Design of Multimodal Instructional Tutoring Agents using Augmented Reality and Smart Learning Objects

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Abstract

This demo presents a novel technique of enriching students' learning experience in electronic engineering laboratories and the basis for its design. The system employs mobile augmented reality (AR) and physical smart objects that can be used in conjunction to assist students in laboratories. Such systems are capable of providing just-in-time information and sensing errors made while prototyping of specific electronic circuits. These systems can help reduce cognitive load of students in laboratories and bridge gaps between theory and practical applications that students face in laboratories. Two prototypes have been developed – (i) an Intelligent Breadboard (IB) prototype that can sense errors like loose wiring, wrong connections, etc. for a specific experiment, and, (ii) an AR application that provides visualization and instruction for circuit assembly and operating test equipment. The intelligent breadboard acts as a smart learning object. Design methods were used to conceptualize and build such systems. The idea is to merge practices of Human Computer Interaction with those of machine learning to design highly situated physically located tutoring systems for students. Such systems can help innovatively in teaching and learning in engineering laboratories.

Keywords: Education | Augmented Reality | Ubiquitous Computing.

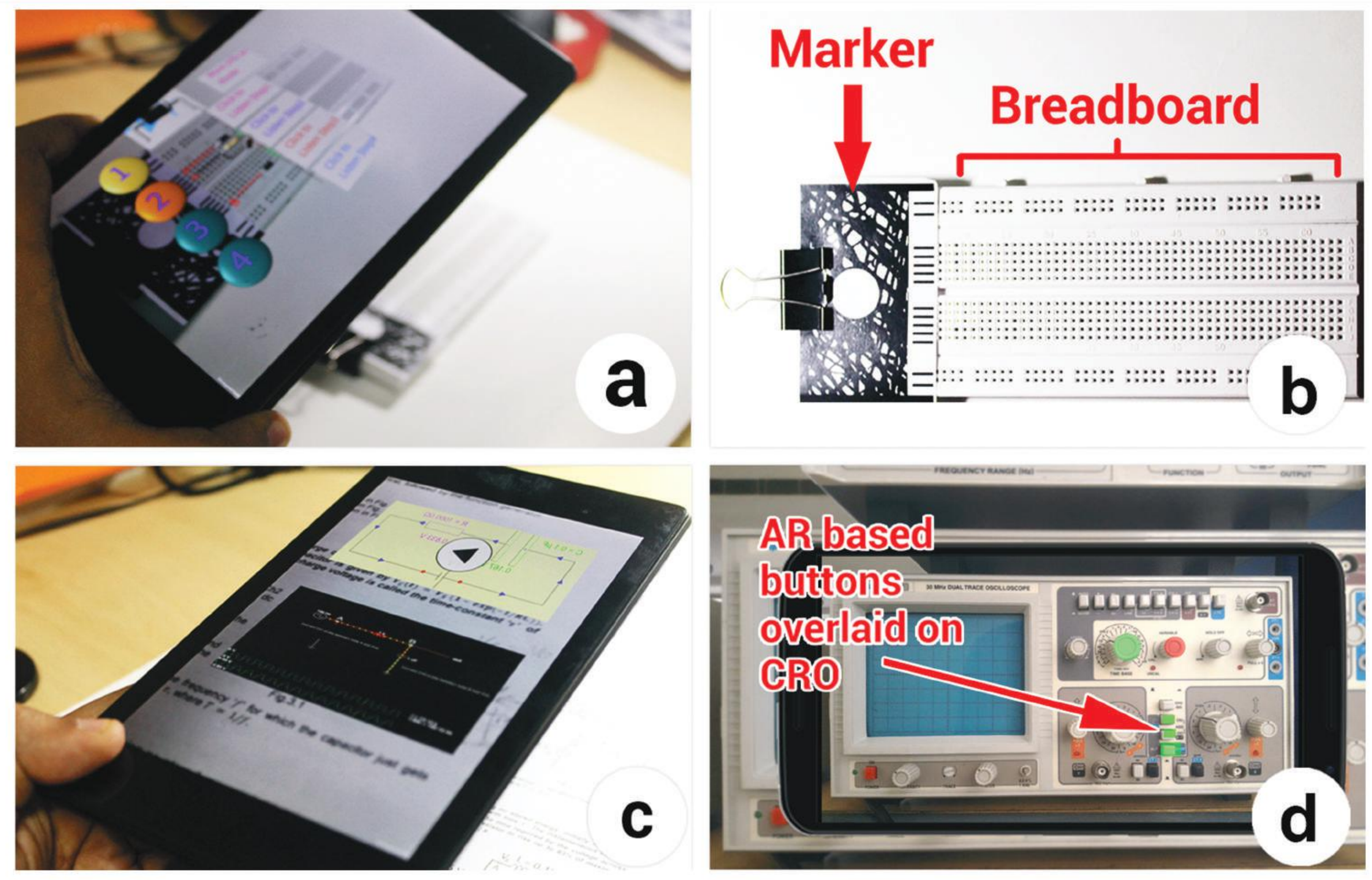

Fig. 1 Augmented Reality application functionalities. The app utilizes both marker and markerless tracking features. (a, b) 3D circuit building instructions are displayed on breadboard attached with a marker, (c) Videos of theoritical concepts of experiment are displayed when the app is hovered over lab manual, (d) Operating instructions for test equipment are displayed using markerless tracking feature, CRO - Cathode Ray Oscilloscope.

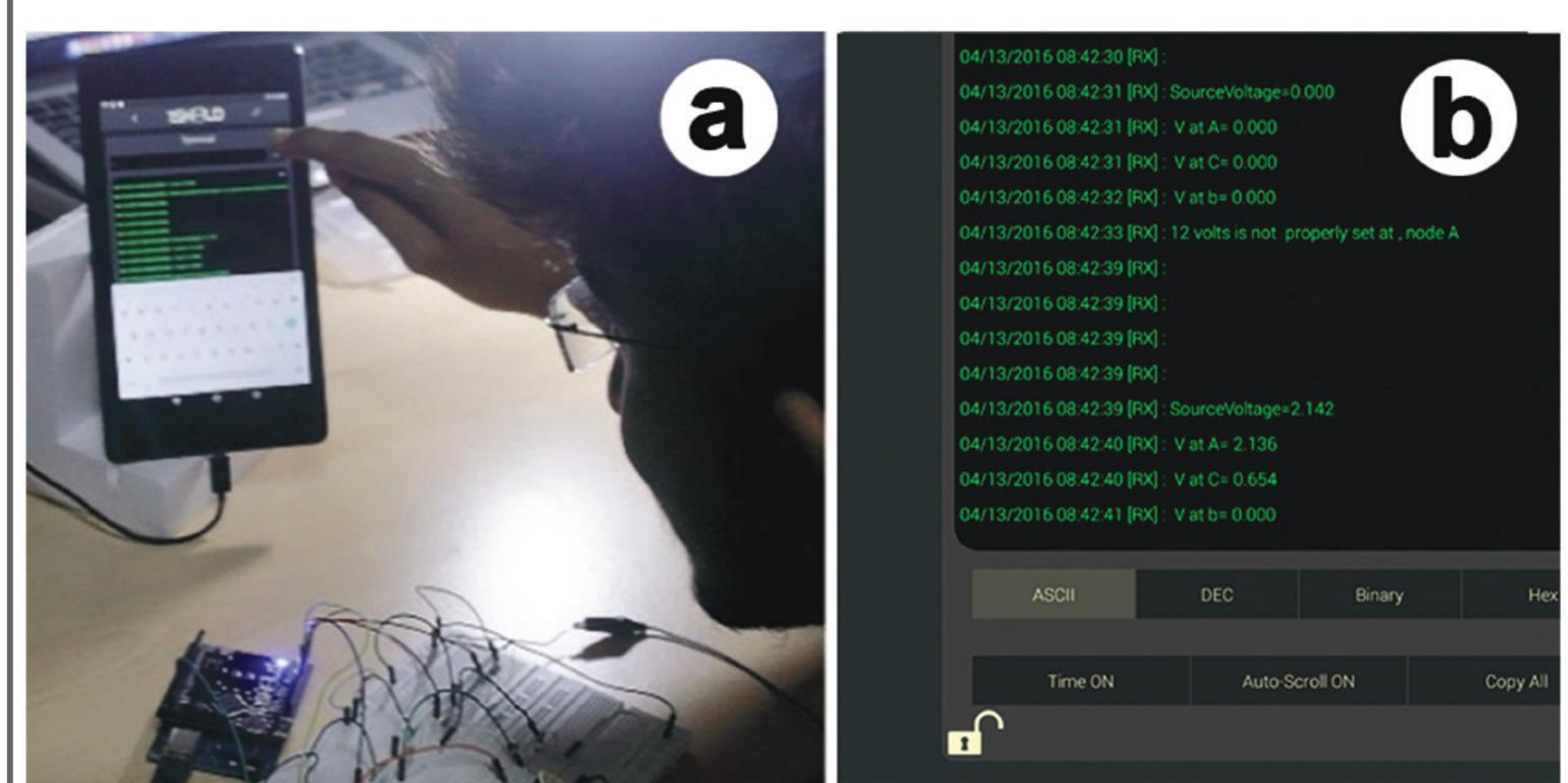

Fig. 2 Intelligent Breadboard setup. The breadboard utilizes both text and voice based interaction modalities via smartphone or digital tablet to provide instructions to user. (a) A user interacting with IB setup via digital tablet, (b) Error is sensed by the breadboard and displayed to user on the screen.

