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IOT Application development on Artix 7 FPGA and Thingspeak IOT Cloud

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ABSTRACT: FPGA with Internet of Things is a latest technology, and this technique has been used to introduce many smart devices with wonderful applications in our day today life. One more challenge for IOT is to handle vast amount of sensing the data generated from smart devices that are resource limited and subject to missing data due to link failures. In this paper mainly going to focus on FPGA with IOT platform, i.e., the use of low-cost FPGA implementation of entire IOT subset including TCP/IP protocol, Control System and Data Acquisition etc. In the past few years, we have enormous improvement in the field of IOT applications on FPGA platform. This technique has been updated with low cost, efficient power usage with real time observing and remote recognizing system. The main objective of this research is to focus how the FPGA based hardware resources can be accessed from anywhere. The maintenance cost of servers can be reduced by building a cloud-based monitoring system. The data losses are avoided with the help of this technique. To make the communication with various internets coupled devices (computer, tablet, mobile phone) at the same time anywhere in the world. There are various business spaces it needs you to observe temperature, light and update the status to the cloud. The temperature, light must be maintained at the moderate level in food preservation process. IOT based temperature, light monitoring system help us to monitor the food preservation system and update the data to the cloud at the regular interval. Artix-7 is latest series of FPGA for complex VHDL design with new VIVADO platform.

KEYWORDS: IOT, Thingspeak, Temperature and Light Monitoring System, Artix-7 FPGA, Vivado 2018.

INTRODUCTION

Web services with FPGA based hardware have already been realized and defined. Their embedded nature permits the developers to simply adjust those services to energetically interrelate with their surroundings, e.g., to attain real-world measurement data or control various actuators. Such entities can be called environmentaware web services in difference to classical web services that work on remote physical or virtual machines. The IOT applications can be developed by implementing IP address with the particular VHDL code in order to make Internet ofThings.

IOT is implemented on various FPGA devices to project diverse devices for various applications. As the number of IOT devices are increasing fast, results the need to build a smart world of devices with less human stimuli [7]. General idea of IOT is to assign an IP address to a relative device to be pinged out from inaccessible distance, broadly used for real time data collection [14].

Internet of Things

The internet has enabled an unpredictable growth of information sharing with the introduction of embedded and sensing technology, the number of smart devices including sensors, mobile phones, RFIDs, and smart grids has grown quickly in recent years. Ericsson and Cisco predicted that fifty billion small, embedded sensors and actuators will be associated with the internet by 2020 [15].

Artix-7 FPGA

The Field Programmable Gate Array (FPGA) is a family of reconfigurable hardware, where Field Programmable means the operation changing capability in the field, and Gate Array means the construction of basic internal architecture of the device. Digital computing tasks can be developed in software and compiled into a bit stream file. This bit stream file contains information about how the components should be wired together. FPGAs combine the best parts of ASICs and processor-based systems, in fact FPGAs are parallel in nature. Advantage of using a software programmed processor is that software is very flexible to change while a disadvantage is that performance can suffer if the clock is not fast. The advantage of an ASIC is that it can provide very high performance because of its dedicated type of operation and its disadvantages are:

1) High cost to volume ratio.
2) Extended delay between designs to end product.
3) Incapability to include new changes after the system is fabricated and
4) Difficulties in debugging errors.

FPGAs fill the gap between hardware and software and offer numerous advantages such as:

1) Flexibility,
2) Reliability,
3) Low cost,
4) Fast time-to-market and
5) Long term maintenance.

After observing this, we conclude that an FPGA is the best reconfigurable hardware platform for the implementation of IoT applications.

II. LITERATURE SURVEY

Various types of research works have been done and still going on day by day to implement IoT applications on FPGA platform. We have read lot of papers which are related to design and implementation of IoT applications on FPGA platform and the work done in those papers is listed below:

Ajay Rupani in her review article title 'A Review of FPGA implementation of Internet of Things' has briefed about the growth of IOT [1].

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Andrea Caputo in his review article title 'The Internet of Things in manufacturing innovation processes: Development and application of a conceptual framework' has briefed about the services provided by IOT[2].

Internet of Things (IOT) is an integrated part of future internet including existing and evolving Internet and network developments and could be conceptually defined as a global dynamic network infrastructure into the information network. Services will be able to interact with these "smart things/objects" using standard interfaces provide the necessary that will link via the Internet, to query and change their state and recover any message connected with them, taking into account security and privacy issues. M Kiruba in her review article 'FPGA implementation of automatic industrial monitoring system' has briefed about the control stability of FPGA [3].

Dr. KK Sharma proposed that, proposed the automatic monitoring of industrial system that deals with the core controller of FPGA, the analogy sensor such as gas sensor, digital sensor, and dust sensor such as PIR motion sensor. This confirms a safer monitoring system. The parameters of Area, Power and timing report are investigated.

