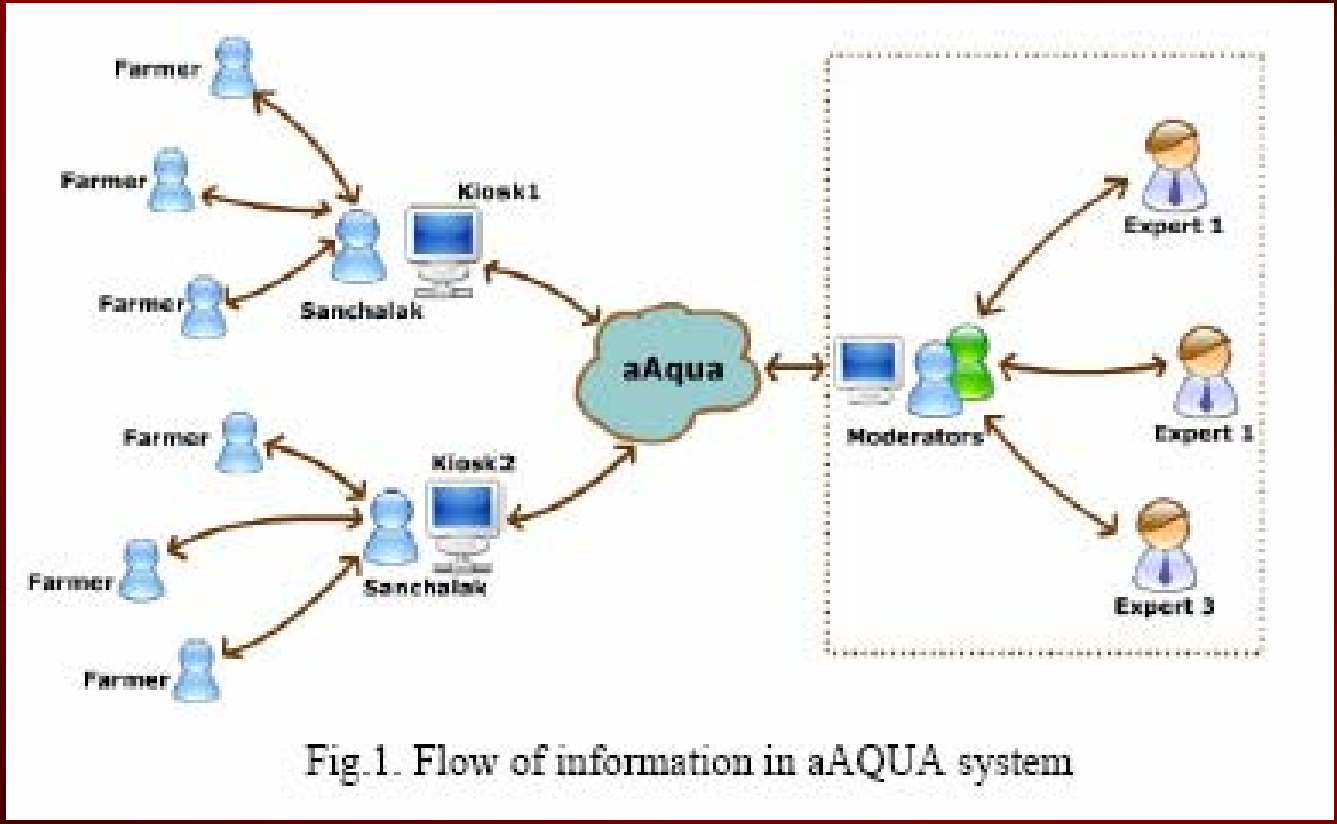
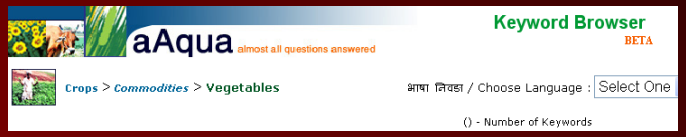


Fig.1. Flow of information in aAQUA system

K. Ramamritham, A. Bahuman, S. Duttagupta, C. Bahuman, and S. Balasundaram, Innovative ICT Tools for Information Provision in Agricultural Extension, 2006
http://www.cse.iitb.ac.in/~krithi/papers/ICTD2006.pdf

