FPGA Based E-Learning System for Primary Schools

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***Abstract*— FPGA based E-Learning system is centered on the reduction of problems on the learning activities for better education in a global and information society. E-learning exploits interactive technologies and communication systems to improve the learning experience. It entirely transforms the way we teach and learn across the board. It will raise standards, and widen participation in lifelong learning. It is soon to become the dominant form of education in the world. A lot of effort is made for improving the work methods and communication among students and professors, to bettering the quality of this kind of studying. The traditional learning provides less interest and interactive classes between the faculties and the students. To overcome these restrictions, this type of visual based audio E-Learning system was created for primary school students. The software tools used were Eclipse-C or Xilinx. Unified Learning Kit (ULK) control panel is used as an output panel and it links the hardware system. Spartan 6 FPGA and TI OMAP Processor is the main functional module in the Hardware system.**

Keywords*— *E-Learning, Eclipse-Primary Schools, Spartan 6 FPGA,TI-OMAP Processor, ULK Control panel.

I. INTRODUCTION

Electronic Learning (or e-learning) may be defined as learning using a computer, usually connected to a network. Many research person believe that e-learning is still in its infancy our society can gain tremendously from e-learning. It increases the speed and degree of dissemination of knowledge. By E-learning today's children may be enabled to develop a self-concept; develop basic decision for making skills. Students need higher level of education to succeed in the new knowledge based society. It also facilitates the acquisition of knowledge and skills and provides flexible learning opportunities to students. One among technology is FPGA based E-Learning system. It provides easy access to the students and it can be develop like a Mobile Application. It limits the time and manual work. This is based on unified technology learning (UTLP) platform. Texas instruments (TI)-open multimedia application platform (OMAP) processor is used. More than four types are available in OMAP processor. Spartan 6 FPGA based e-learning done by OMAP 3530 processor. It is the name of Texas instrument's application processors. This processor is a systems on a chip (SoC), function much like a central processing unit (CPU) to provide laptop-like functionality for smart phones or tablets. Field Programmable Gate Array (FPGA) device plays a vital role in this E-Learning system. FPGA/UTLP Spartan kit can work with character LCD display, Graphical LCD display, LED display and audio output port. These ports are providing visual and audio output for kids with the help of Software tools. This e-learning system reduces manual work and time.

Anne Derry berry [1] (1997) Proposed (Serious games: online games for learning) a Serious game, expected to be a US$1.5 billion global market in 2008, are being described by some analysts as the next wave of technology-mediated learning. As organizations intensify their efforts to engage with members of today's workforce, serious games offer a powerful, effective approach to learning and skills development. This paper looks at serious games and their potential as learning tools. It also asks and answers some of the initial questions that challenge decision-makers, designers, and developers alike: Do serious games really promote learning? Who uses serious games? What do learners think about serious games? How do we start a serious game initiative for our organization? Three distinct groups of stakeholders will have immediate and direct involvement with serious game design and development: Game designers who are being asked to include instructional elements within game play and are looking for guidance on how to make those additions learning designers who are interested in adding computer games and simulations to their learning designs.

Alexander Vera [2] (2000) proposed (Remote Laboratories for E-learning of Digital System Design) Remote Laboratories allow students to practice the experiments related to specific fields. Many research works are still being developed, which encourages the implementation of alternative teaching/learning models. This is a challenge for engineering education because its highly practical contents are difficult for carrying in distance learning. This paper presents architecture

for remote laboratory of Digital Systems Design focused on supporting blended teaching. Learners may access to a remote training board based on a Field Programmable Gate Array (FPGA); then, they may execute a test by a logic analyzer module, and interact with other online users by integrated web 2.0 services. This paper describes both the hardware platform and the software application of the proposed system.

Cantoni et al [3] (2005) proposed an article (Perspectives and challenges in e-learning: towards natural interaction paradigms) of e-learning. In that role of Information and Communication Technologies (ICTs) in educational development has been world-wide recognized as a priority in order ‘‘to reinforce academic development, to widen access, to attain universal scope and to extend knowledge, as well as to facilitate education throughout life’’ (Council of Ministers of Education, Canada, Report of the Canadian Delegation to the UNESCO World Conference on Higher Education, Paris, October 5–9, 1998). As a consequence, developments in ICTs have had a significant impact on conventional higher education, as the University of the 21st century takes shape. By analyzing traditional learning models as opposed to new e-learning paradigms, this paper provides a global overview on future learning systems, from both technology- and user-centered perspectives. In particular, the visual component of the e-learning experience is emphasized as a significant feature for effective content development and delivery, while the adoption of new interaction paradigms based on multi-dimensional metaphors and perceptive interfaces is presented as a promising direction towards more natural and effective learning experiences.