FPGA Implementation of Automatic Industrial Monitoring System. In this paper, authors proposed the automatic monitoring of industrial system that deals with the core controller of FPGA, the analog sensor such as gas sensor, digital sensor, and dust sensor such as PIR motion sensor [8]. To monitor industrial equipment, various sensors have been used and their voltage range is 4.4 V. This confirms a safer monitoring system. The parameters of Area, Power and timing report are analyzed. The consumption of area is 937 LUT's, power obtained is 48.11mW and delay is 9.065ns from QUARTUS II 10.0. The maximum voltage to operate the ALTERA CYCLONE BOARD is 3.3V. This has the input frequency of 50 MHz which is generated from the crystal oscillator. The GSM module and ADC are coded in VHDL language. Finally, the output can be measured through mobile network and LCD displays its current status. This work can be improved further by connecting proximity sensor, and various other sensors depending on the industry requirement. The automatic monitoring system using IoT(Internet of Things) can be considered for the future work. This paper helped us to understand the concept about IoT.

WLAN Specific IoT Enable Power Efficient RAM Design on 40nm FPGA. In this paper authors proposed the design and Implementation of power optimized RAM on 40nm FPGA. This RAM is design as IoT enable by adding an additional input of 128-bits and through this the RAM can be accessed via internet [7]. Xilinx ISE 14.6 used to simulate this design. Four different types of LVCMOS and five different WLAN frequencies are taken into account.At WLAN frequency 2.4GHz, there is maximum drop of 85% and at 0.9GHz there is minimum reduction of 64.91% in IO power with using LVCMOS12 instead of LVCMOS25.This design of RAM is implemented using 40nm FPGA, further it can be executed using 28 nm and 16 nm ultra-scale FPGA. LVCMOS IO standard is used for power efficient design in this work. In future there is a vast scope to reframe this work using other IO standards like Stub Series Terminated Logic (SSTL), High Speed Transceiver Logic (HSTL).

FPGA Implementation of QoS Multicast Routing Algorithm of Mine Internet of Things Perception Layer based on Ant Colony Algorithm: In this paper, the authors improved the ant colony algorithm, and analyzed simulation results of the improved algorithm, and proved the convergence of this improved algorithm. Perceiving network topology of QoS multicast routing network by using improved ant colony optimization algorithm, then construct a dynamic network topology to form a multicast tree. In view of space and time complexity of ant colony algorithm, adopts FPGA to realize QoS multicast routing algorithm of mine internet of things perception layer based on ant colony algorithm [9]. Experimental analysis proved that FPGA realization of QoS multicast routing algorithm of mine internet of things perception layer based on ant colony algorithm is feasible.

FPGA based Preliminary CAD for Kidney on IoT Enabled Portable Ultrasound Imaging System: In this paper, the authors proposed a fully automated kidney abnormality detection system based on wavelet-based noise removal, robotic feature selection and administered classification. Experimental results show that the designed classifier authenticates the abnormality without any error. Providing such information helps sonographers to recommend immediate precaution and also monitor disease progression. Thus, the proposed technique aids preliminary CAD for kidney on IoT enabled portable ultrasound systems [10].

Research Directions for the Internet of Things: In this paper, the author proposed one vision of the future is that IoT becomes a utility with increased superiority in sensing, actuation, communications, control, and in creating knowledge from huge amounts of data. This will result in qualitatively different lifestyles from today. What the lifestyles would be is anyone's guess. It would be fair to say that we cannot predict how lives will change. We did not predict the Internet, the Web, social networking, Facebook, Twitter, millions of apps for smartphones, etc., and these have all qualitatively changed societies' lifestyle. New research problems arise due to the large scale of devices, the connection of the physical and cyber worlds, the openness of the systems of systems, and continuing problems of privacy and security [11]. It is hoped that there is more cooperation between the research communities in order to solve the myriad of problems sooner as well as to avoid reinventing the wheel when a particular community solves a problem.

Reconfigurable FPGA-based embedded Web services as distributed computational nodes: In this article, the authors presented a concept for a better utilization of spare FPGA resources by employing them to perform independent computational tasks. They apply this approach toFPGA based embedded and environment-aware Web services compliant with the SOA paradigm. Additional functional modules have to be provided for each service and particulararchitectural guideline have to be followed, which they present in this paper as a reference. They attempt to keep additional hardware costs as low as possible. Initially, they applied the concept presented to the previously developed FPGA hardware software platform designed to run various Web services. Future development goals include:

a. Automatic service advertising(which is related to the issue of service repository [12])

b. Developing or adapting available algorithms which would allow us to automatically move computations between

FPGA based Web services and the service management subsystem to ensure uninterrupted Web service operation.
Field Programmable Gate Array (FPGA) circuits play an important role in major recent embedded process control designs. However, exploiting these platforms requires deep hardware conception skills and remains an important time-consuming stage in a design flow. High Level Synthesis technique avoids this bottleneck and increases design productivity as observed by industry specialists.
Unlike general-purpose computing systems, which separate the design of hardware and software, embedded systems involve the simultaneous design of hardware and software. The challenge of creating a system which clusters FPGAs in a distributed computing environment requires designers to be knowledgeable in hardware, software, and networking concepts.
Looking to above literature review, the problem arise is that how to implement the applications of IOT on the FPGA platform.