Introduction

- aAQUA: almost All QUestions Answered
- Agricultural portal in India
- Main goal to answer questions from farmers
- Uses novel database and information retrieval techniques
- Experts provide answers/solutions which are cached for future use
- Farmers can provide feedback and experts respond
- Pictures and multiple languages are used



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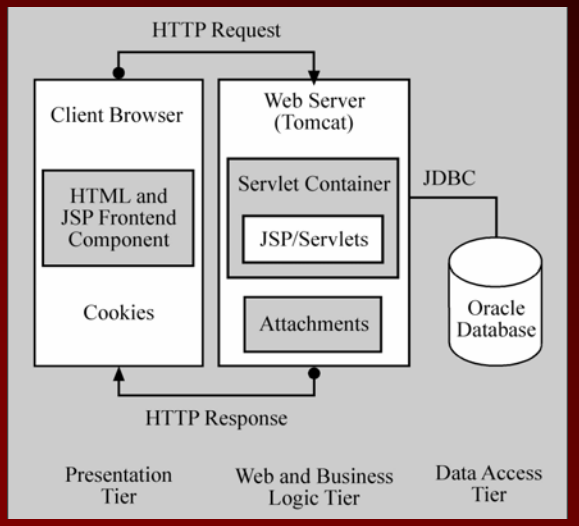
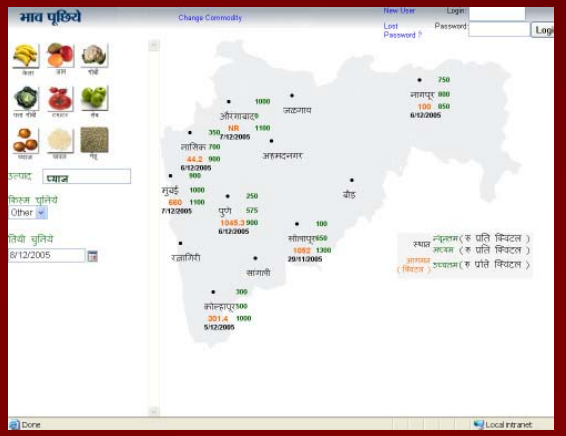
Results & Challenges

- Experts' response times average 36 hours
- Help-desk operator follows up with farmers a week after the solution is provided
- Expert calls the farmer to follow up if solution failed
- Farmers can call the center if online system cannot be accessed
- Interface suitable for novice internet users
- Can be accessed easily through low-bandwidth or intermittent connectivity
- Allows recycling of expert answers
- Provides crops library and crop doctor

Future Work

- Access through mobile devices
- Experimenting with radio, SMS, and telephone access
- Farmers can register for alerts
- Extend to providing more information such as weather reports
- Extend to applications in education, healthcare, eGovernance, etc.





