GENI Educational Kits using Wireless Sensor Networks

a.k.a. SensorKits

Spiral 4 – Annual Report

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1. Major accomplishments

- We have created a light-weight Benchtop miniArray Kit (BAK) virtual machine image of the Kansei software that is installable by a single DVD, capable of distribution in the kits.
- We have reduced the set-up time necessary to deploy a new wireless sensor network from days of command-line work to minutes of configuring the VirtualBox GUI.
- We added a plug-and-play capability to the BAK software to recognize and configure sensor motes automatically when inserted by users.
- We have partnered with educators to develop lesson plans that utilize wireless sensor motes and meet criteria for STEM national education standards.
- We have developed initial lesson plan documents, user help guides, and experiment software that utilizes light, temperature, sound, and radar sensors.
- We have set up an ORCA site authority actor to represent the BAK kits in the ORCA control framework running on servers in Columbus, Ohio.
- We have created a Science Apps repository that is included in the local kit cache with additional apps available online.
- We have conducted training sessions and set up BAK kits at adopter sites.

2. Milestones achieved

- SENSORKITS: S4.a GEC12 Present project plan, expected experimenter services, and benefits to GENI community during new projects session at GEC12
    - Done.
- SENSORKITS: S4.b GEC13 Develop and deliver a lightweight implementation of the KanseiGENI aggregate manager for Benchtop mini-Array Kits (BAKs). Demonstrate at GEC13
    - Done.
- SENSORKITS: S4.c GEC14 Integrate aggregate manager of BAK kits with the ORCA control framework by re-factoring the Site Authority so it can run on a GENI compute cluster, separately from the resource constrained kit controllers. Pilot test and deliver BAK kits and BAK training material for kit operators and users; demonstrate use of application store and data store from local kit cache (as opposed to GENI cloud cache). Conduct training session at adopter site (e.g., educational organization or science museum).
    - Done.

3. Deliverables made

1. BAK virtual machine images that contain all functionality of KanseiGenie in a DVD. http://kansei.cse.ohio-state.edu/KanseiGenie/Downloads/

2. Six BAK testbeds with motes were installed in a lab at IIIT-Allahabad for use in courses on Wireless Sensor Networks and on Embedded Systems.

3. A wiki page for integrating BAK/PAK software into lab-based STEM education is available at: https://sites.google.com/site/stemsensors/

4. The Science App Store for downloading newly published experiments is available at: http://kansei.cse.ohio-state.edu/KanseiGenie/Downloads/Apps

5. Kit installation instructions, a link to tutorials for using the KanseiGenie web portal, and initial lesson plan offerings are available at: http://sites.google.com/site/kanseilite/

6. Lesson plans for STEM experiments are available at: https://sites.google.com/site/stemsensors/lessonplans

4. Description of work performed during Spiral 4

We have accomplished the Sprial 4 objectives of the Sensor Kits using Wireless Sensor Networks project by improving, shrinking, and distributing the KanseiGenie software as a downloadable virtual machine while in parallel creating STEM education experiments.

Summary of accomplishments in KanseiGenie BAK software:

- Reduced the footprint of the KanseiGenie software from 12GB to 4GB.
- Reduced the setup time for a new sensor network from days to under an hour.
- Streamlined and centralized the configuration of KanseiGenie software from hand-coded solutions to configuration files.
- The BAK software is distributed via download on the KanseiGenie website since December 2011.
- Kits include pre-made experiments and experiment data is automatically saved.
- The BAK software is represented by an ORCA actor running in the cloud for non-local access.

Summary of accomplishments in training materials and lesson plans:

- Created microphone-based lesson plans that address national STEM standards.
- Software for the Intensity of Sound lesson plan complements the Temperature Carrier and Radar-Pendulum apps.
- Pilot-tested training materials are available for download by kit operators and users.
- Local kit caches include the Temperature and Light Carrier application.

- Additional applications may be manually downloaded from the “Science Experiments Apps Store” and placed in the local kit cache via the web interface.
- User-facing website with setup instructions and experiments.
- Training session conducted at IIIT-Allahabad.

5. Project participants

Investigators:

Anish Arora

Rajiv Ramnath

Staff:

Michael McGrath

Wenjie Zeng

Jing Li

Volunteers:

Adam Stohs (Engineering Physics)

Steve Stonebraker (Physical Science)

Prof. Andrew Heckler (Physics)

Prof. Dean Cristol (Education)

Prof. Hae-Jin Lee (Mathematics Education)

Undergraduate capstone volunteers:

Evan Dawson

Steven Warton

Bai Yuan

Abdul Alkaharashi

6. Publications (personal and organizational)

The GEC14 curriculum workshop presentation and demo poster are available on the GENI wiki at http://groups.geni.net/geni/wiki/SENSORKITS

7. Outreach activities

- Regular STEM lesson plan meetings brought together experts on teacher training, secondary school educators, and leaders who have successfully piloted STEM education initiatives.

- The PI participated in a Nobel Laureate Science Conclave at IIIT-Allahabad in November 2011, where he interacted with a large number of undergraduate and high school students and their teachers. He had three sessions where he demonstrated science experiments using wireless sensor networks. (The specific sensors leveraged were low power radars, temperature and light sensors.) He also conducted live tutorials on the use of the BAK kits.

- IIIT-Allahabad volunteered to adopt the kits for use in their lab-oriented courses. This led to their installation of the six BAK testbed in their microelectronics department labs. OSU provided support in the process.

8. Collaborations

STEM:

Secondary school teachers from Thomas Worthington High School and Columbus West High School attended curriculum development meetings. The educators provided input regarding possible mathematics and physics experiments.

Capstone:

Four undergraduate students build a smartphone application to be used in conjunction with the PAK. The cellphone application will be a tool used by researchers to create and monitor experiments.

9. Other contributions

We have contributed to the following GENI activities:

- PI Rajiv Ramnath presented the project plan at GEC12.
- Student Mike McGrath participated in GEC13.
- PI Anish Arora presented at GEC14's Curriculum Workshop and the July 9 Curriculum session.
- PI and student Mike McGrath presented the BAK virtual machine and Temperature/Light carrier demo at GEC 14's Demo Session.