System Implementation

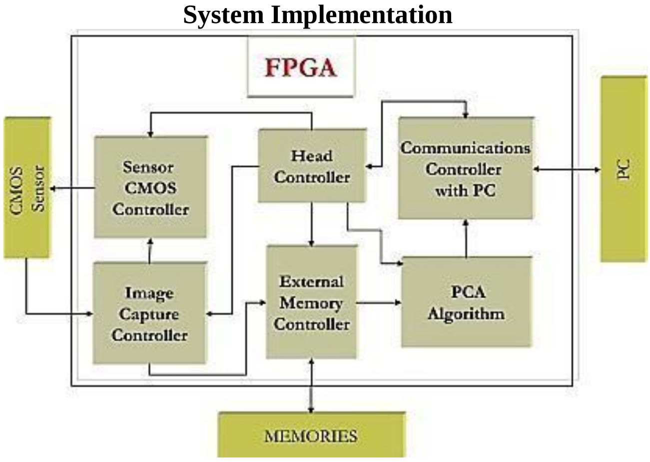

Figure 1: Block diagram of FPGA.

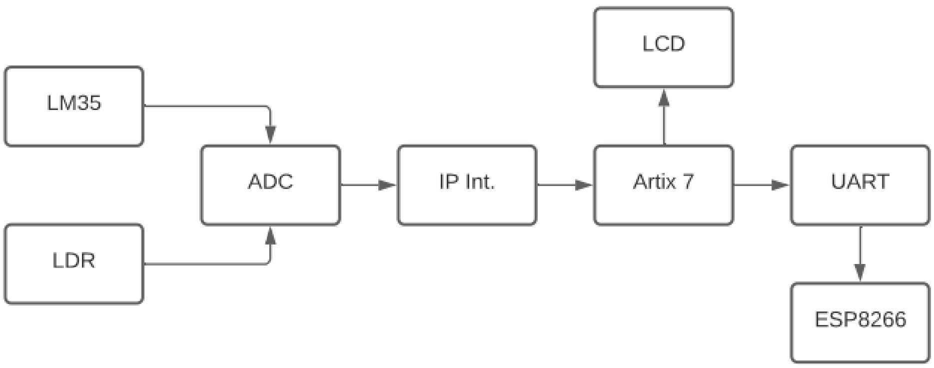

Figure 2: Block diagram of our proposed model.

The general FPGA architecture is shown in Fig. 1 consists of three types of modules. They are I/O blocks, Configurable logic blocks (CLB) and Switch Matrix/Interconnection Wires. The FPGA has two dimensional arrays oflogic blocks which is used to arrange the interconnection between the logicblocks.

FPGAs have gained rapid growth over the past decade because they are useful for a wide range of applications. Some of the applications are cryptography, filtering and communication encoding and many more.

Figure 2 is a proposed model of our complete system. A temperature sensor is a thermocouple or a resistance temperature detector (RTD) that gathers the temperature from a specific source and alters the collected information into understandable type foran apparatus or an observer. Temperature sensors are used in several application namely HV(high voltage) system and AC(alternating current) system environmental controls, medical devices, food processing units, chemical handling, controlling systems, automotive under the hood monitoring andetc.

LDR and resistor connected in series to form a light sensor. It gives the input to ADC using IP Integrator and further connected with FPGA.

Artix 7 FPGA starter kit consists of on board 8 channels ADC with channel connected with LM35 temperature and LDR sensor. VHDL code is used to perform conversion of analogy to digital and read the LM35 output as a digital data and 2*16 LCD is used to display theoutput.

ESP826 Wi-Fi Module is used to transmit the temperature data wirelessly to the Wi- Fi Modem at the other end with internet connection. ESP826 Wi-Fi Module can be initialized using set of AT Commands. After the initialization process, we have to program for configuring the Wi-Fi module as a TCP/IP client. The Wi-Fi module is shown in figure 3.

III. CONCLUSION AND FUTURE WORK

The IOT based embedded system has facing many challenges in difficult IOT applications. The Field Programmable Gate array structure is the alternate arrangement to overcome the problem which is facing in ARM processor. In this paper, we have introduced the study of technology paradigm for IOTs on FPGA Platform. The IOT based FPGA includes communication protocols, Data Acquisition and controlling systems. The temperature, Light has been monitored with the combination of IOT and FPGA architecture and for every second time period the temperature, light has been updated in the particular IP address. There are various business spaces it needs you to observe temperature, light and update the status to the cloud. The temperature must be maintained at the lowest level in food preservation process. IOT based temperature monitoring system help us to monitor the food preservation system temperature, light and update the data to the cloud at the regular interval.

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