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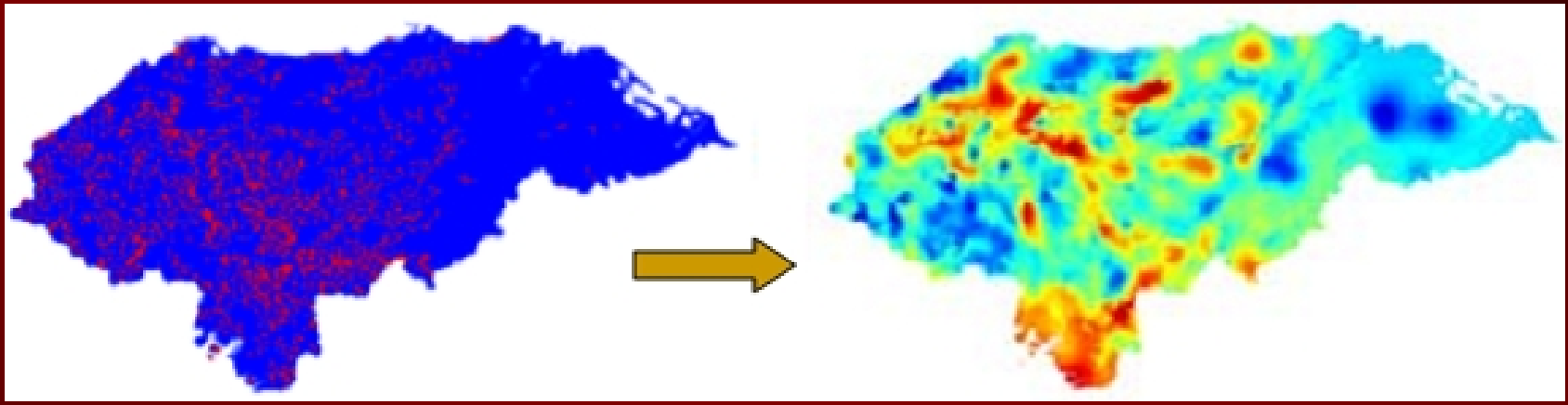
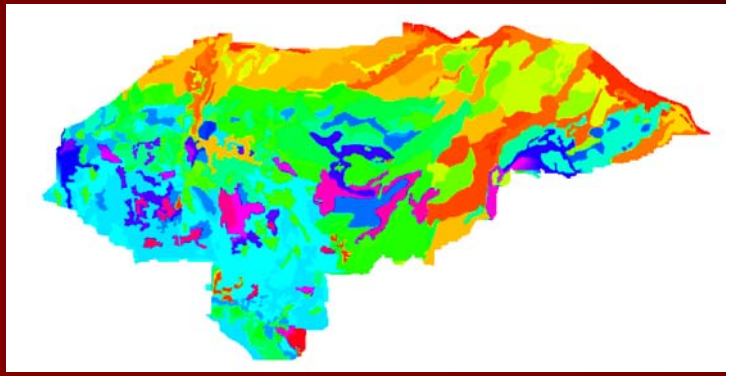
Statistical Soil Mapping



Juan Pablo Gonzalez, J. Andrew Bagnell, Simon Cook, Thomas Oberthur, Andrew Jarvis and Mauricio Rincon, Gaussian Processes for Statistical Soil Modeling of the Tropics, 2005
http://www.ri.cmu.edu/pub_files/pub4/gonzalez_juan_pablo_2005_2/gonzalez_juan_pablo_2005_2.pdf

Introduction

- Started as a V Unit
- Working with CIAT – Intl. Center for Tropical Agriculture (situated in Columbia)
- Used Artificial Intelligence/ Machine Learning techniques to dramatically improve soil maps
- Soil maps:
  - 1:24,000 ratio (30 m scale); 100% coverage: USA
  - 1:5,000,000 only (over 5 km) based on US soil taxonomy: FAO map