Ellen Wagner [4] (2005) described (Delivering on the Promise of e-Learning) It is re-emerging as a solution for delivering online, hybrid, and synchronous learning regardless of physical location, time of day, or choice of digital reception/distribution device. This white paper considers some of the reasons that institutions and enterprises are turning to e-Learning to help engage learners with ideas and information in revolutionary ways. It also takes a look at a number of the “Lessons e-Learned” that summarize years of empirical evidence exploring learning technologies use and cognitive achievement. Finally, it offers practical suggestions for creating digital learning experiences that engage learners by building interest and motivation and providing opportunities for active participation.

Mir Jana Radovic-Markovic [5] (1973) proposed an article (Advantages and Disadvantages of e-learning in Comparison to Traditional forms of Learning) in that Internet education is soon to become the dominant form of education in the world. A lot of effort is being devoted into furthering the work methods and communication among students and professors, aimed at bettering the quality of this kind of studying. Moreover, further development of virtual education in the future will depend on the advance of contemporary technologies and the Internet. Having this in mind, the author of this paper has tried to explore to what extent the previous results have been accomplished, as well as to classify the different modalities of this kind of learning and to ascertain their advantages and disadvantages. A special emphasis has been put on the great utility value for all developed economies, which have made great progress in the development rate and in the spreading of virtual faculties’ network. At the end of this research paper, recommendations are given, and further trends of Internet education are established, juxtaposed to the classic forms of studying, based on the latest research results in this field. The author especially emphasizes the fact that faculties with “classrooms without walls” will not fully replace traditional faculties. The value of this paper lies particularly in the fact that it builds not only on the contemporary research findings, but also on the author’s personal experience as a professor engaged in this form of student education.

Lect.Nayak S.K [6] (2008) proposed a journal (E-learning Technology for Rural Child Development) called E-learning Technology for Rural Child Development 21st century is the century of Hi-Tech. Recently Hi-Tech is comprises with IT, ICT, BT and Nano-Technology. Today ICT (Information Communication Technology) is a unique technology which is used universally in all span of life. ICT plays a predominant role in the creation and development of knowledge. The ICT revolution has changed the learning process of childhood up to the real world. E-learning is a combination of learning services and technology to provide high values. Internet plays a vital role in e-learning. E-learning is attaining significance in the world of internet. Due to the advantages of in internet, e-learning reached at anytime and anywhere. To meet the demands of our global economy, there must be corresponding adoptions of e-learning in child education to develop 21st century skills. Computers are reshaping children’s lives, at home and at school in profound and unexpected ways. In this paper, we have discussed problems, considerations, issues and approaches to e-learning in India with giving stress on important features of e-learning and benefit of e-learning for rural child development. The paper also highlights e-learning’s applicability and acceptance in developing country like India. Digital learning in India is limited one but implementation and planning for e-learning and development of ICT is important. E-learning technologies have great potential to spread learning. However, the benefits of these technologies have to reach the rural masses of India; otherwise it will be one of the causes of the Digital Divide.

Sinhaloo M.S & Narsozj [7] (1993) proposed a paper (An Interactive E-Learning Tool for Kids in Mauritius) Sunhaloo M.S gave an overview of an interactive e-learning tool which we have developed for kids aged from eight to eleven years old in Mauritius. By developing this software, they aim at promoting self-learning and developing information and communication technology skills among the youngsters in Mauritius. The e-learning tool developed is based mainly on the science curricula covered at upper primary and lower secondary levels, in the Mauritian schools and colleges respectively. Our software does not intend to render obsolete or replace the existing pedagogical approaches. On the other hand, it will complement the existing teaching and learning methods.

Tomoko Kashima [8] (2005) described a paper (Proposal of an e-Learning System with Skill-based Homework Assignments) In this paper, Tomoko Kashima build a learning environment that combines "lectures", "e-Learning", and

"push-type homework assignments". Tomoko study the feasibility of automatic homework assignments by the degree of comprehension and also quantitatively evaluate the degrees of achievements of each student. Furthermore, we develop a push-type e-Learning system that permits studying with a cellular phone for instantly and automatically receiving assignments by e-mail. Not only active students but also inactive students can get assignments by e-mail. Therefore, we expect that a familiar and easy study situation can be created by developing this e-Learning environment. Our system uses the accumulated learning history and information recommendation processing based on collaborative filtering for making assignments. Thus, presentation of an assignment to each student based on his skill level can be combined with the tendency for covering every topic of study. The result of our research considers the feasibility of content-based filtering by text-mining processing towards homework assignments in future systems.

