Research and Development of Portable Instrumentation Lab using Arm-7

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Abstract: ***The main goal is to solve the trade-off between the need for performing the real laboratory in engineering students and the real time analysis the sensors characteristic in the industries, the rapid development in the research and innovation field was supposed to ease the workload of scientists and engineer. As more and more sensors/transducers are being introduced in the market, engineers are having trouble to pick the best suited sensor for the application, hence the sensors and the signal conditioning circuit are the main part and are discussed in this paper. Writing firmware for the controllers so as to read the specific characteristics is also very important task. The fast popularization of embedded Advanced RISC (Reduced instruction set computer) Machine (ARM) processor, it has been a trend that ARM processor can substitute the single-chip to realize data acquisition and control. A new kind of input/output portable instrumentation lab on embedded ARM platform has been researched and developed in this paper, whose hardware platform use 32-bit embedded ARM microprocessor, and software platform use the GNU and the compiler use the win-ARM. In the existing instrumentation labs with different interfacing card are required for different transducers. In Moreover all instrumentation labs, are using personal computer for output analysis, so dedicated software are required for different sensors, for study, compare and detection of sensor. So in all complexity and setup area increases and hence portability decreases.***

Keywords: Embedded ARM, 24-bit Analog-to-Digital Converter (ADC), signal conditioning, Graphic Liquid Crystal Display (GLCD), software calibration

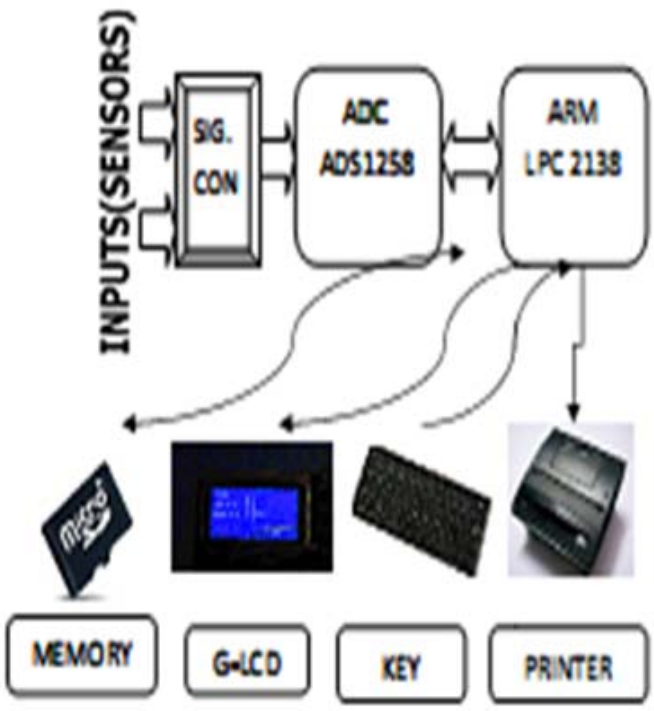
1. Introduction

The objective of the paper is to develop a portable instrumentation lab which any one can carry with them anywhere in the same way as, any one carry their Laptops. We have an aim that in near future this system shall gain the same popularity as a DMM (digital multi-meter) in present time. The most time consuming tasks are: 1.Developing the signal conditioning Printed Circuit Board (PCB) and data comparison schemes.2.Writing firmware for the controllers so as to read the specific characteristics [6].3.Need to rush to the high-fi electronic work bench every time we need to test a new sensor [2].

A significance of this paper is that it will ease the workload/pressure from the minds of scientists, engineers and students all alike. Thus they can be able to concentrate on bigger projects and contribute to the development knowledge acquisition and thus benefit the humanity at a much better pace. In this paper, a new kind of instrumentation lab based on ARM embedded platform has been researched and developed, which can measure all kinds of electrical and thermal parameters such as voltage, current, thermocouple, stress, strain, and so on. The measured and compare data can be displayed on GLCD of the system [6, 7], and at the same time can be print using thermal printer.

