Student-Scope: Handheld All-in-One Electronics Lab Assistant Device with USB Connectivity for Engineering Students

Problem – Multi Tool Labs

Test and measurement instruments such as oscilloscopes and multimeters are the traditional hardware tools, an electronics engineer would have on his bench. Students in engineering curriculum, when exposed to these instruments, often come across a multitude of equipments such as voltmeters, ammeters, oscilloscopes and even simple things like calculator. Even after the touchscreen based smartphone revolution, most of the engineering colleges in India continue the tradition of introducing the students to a decade old instruments.

What we need?

Today's students want to solve problems and experience engineering regardless of where they are - in lecture, in the laboratory, or the study room. Professors want to provide a hands-on learning experience to empower students who want to tinker, experiment, and explore concepts. With a portable laboratory, a student can learn concepts in their preferred environments and provides a supplement to the traditional lecture and laboratory based courses.

Modern Subjects – Embedded Systems

The other drawback in the older instruments is its lack of assistance to develop modern engineering systems which involves embedded systems and VLSI design. Embedded Systems and VLSI Design are a culmination of electronics and computers and as a result requires a special understanding of the subject. Embedded system in itself is a very vast field with multiple sub domains and it has already become a basic skill set necessary for a successful career for a graduate in electronics engineering.

Our Solution

Our aim is to design and develop a portable device called Super-Scope which is ALL-IN-ONE electronics lab equipment that has multiple functionalities needed by a modern day engineering student for his practical experiments in electronics and computer labs that would replace the existing plethora of instruments. The device is a fully operated from touchscreen using touch buttons and menus.

The Feature List

The device has the following features built in:

Digital Signal Oscilloscope – used to monitor signals acquisitioned through the inbuilt 10-bit **A to D converter**. This device is single channel, 100 KHz bandwidth. The signals will be shown in color waveforms in a nice **65K Color QVGA Touchscreen TFT Graphical LCD Display**.

Waveform Storage and Playback – used to save the acquired signals for analyzing and viewing. The storage medium is a 2GB **MicroSD** memory card.

Frequency Generator – used to generate pulses at variable frequencies with added pulse width control

Logic Analyzer – used to analyze serial protocols such as UART

Voltmeter – used to measure the input DC voltage

Ammeter – used to measure the input DC current using current shunt resistor drop

Ohmmeter – used to find the resistor values, short circuits and components such as diodes

Tachometer – used to measure the speed of the rotating shaft of the motor using the **Rotary Encoder**

Audiometer – used to monitor the audible frequency signals sensed via **Microphone** circuitry.

3-axis Motion Monitor – used to measure acceleration or tilt or motion on all three axis using **3-Axis MEMS Accelerometer**

Light Meter – used to measure the brightness of the incident light in terms of Luminosity using **Light Sensor**

Temperature Probe – used to measure the temperature or heat of atmosphere or an object in degree celsius

Calculator – used to perform math calculations using touchscreen keypad

The software uses **Graphics Library** and the user interacts with the device using touchscreen buttons and menus. The device has a USB-UART bridge circuit that gives **USB connectivity** for Desktop/Laptop communication for data logging the measured quantities. The logged data can be used for further analysis. This process can be fully controlled by the user from the device UI. It also helps to easily upgrade the firmware of the device from a desktop/Laptop. The device is controlled by **LPC1313**, a powerful 32-bit **ARM Cortex-M3** microcontroller from **NxP Semiconductors**.

Software Tools Used:

- Programming Language: Embedded C
- Development Tool: LPCXpresso IDE (Eclipse based)

Embedded Protocols Used:

- I2C, SPI, UART, USB

Software Libraries Used:

- Graphics Library for TFT LCD
- Touchscreen Driver Library via SPI
- USB - UART Driver Library
- Micro-SD Card Driver Library via SPI
- MEMS Accelerometer Driver Software via I2C
- INA219 Chip Driver Software via I2C
- Cortex-M3 Peripheral Device Driver Library
- CMSIS from ARM

Project Advantages

- Replaces the traditionally used lab instruments in an ALL-IN-ONE device
- Enables student to solve problems and experience engineering regardless of where they are - in lecture, in the laboratory, or the study room.
- Enables professors to provide a hands-on learning experience to experiment within the classroom.
- Assists in developing modern engineering systems which involves embedded systems and VLSI design.
- Advanced TFT Color display for rendering clear waveforms and operated with the latest touchscreen interface similar to smartphones.
- Designed around LPC1313, a 32-bit ARM Cortex-M3 microcontroller provides high performance at very low power budget suitable for portable equipments like our super-scope.