Enriching Student Learning Experience using Augmented Reality and Smart Learning Objects

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1. Abstract:

Physical laboratories in Electronic Engineering curriculum play a crucial role in enabling students to gain "hands-on" learning experience to get a feel for problem-solving. However, students often feel frustrated in these laboratories due to procedural difficulties and disconnects that exist between theory and practice. This impedes their learning and causes them to lose interest in the practical experiment. This research considers the approach of ubiquitous computing to address this issue by embedding computational capabilities into commonly used physical objects in electronics lab (e.g. breadboard) and making use of mobile Augmented Reality application to assist students. Two working prototypes have been proposed as a proof-of-concept. These are (i) an AR based lab manual and circuit building application, and, (ii) Intelligent Breadboard - which is capable of sensing errors made by students. It is posited that such systems can help reduce cognitive load and bridge gaps between theory and practical applications that students face in laboratories.

Keywords: Education • Augmented Reality • Intelligent Breadboard

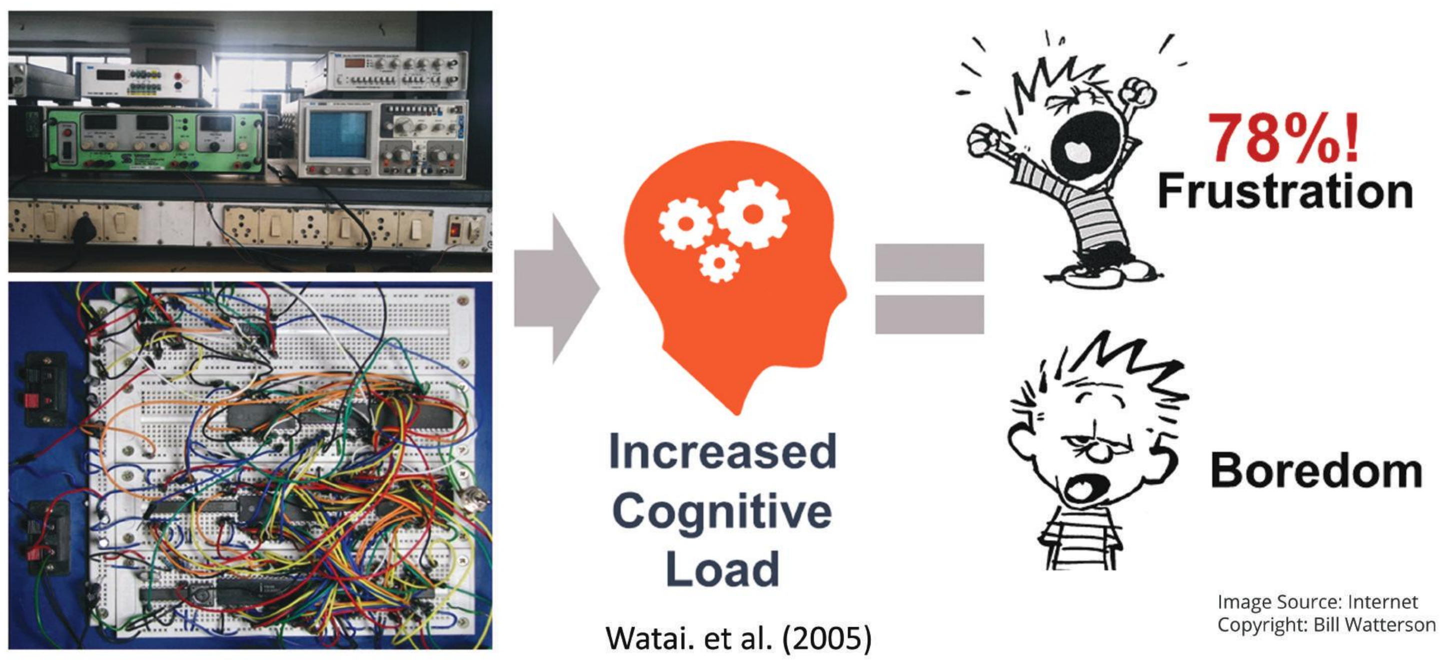


Fig 1: Students are often bogged down by procedural difficulties during experiments which increases their cognitive load.