Devajit Mahanta, Majid Ahmed [9] (2012) described a paper (E-learning Objectives, Methodologies, Tools and its Limitation) E-Learning is the use of technology to enable people to learn anytime and anywhere. E-Learning can include training, the delivery of just-in-time information and guidance from experts. It has become an increasingly popular learning approach in higher educational institutions due to the rapid growth of Internet technologies. E-Learning allows users to fruitfully gather knowledge and education both by synchronous and asynchronous methodologies to effectively face the need to rapidly acquire up to date know-how within productive environments. There is also present various limitations in E-Learning. This review work discusses on various E-Learning Objectives, methodologies and tools and limitation of E-Learning. The main focus of e-learning methodologies is on both asynchronous and synchronous methodology. The paper looked into the three major e-learning tools.

The paper also looked E-Learning limitation in particular related with technologies, personal issues, comparison with traditional campus learning, design issues, and other issues. Finally the paper suggests that synchronous tools should be integrated into asynchronous environments to allow for "any-time" learning model and also given a remark that E-Learning needs to improve from various barriers.

In this paper, to provide easy E-Learning access to the students and faculty and to develop an application for Smart Phone, tablets. This interface has been implemented in Unified Technology Learning Platform kit which increases the efficiency and user satisfaction.

II. METHODOLOGY

A. *Description*

The program is coded using eclipse software and compiles it. After compilation, the ULK control panel is interfaced to the UTLP kit. The code is loaded in control panel and run to the system. It is processed by using two devices. They are Texas OMAP 3530 processor and Xilinx spartan6 FPGA. According to the given input, the output is displayed in console window; character Liquid Crystal Display, Graphical Liquid Crystal Display and audio output.

B. *Eclipse*

Eclipse is multi-language software which is developed by development environment tool including an integrated development environment (IDE) and an extensible plug-in-system. It is written mostly in Java. It can be used to develop the applications in Java program and, by means of various plug-in systems,

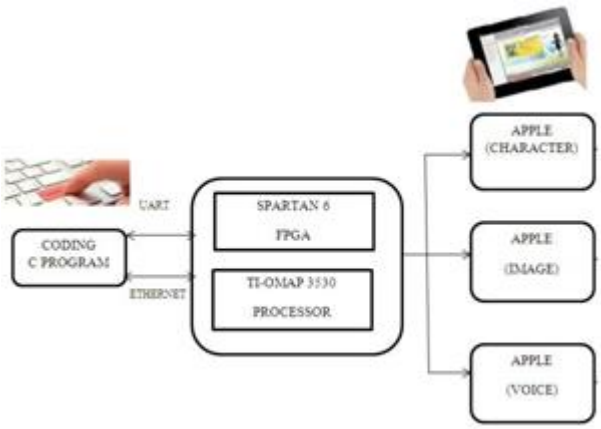


Fig.1. Block Diagram of FPGA Based E-learning

Other programming languages including Ada, C, C++, COBOL, FORTRAN, Haskell, Perl, PHP, Python etc. Eclipse IDE tool is a tool which is used for developing applications based on C language for UTLP.

C. *ULK control panel*

The ULK (Unified Learning Kit) control panel is an application program and it is developed using Ubuntu development personal computer which facilitates the communication between the Ubuntu Host personal computer and the Unified Technology Learning Platform (UTLP). It also enables downloading and executing the UTLP program in usual mode. Fig 3, shows the host and client interface.

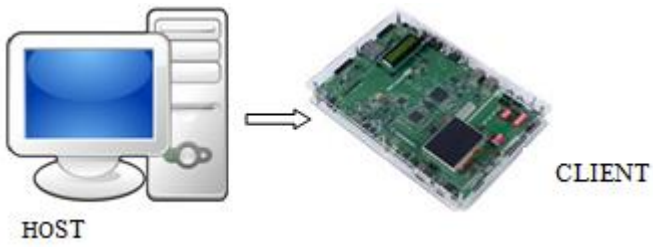


Fig.2. Host and client Interface

D. Texas OMAP3530

The ULK (Unified Learning Kit) is based on Texas Instruments OMAP3530 application processor and Spartan-6 FPGA. The Texas Instrument OMAP 3530 processor is a high performance processor which is based on OMAP architecture. It is used to support high-speed devices and number of thread processing applications. The OMAP3530 processor supports with different interfaces such as Mobile DDR, Nand Flash, Audio in & out, TV out, Touch screen LCD, VGA out, Ethernet, Keyboard, USB two SD cards, Control sensor header, I/O expansion connector, I2C header for GPS, Bluetooth & Modern Connectors, Simple Digital Interface connector, IrDA connector, Camera Connector & LCD connector.