2. System Architecture

The whole structure chart of the instrumentation lab and monitoring system based on embedded ARM platform is shown in Figure 1. In the scheme of the system, the instrumentation lab modules are developed by embedded ARM processor [5], which can be widely used to diversified industries such as CNC machines, Rotary Machines (RTM), Universal Testing Machine (UTM), multi channel data loggers, sensor characteristic study, electric power, petroleum, chemical, metallurgy, steel, transportation and so on. The system shall also have a small thermal printer which can be used to print test results and plot graphs between two different transducers. The system will also have a graphical LCD to display real-time analysis and a user friendly GUI that can be navigated by using a PS2 keyboard or a small 4x4 matrix keypad.



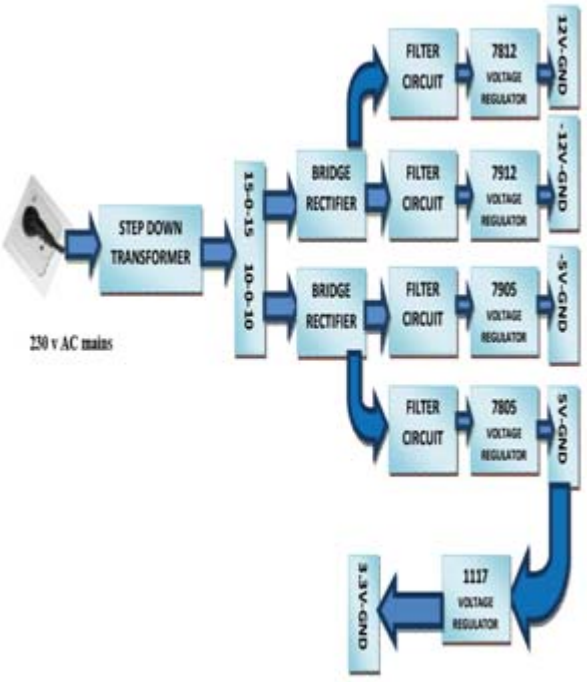


Figure 1. Structure design of the system

3. The Hardware Design of The System

The instrumentation lab system based on embedded ARM platform has high universality, each acquisition device equipped with 48-way acquisition I/O channels and isolated from each other [6, 7, and 8].

Each I/O channel can select a variety of voltage and current signals. The structural design of the embedded instrumentation lab is shown in figure 2 The system equipped with some peripherals such as power, keyboard, and reset, ADC, printer, signal conditional circuit, Inter-Integrated Circuit (I2C), Secure Digital (SD) card, and so on.

The A/D interface circuit is independent with the embedded system, which is beneficial to the system maintenance and upgrade. The system shall also have a small thermal printer which can be used to print test results and plot graphs between two different transducers. The system will also have a graphical LCD to display real-time analysis and a user friendly GUI that can be navigated by using a PS2 keyboard or a small 4x4 matrix keypad. In the instrumentation lab main part is the signal conditioning circuit and another important is the application of A/D conversion. The realization process of A/D driver depends mainly on the conversion time of A/D converter, the analog frequency of the conversion value, the number of input channels, and the conversion frequency and so on. The typical A/D conversion circuit is made up of analog multiplexer (MUX), amplifier and analog to digital converter (ADC).