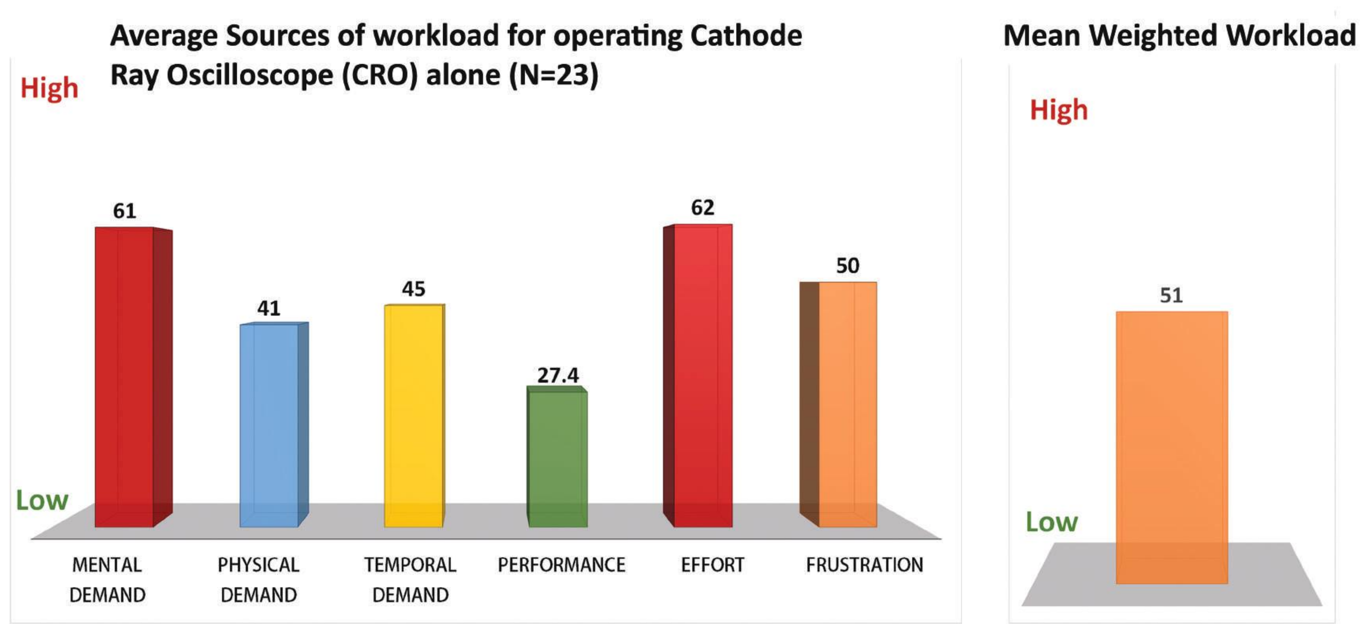
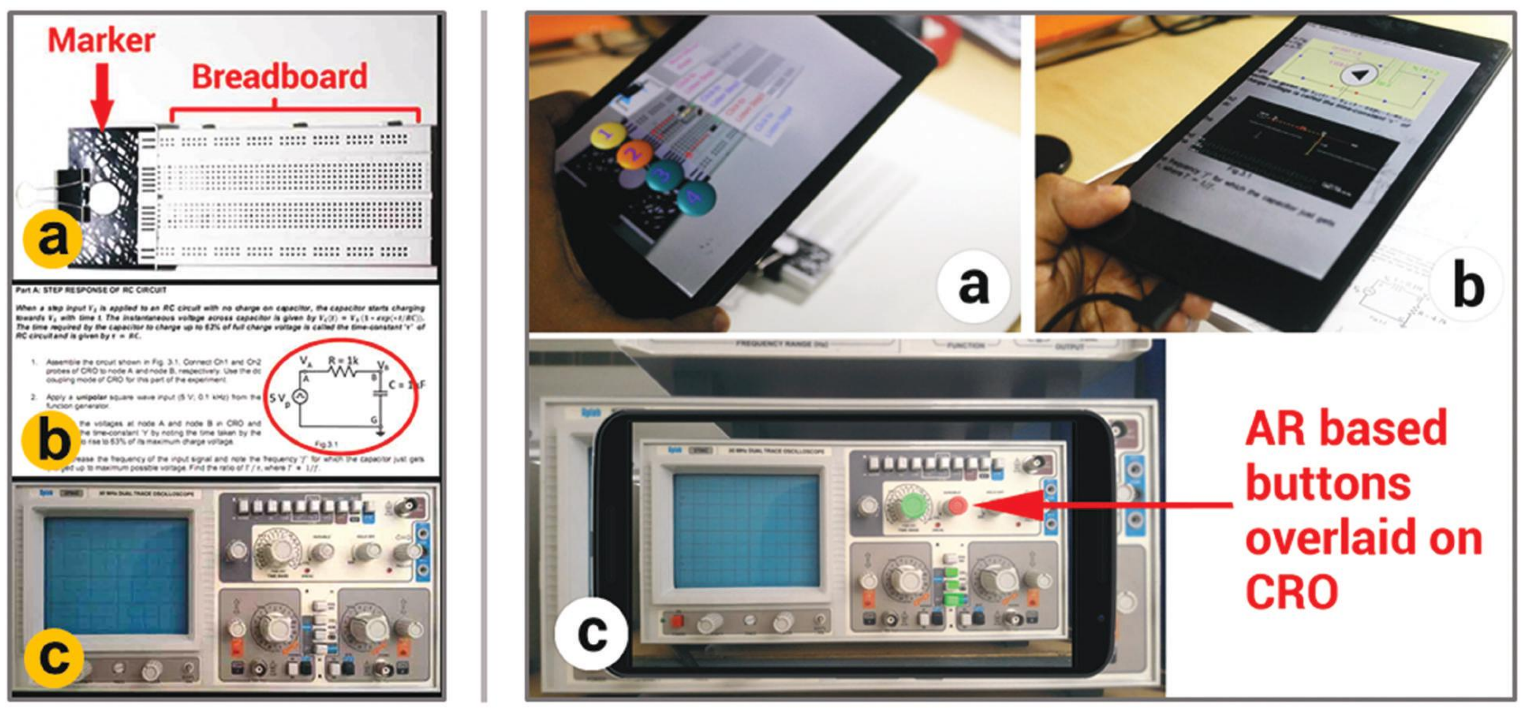