E. Spartan-6 FPGA

The Spartan-6 FPGA has some features include
Xilinx's XC6SLX25T FPGA
SPI PROM from Atmel (2Mbyte)
DDR2 SDRAM of 64 Mbytes
I2C EEPROM of 256 Kbits
10/100Mbps Ethernet PHY and RJ45 LAN connector
UART transceiver
4x4 keyboard interface
16x2 character LCD through parallel interface
10bit ADC with parallel interface
12bit DAC with parallel interface
JTAG interface
7 segment LED's
DIP switches & Status LED's
20-pin header with 5V compatible
70-pin I/O expansion connector

F. UTLP- Interfaces

UTLP has different devices and interfaces which can be accessed both in the normal mode and in the lab mode. The program developing and executing them using control panel for the following devices in the normal mode such as 7 segment display, Character LCD, Keyboard, Graphics LCD, Touch panel.

API stands for Application Programming Interface. APIs are the functions provided by interface libraries. Developers use these library calls in their programs for an interface functionally. At the linking time, the API library binaries to make an executable program. In the UTLP normal mode, there are interface libraries provided for different devices and functionality.

Reads a string from the control panel input window-
Void ulk_scanf_string (char*user_ string)
Outputs a string on the serial port-
Uint8 ulk_printf (const char*fmt….)

G. Character LCD

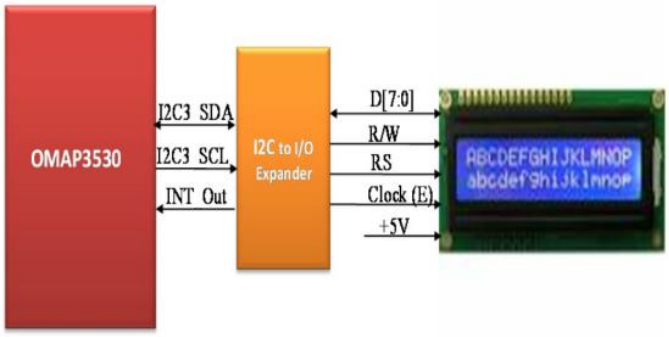


Fig.3. Character LCD

A 16x2 LCD shows to display 16 characters per line and has 2 lines. Each character is displayed in 5x7 pixel matrix. Character LCD interface is shown as Fig.4. Below. The 16x2 character LCD is connected through the I2C interface.

H. Graphics LCD

The graphical LCD is used to display the pictures and characters. The graphical LCD has many applications such as mobile phones, video games, and lifts etc., The 3.5 inch graphics LCD is connected as follows. It has a resolution of 320x240.

Fig.4. shows the graphical LCD display.

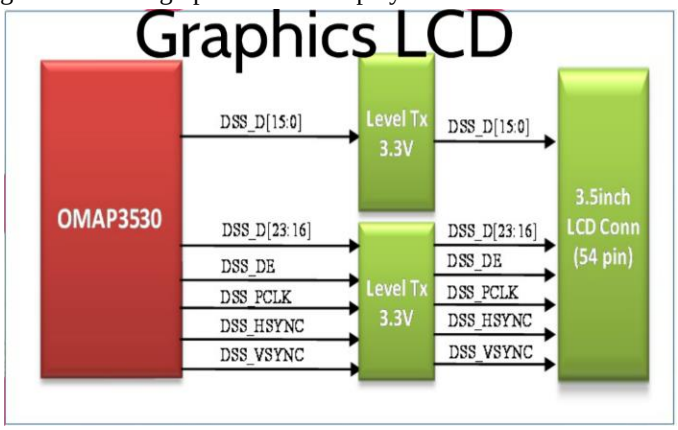


Fig.4. Graphical LCD

I. Touch panel

The touch screen analog signals from the external LCD will be interfaced with touch screen controller through 4 pin 2.54mm pitch header. The touch screen analog signals from the 3.5inch LCD will be interfaced with touch screen controller through the 54pin LCD connector itself. The 4-wire, 12bit resolution, low voltage touch screen controller TSC2046IPWR from TI is used. Fig.5, shows the touch panel diagram.