Methodology

- This research utilizes User-Centered Design approach as practiced in Human-Computer Interaction. Both quantitative and qualitative methods of data collection have been employed. Usability testing methods were extensively used to conceptualize and develop the prototypes.
- User testings were amongst seventy-nine participants (N=79) with our AR application, depicted in figure 3 below.
- We hypothesize that our prototypes will reduce the cognitive load experienced by students in labs while conducting experiments.

Conclusion

The prototypes proposed and presented in this demo present various modes of interactions which are possible with SLO and AR. These are screen and voice based interactions. Screen based interactions employ text and AR based approach, see figures 1, 2 and 4, while the latter uses voice-based methods to impart instructions to students. The proposed system provides structured information to students at the right time so that they can relate to situation and context of the experiments being performed in lab.

Fig. 3 User-testing being conducted with our AR application.

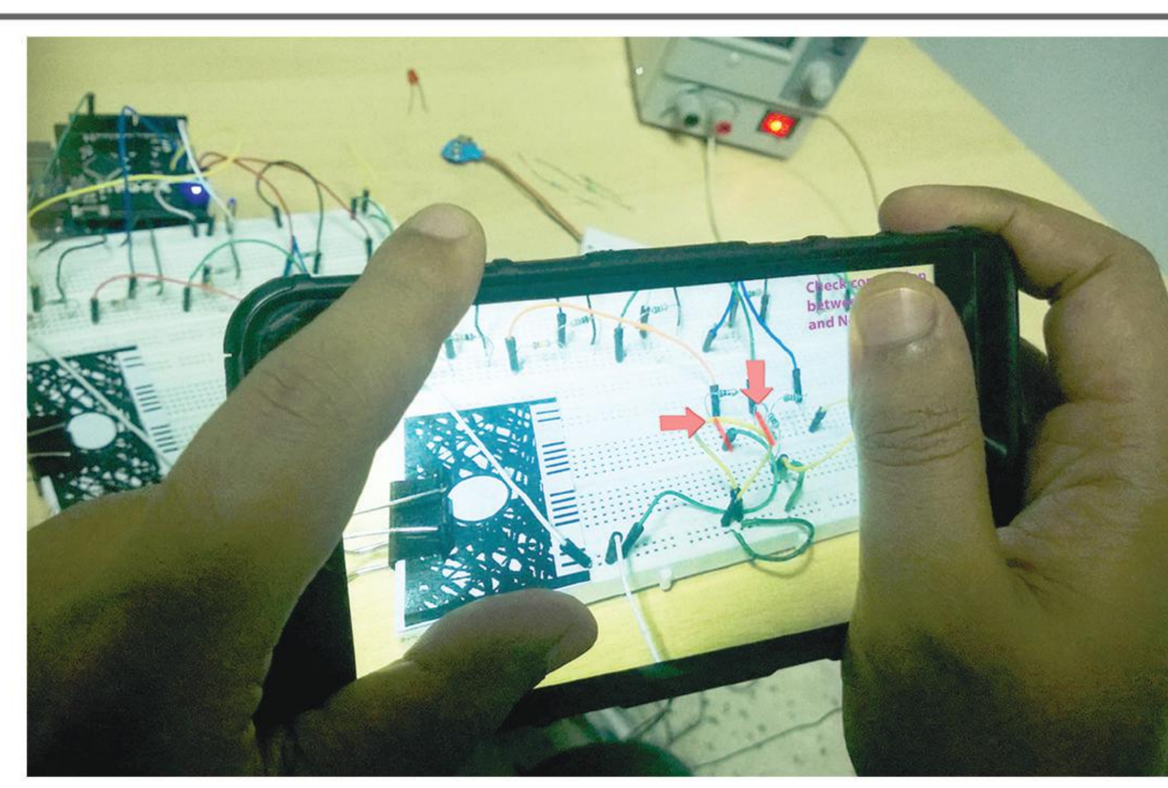

Fig. 4 AR and SLO used in conjunction (under development).

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