Fig 2: Students subjective workload accessed using NASA TLX questionnaire.

2. Prototypes



a) Marker and Marker-less tracking

b) Digital information augmentation over real space

Fig 3: Prototype 1 - Augmented Reality application for Electronics lab and its functionalities. (a) Tracking features, (b) Information display through AR view for breadboard, lab manual and test equipment.

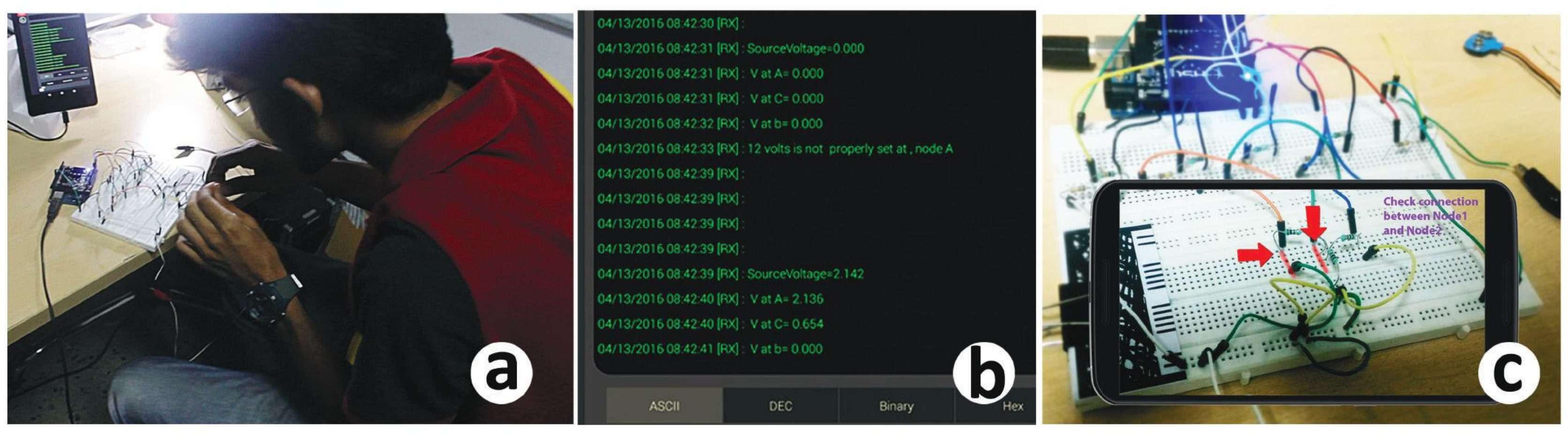
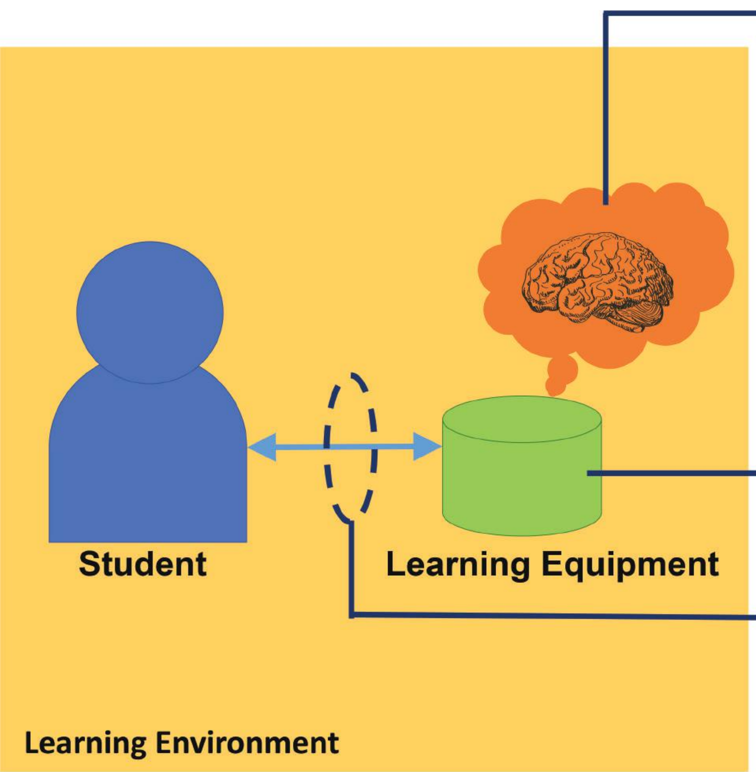


