A web-based, virtual laboratory assistant called VOLTA was developed at Temple University. We have used VOLTA on electric circuits laboratory for three semesters. Students could perform their circuits labs with VOLTA and hardware kit (Spintek Boards and basic circuit elements). Students can learn quite a bit by experimenting with the basic circuit elements, however, the laboratory equipment and the teaching assistant have to be available. Through well-designed VOLTA software, students could do circuit lab any time, anywhere. We found out that the students who used VOLTA tend to learn more than the students in the traditional circuits laboratory. This experience made investigators realize the importance of the laboratory education in our engineering curriculum. The investigation interacted a lot more with the teaching assistant and the students through this project. Furthermore, the investigators and his students have participated on two national and three local ASE conference. We also wrote educational journal article based on this project.

SENIOR DESIGN PROJECT

In 2012, the investigators and his students have participated on two national and three local ASSE conferences. We have written educational journal articles based on this projects. One project is that the web-based virtual teaching assistant will improve student's learning in the software. Perhaps the most important lesson that we all learned from this project is that web-based virtual teaching assistant will improve student's learning by allowing them to explore electric circuits at their convenience.

VOLTA SOFTWARE DESIGN

VOLTA consists of five modules and a database. The modules are: (1) Instructor module; (2) Student module; (3) Help module; (4) Circuit recognizer module; and (5) Speech module. The instructor module is used to administer VOLTA and content update. The student module is used to provide the enrolled students virtual assistant through a web-based graphical user interface. Help module in conjunction with the Circuit recognizer module and the Speech module. VOLTA is implemented using Python scripts in Django web framework (version 1.6.5). For the database, SQLite is used.

VOLTA OVERVIEW

VOLTA is implemented as a client-server model, where the clients communicate with the server via the internet. VOLTA provides 24/7/365 virtual assistant. Offers immediate, direct help for struggling students. Gives instantaneous feedback on laboratory work and tests. Links to instructional videos, definitions, and explanations. Allows instructors to customize laboratory layout.

USER INTERFACE AND HARDWARE

User Interface:

- VOLTA url: volta.temple.edu/vlta
- Students perform experiments using step-by-step guide (Fig. 4).
- Students can type questions relevant to circuits and labs for the answers.

Hardware:

- Students are provided with a compact, portable circuit board (Electronics Explorer Board) (Fig. 5).
- The board comes with a USB cable, a power adapter, and circuit element kit. Also, the board is equipped with the function generator, multimeter, and oscilloscope which are controllable by software (Waveforms).
- VOLTA and EE board empower students to carry out the circuit lab experiments outside the lab room (provided PC, power, and internet availability).

CIRCUIT RECOGNITION MODULE

The circuit recognizer module helps the students verify their simulated circuit and debug their hardware circuit. This module contains an image processing algorithm based on template matching for automatic recognition of the simulated circuit schematics. This module also helps to debug a hardware circuit by providing a circuit tracer.

SPEECH MODULE

The speech module provides a more flexible means for assisting the student. It provides voice activated help in VOLTA. This module helps by detecting emotional state of students.

HELP MODULE

The help module provides the students with a teaching-assistance-like-service in virtual format. The students can seek help from this module at any point during the VOLTA session. This module provides multiple pre-loaded help files: definitions of circuit terminology, questions and answers about basic circuit and related lab, safety video tutorial, basic instrument use video tutorial, forum for discussing the problems. This module works in conjunction with a circuit recognizer module and a speech module. The circuit recognizer helps the students verify and debug their circuits. The speech module gives options of voice-activated smart search capability and emotion detection.

ASSUMPTIONS

1. VOLTA supports students during undergraduate circuits laboratory activities, even when the teaching assistant is unavailable.
2. The study showed a modest performance improvement in Fall 2014 and a large performance improvement in Spring 2015 between VOLTA-taught and traditionally-taught students.
3. After implementing all the features of VOLTA, we expect that it will enhance user experience and decrease the user frustration.

REFERENCES