Demo: Turning Mobile Phones into Educational IoT Devices

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Abstract

The demonstration introduces PhoneIoT, a mobile app that allows students to access their smartphones programmatically over the Internet. PhoneIoT supports access to live sensor data from the device and controlling a customizable display on the phone's screen. PhoneIoT allows students to learn the fundamental concepts of distributed computing and networked sensing using NetsBlox, a simple but powerful block-based programming environment. PhoneIoT is also accessible from PyBlox, a Python IDE specifically designed to ease the transition from blocks to text, as well as through an open-source Python library. PhoneIoT makes it possible to teach networked sensing and actuation without extra hardware from high school up.

CCS Concepts

• **Applied computing** → **Interactive learning environments**; • **Computer systems organization** → **Embedded and cyber-physical systems**.

Keywords

IoT, Secondary Education, Distributed Computing, Learning Environments

While distributed computing, computer networking, and the Internet of Things (IoT) are ubiquitous in modern life, these technologies are rarely taught in introductory K-12 computer science classes. Although some students gain exposure to embedded computers through makerspaces using devices like Raspberry Pis or micro:bits, these experiences are often disconnected from real-world IoT applications and limited by cost, logistics, and teacher expertise. Given that over 84% of U.S. teenagers own smartphones equipped with powerful sensors (accelerometer, gyroscope, microphone, camera, GPS) and internet connectivity, these devices present an untapped opportunity for accessible IoT education.

This demo introduces PhoneIoT, an open-source mobile application for Android and iOS that transforms smartphones and tablets into programmable IoT devices. PhoneIoT integrates with NetsBlox, a block-based programming environment that extends traditional visual programming with networking capabilities through Remote Procedure Calls (RPCs) and message passing. This combination enables novice programmers to create sophisticated distributed applications using familiar drag-and-drop interfaces while learning fundamental IoT concepts.

PhoneIoT provides two primary capabilities that address core IoT educational requirements. First, it offers comprehensive sensor access through both polling and streaming paradigms. Students can request instantaneous sensor readings via RPC calls or register for continuous data streams by specifying message types and update intervals. This dual approach naturally introduces concepts of different data access patterns while demonstrating real-world IoT communication methods.

Second, PhoneIoT enables creation of customizable interactive interfaces on mobile devices. Students can programmatically add GUI controls including buttons, text fields, image displays, toggle switches, and virtual joysticks. These controls use a relative, percent-based coordinate system that ensures projects work across different screen sizes, promoting shareability between students. User interactions trigger messages sent back to the student's NetsBlox program, enabling sophisticated input handling and real-time feedback.

The system employs a client-server architecture where the NetsBlox server mediates communication between browser-based student programs and mobile devices running PhoneIoT. The UDP protocol was chosen for its speed and packet-based nature, which provides authentic learning opportunities about network reliability and error handling in distributed systems.

Privacy protection is paramount given the K-12 audience. PhoneIoT implements multiple safeguards: automatic disconnection when the screen turns off, expiring random passwords for device access, microphone access limited to volume levels, and camera access restricted to user-initiated image captures.

PhoneIoT enables engaging projects that would be complex to implement from scratch but become accessible through the provided abstractions. Example applications include GPS trackers that plot movement on interactive maps, accelerometer plotters for real-time sensor analysis, and custom robot remote controllers that combine PhoneIoT's GUI capabilities with physical or virtual robot control. These projects demonstrate key IoT concepts including sensor fusion, real-time data processing, distributed system design, and human-computer interaction.

Students can also utilize PhoneIoT from Python either as a built-in feature of PyBlox, a tool helping NetsBlox users transition to text-based programming or using a Python library. The demo will showcase various networked sensing application using both block-based and Python examples.