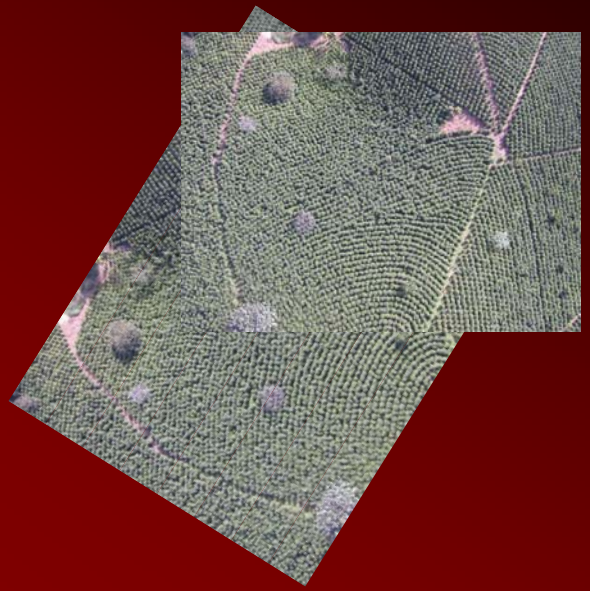


Results & Challenges

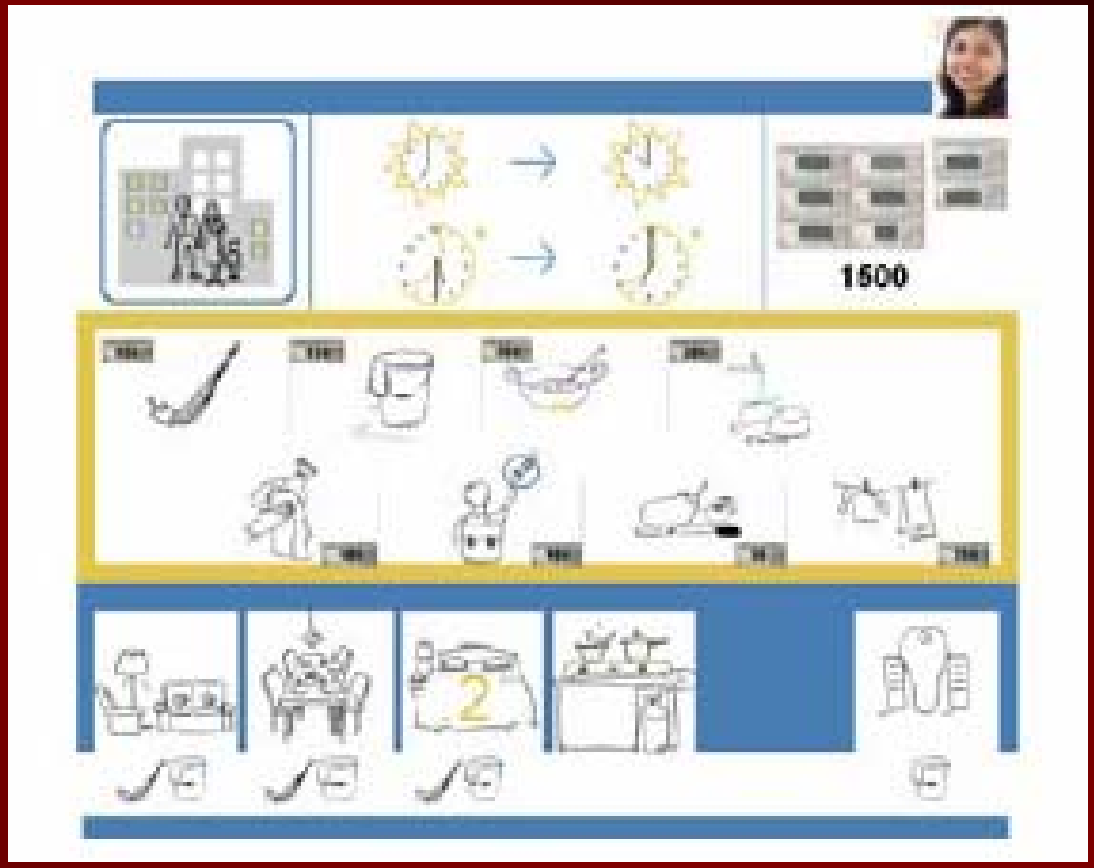
- Used:
  - 2500 soil samples from Honduras
  - Digital maps of Honduras
  - Derived variables
- Honduras (112,000 km^2)
  - 40 minutes @ 1km
  - 3.4 days @ 90m
  - 30 days @ 30m
- Applied Gaussian Processes
  - Quantitative predictions
  - Quantitative estimate of confidence
  - Complete coverage
  - Continued improvement
- Matched/advanced state of the art in predictive soil mapping

Future Work

- Compare performance with other learning techniques (mainly with regression techniques)
- Validate results in other locations
- Use active learning for collecting new data and improving models
- Partner with CIAT on other projects
  - Weather insurance
  - Species distribution



Text-Free User Interfaces



Indrani Medhi, Aman Sagar, and Kentaro Toyama, Text-Free User Interfaces for Illiterate and Semi-Literate Users, 2006
http://research.microsoft.com/users/indranim/Text-FreeUI.pdf

Introduction

- User interface for novice/illiterate users (with no other help)
- Domestic laborers in Bangalore slums were chosen
- Two applications:
  - Job search
  - City navigation