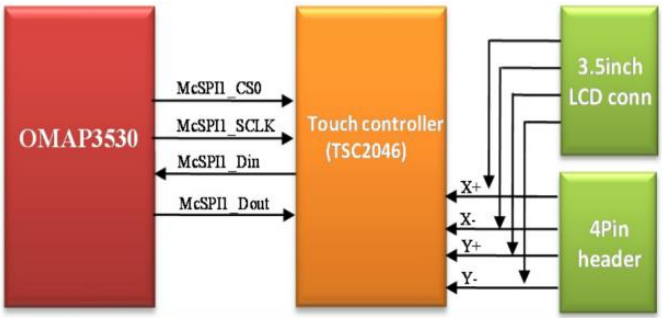


Fig.5. Touch panel

J. Implemented in UTLP kit

Unified Technology Learning Platform (UTLP) is an integrated learning environment consisting of hardware and software tools as shown in Fig.2.

The features of UTLP are,

TI OMAP 3530 SOC with ARM Cortex A8 600MHz CPU,
DM64X+ 430MHz DSP,
Xilinx Spartan-6 LX25T FPGA,
128MB CPU RAM –mDDR
64MB FPGA RAM-DDR2
128MB NAND FLASH
Video OUT-VGA, LCD-local/external
AV Support & TV Out
Video IN-Camera, Audio in, audio out, stereo out
Boot Loader, Xloader, Uboot Operating Systems
Linux X11 (Graphics)
Eclipse IDE & XILINX ISE Web Pack
Stub Application & ULK Control panel

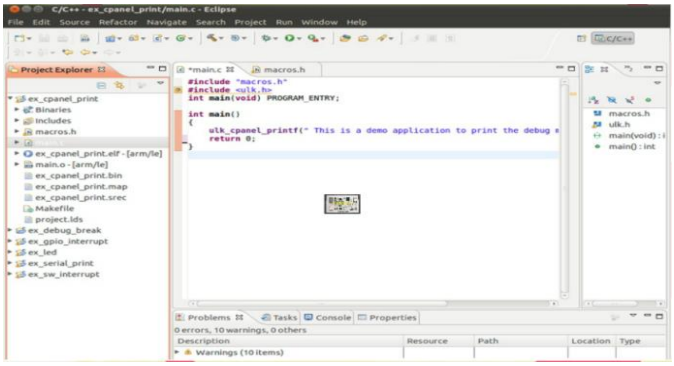
The ARM-8 Cortex processor, based on the ARMv7 architecture, has the ability to scale in speed from 600MHz to greater than 1GHz. The Cortex-A8 processor can meet the requirements for power-optimized mobile devices needing operation in less than 300mW.

The program has been implemented in Unified Technology Learning Platform kit display. An output can be displayed on CLCD with the help of Application Programming Interface (API) which is coded using Eclipse software.

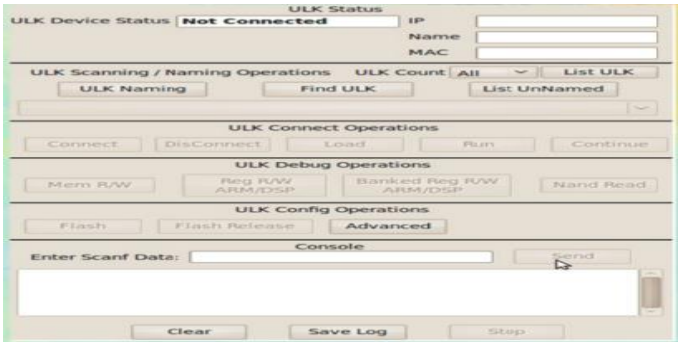
Fig.6. Unified Technology Learning Platform (UTLP) kit