Fig 4: Prototype 2 - Intelligent Breadboard senses errors made by users for specific experiments and provides instructions to them in a manner similar to that of a human instructor. (a) A user working on IB, (b) The mobile interface provides text and voice based instructions, (c) AR based interaction modality.

Main functionalities of both these prototypes:

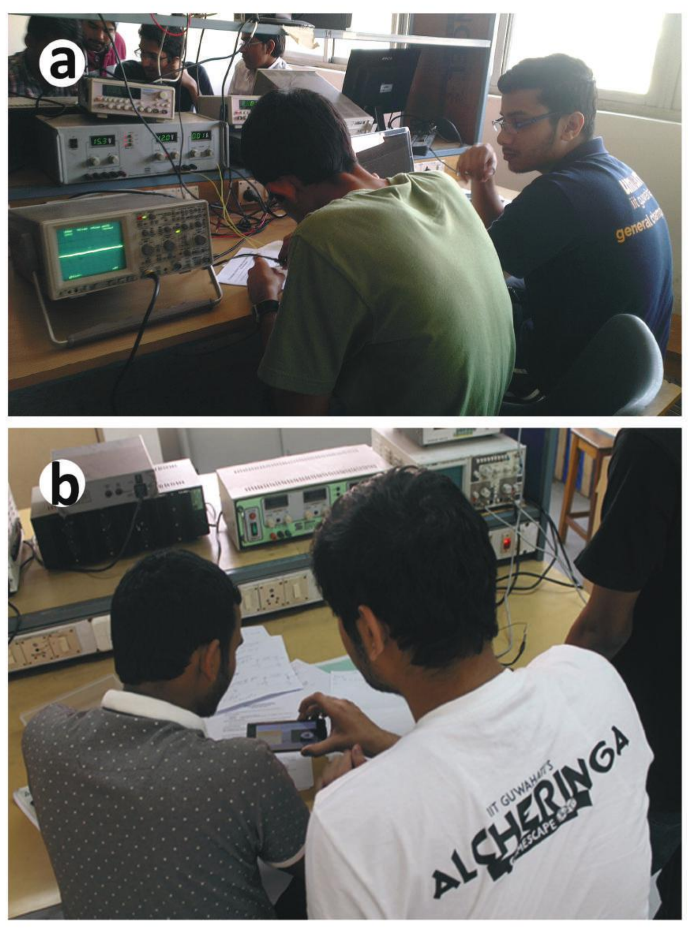
- Voice, Text and AR based interaction and instructional modality.
- Error sensing using IB for specific experiments .
- Marker and Marker-less AR tracking.

3. Research Questions and Methodology



1. Are there guidelines /heuristics for embedding intelligence in such equipment? If not, can they be developed based on experiments?
2. What type and how much of intelligence be embedded in such equipment? In what form should it be embedded?
3. How to establish interaction between such equipment and the user? Which usability principles apply?

Fig 5: Student's interaction with learning equipment in a lab learning enviornment.



This research is mainly rooted in the Human-Centered Design approach and utilizes both qualitative and quantitative methods of data collection.

Instruments used for data collection and analysis:

- Field observations, videography, photos
- Semi-structured Interviews, Questionnaires
- Content and Interaction Analysis, Statistical tools

Fig 6: (a) Contexual Inquiries were conducted to identify problems faced by students and conceptualize prototypes, (b) User-testing with AR application in live lab session.

Following hypotheses are being tested:

H1: AR app and SLO are expected to reduce the cognitive load of students in electronics lab practical.

H2: AR app and SLO are expected to increase students' performance in electronics lab practical than their current level.

4. Conclusion:

The main contribution of this research work is in offering novel tools for situated learning in an engineering higher education context in the form of Augmented Reality application and Smart Learning Object. The progress so far has been validated in part with encouraging positive results.

References

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ICMI 2016
International Conference on Multimodal Interaction 2016, Tokyo, Japan