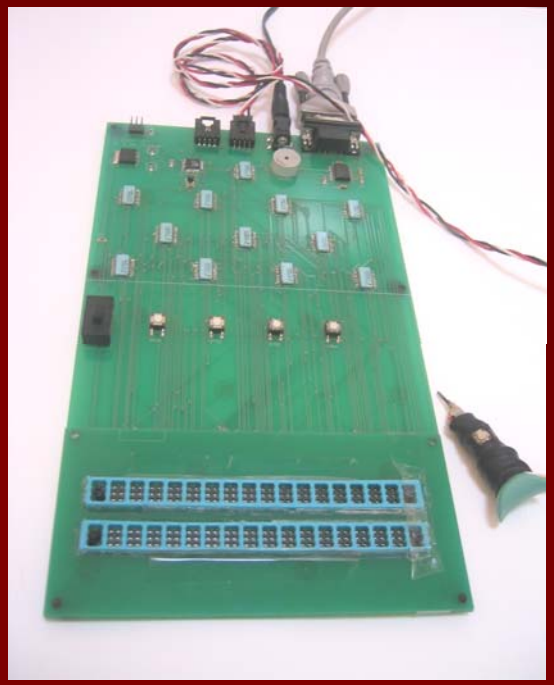
Results & Challenges

- Design principles:
  - Avoid text
  - Numbers are ok
  - Use semi-abstracted graphics
  - Photo-realism with deeper interaction
  - Pay attention to subtle graphic cues
  - Provide voice feedback
  - Provide help at all stages
- Text-free but not click-free
- Landmarks were important for navigation
- Testing conducted in homes
- Used trusted contacts
- Bollywood Method to encourage feedback
- Collaborative use

Future Work

- Ethnographic process: 180 hours with 80 men and women from Bangalore slums
- Strong preference for text-free interface
- Help on every “page” was important
- Include short movie that loops at the beginning
- Move towards use-studies with no external assistance

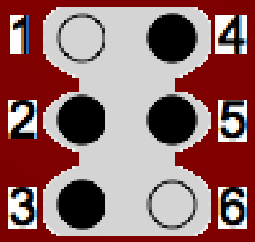
Braille Tutor



N. Kalra, T. Lauwers, and M. B. Dias, A Braille Writing Tutor to Combat Illiteracy in Developing Communities, 2007
http://www.ri.cmu.edu/pubs/pub_5676.html

Introduction

- Collaboration with Mathru School for the Blind
- > 90% of world's blind population live in developing countries
- < 3% of them are literate
- Braille:
  - Tactile writing system
  - Six dots per cell
  - Write by embossing paper
  - Traditionally with slate and stylus



Results & Challenges

- Successful 6-week long field test in Summer 2006
- Tutor catered specifically to needs of students and teachers in under-resourced communities
- Designed to be low-cost and robust
- Currently has activities for 3 grade levels Quantitative predictions
  - dots - letters
  - words
  - sentences
- In use at Mathru
- Second version of tutor developed based on feedback

Future Work

- Battery-powered
- Independent of computer
- Adaptive to skill level of user
- Longer, more extensive field study at Mathru
- Field studies at other locations
- Other languages (Arabic Braille)
- Games to increase enthusiasm

Project for Healthcare in Pakistan

- Speech-driven system for paramedical workers in Pakistan (e.g., Lady Health Worker Program)
- Background (Motivation)
  - Intersection of
    - People

      Motivated faculty and graduate student from Pakistan
    - Funding

      MSR Digital Inclusion RFP
    - Stakeholders

      Visit to Pakistan found Aga Khan University, a leading medical school
      - » Has substantial community health program

Research Questions

[This is a research project, not a full deployment]

- Will it work?
  - Urdu language speech recognition is limited
- What interfaces and dialog systems are best?
  - “Natural” conversation, directed dialog, keyword searching, etc.
- Are semi-literate users a compelling “market”?
  - Literate can read, instead; illiterate may not have a substantial driver to use

Design Sustainability

- Technology
  - Centralized design, using phones in the field, makes maintenance and upgrading simpler
  - Can be maintained by a motivated IT user (doesn't require a speech researcher)
- Financial
  - Preliminary analysis indicates positive cost-benefit analysis, indicating ongoing government or donor support would be justified
- Stakeholder incentives
  - If it works during the controlled trials, will users continue to use it subsequently?

Ongoing and Future Work

- Developing a Prototype
  - Technical challenges
    - Vocabulary
    - Acoustic models
- Healthworker interaction
  - Dialog preferences
  - Needs Assessment
    - Training, Diagnosis, etc.
- Determining systems and incentive structures