III. EXPERIMENTS AND ANALYSIS

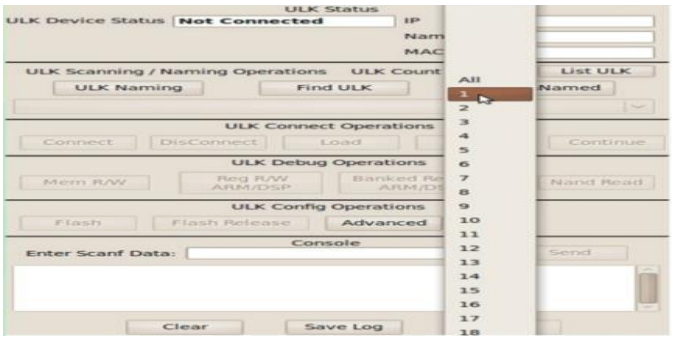
The program was coded and successfully simulated byusing the Eclipse software. Eclipse software main .c application program window is shown in the figure 3a. After the simulation, it is interfaced to the Hardware using the Application Programming Interface. Completion of the Application Programming Interface process, the compilation process takes place as shown in Figure (a). The Figure (b) shows the control panel window, which act as an output panel. The control panel application opens up the window as shown in Figure (c) and shows click on the ULK count button. It will open up a dropdown list. Select 1 because there is only one UTLP connected to the host Personal Computer. Figure (d) shows the load button is used to download an executable bin file from host Personal Computer (PC) and UTLP. Click on load button and it opens up the following window shows in the figure 3e. Set the load address to 82000000. Click the browse button to select a previously compiled .bin file at the location. The test is the home directory which will be different on your machine as per the computer name. So select the correct location. File type set to binary file. Click the load button and following message is displayed. Figure (f) shows the successful loading operation. Click OK to continue the process and on successful loading the following message is displayed. The console window output is shown in the display. Figure (g) shows the Character LCD (CLCD) output. Based on the input given, the output is displayed in the LCD.



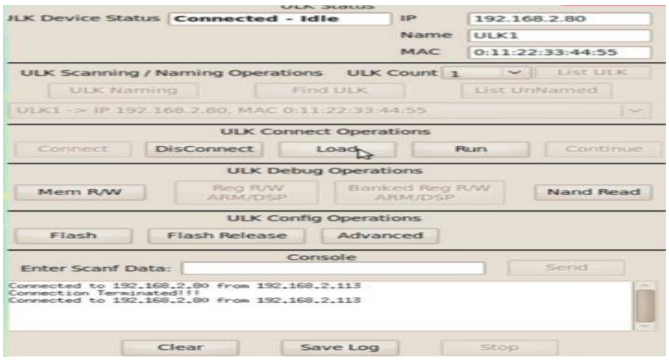
(a)Programming window in Eclipse C



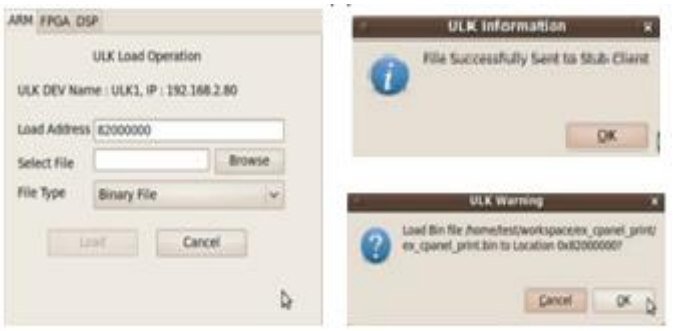
(b)ULK control panel



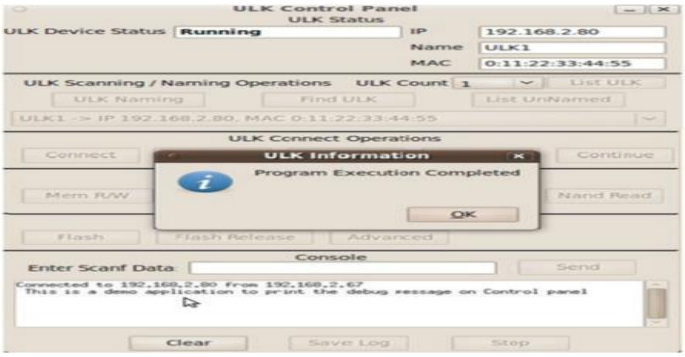
(c)Different Applications in ULK control panel



(d)Loading of code into Hardware kit



(e)Information about successful loading



(f)Program execution and output on control panel

(g)Character LCD display output on Hardware kit

IV. CONCLUSIONS

By implementing our system in primary schools, we can improve learning activities for better education in a global and information society. Spartan 6 FPGA based learning system provides easy E-Learning access to the students and faculty. It develops an application for Smart Phone, tablets. This allows users to fruitfully gather knowledge and education to effectively face the need to rapidly acquire upto date know how within productive environments. It will become an increasingly popular learning approach and application in higher educational institutions due to the rapid growth of Internet technologies.

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