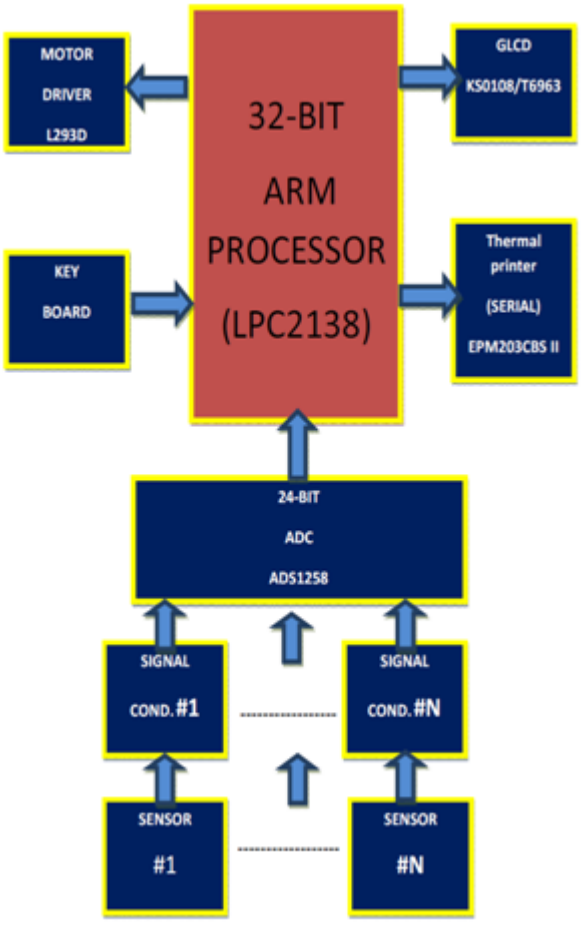


Figure 2. Hardware design of the system

4. Software Design of The System

The system software of the instrumentation lab based on embedded ARM platform use the GNU and the compiler use

the win-ARM, which is Open -source and can be grafted, cut out and solidified [6]. The design of application system and made the whole structure of the system simple and the complex application hierarchical.

4.1 Algorithm

Step1. START
Step2. Initialize Printer, Graphical LCD, ADC, System PLL, check RTC data and display on LCD. Load files system on memory card.
Step3. If memory card connected go to step4 else go to step5
Step4. Warn user for a memory – error go to step
Step5. Display available test profile options configured in mem-card
Step6. Scan all slots for available sensors
Step7. Read calibration factor stored in mem card
Step8. Perform real time interpolation of sensor data from selected sensors
Step9. Ask user to print report if yes go to step10 else step 11
Step10. Print and save report. Go to step5.
Step11. Save report. Go to step5
Step12. STOP

The design of the whole system includes the tasks of the operating system and a series of user applications. The main function of the system is mainly to realize the initialization of the system hardware and the operating system. The initialization of hardware includes interrupt, keyboard, LCD and so on. Figure 3 shows the basics flow chart of the whole instrumentation lab.

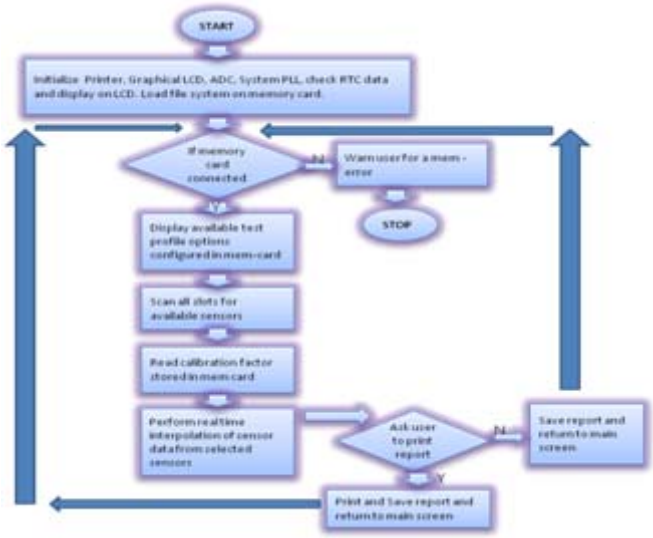


Figure 3. Flow chart

5. Conclusions

With the rapid development of the field of industrial process control and the wide range of applications of CNC machines, RTM machines, UTM machines, multi channel data loggers, sensor characteristic study, electric power, petroleum, it is necessary to make a higher demand of the data accuracy, signal conditioning and reliability of the control system. The instrumentation lab based on single-chip has been gradually eliminated because the problem of the poor real-time and reliability. With the fast popularization of embedded ARM processor, there has been a trend that ARM processor can alternate to single-chip to realize data acquisition and control. The embedded ARM system can adapt to the strict requirements of the, instrumentation lab such as the function, reliability, cost, size, power consumption, and many more.

In this paper, A novel kind of ARM-based embedded instrumentation lab has been researched and developed, whose hardware platform use 32-bit embedded ARM processor, and software platform use open-source GNU. It is mainly used in the collection, monitoring and comparing of all kinds of electrical, mechanical and thermal signals so it is ease the workload of scientists and engineer.

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Author Profile

Amit Shrivastava received the B.E in Electronics & Telecommunication from M.P.C.C.E.T, Bhilai in 2005 and M.E in Communication from S.S.C.E.T, Bhilai in 2011. During 2005-2009, he stayed in Embedded System & Design field Pune, after that he is working as an Assistant Professor in S.S.I.E.T, Bhilai (C.G.).