Design and Development of FPGA Based Wireless SoCfor Precision Agriculture

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ABSTRACT

Crop farming in India is labored intensive and obsolete. Farming is still dependent on techniques which were evolved hundreds of years ago and does not take care of conservation of resources. The newer scenario of decreasing water tables, drying up of rivers and tanks, unpredictable environment presents an urgent need of proper utilization of water. We have the technology to bridge the gap between water usage and water wastage. Technology used in some developed countries is too expensive and complicated for a common farmer to understand. Our project is to give cheap, reliable, cost efficient and easy to use technology which would help in conservation of resources such as water and in atomizing farms. We proposed use of Position sensor, Light intensity sensor, temperature sensor, Remote lights, and switches at suitable locations for monitoring of crops. The sensing system is based on a feedback control mechanism with a centralized control. The sensor data would be collected in a central processing unit which would take further action. Thus, by providing right amount of water we would increase the efficiency of the farm. The farmer can also look at the sensory data and decide course of action himself. We have made the interface of our project keeping in view the educational and financial background of average Indian farmer. In this project we proposed a low cost and efficient wireless sensor network technique to acquire the Position and light from various locations of farm and as per the need of crop controller take the decision to make irrigation ON or OFF.

Keywords: CORTEX-M3; FPGA; Gyroscope; SoC; WSN.

1. Introduction

Wireless Sensor networks(WSN) are getting lots of popularity in recent years due to their wide applications like military and disaster surveillance, industrial product line monitoring, agriculture and wildlife observation, healthcare, smart homes etc. Many sensor nodes working together collect information from the environment and then transmitting this data to a base station forms the sensor network.A wireless sensor network is design for sensing and processing parameters like temperature, humidity, and sound. After sensing data sensor nodes sends it through wireless channels. Wireless Sensor networks (WSN) are getting lots of popularity in recent years due to their wide applications like military and disaster surveillance, industrial product line monitoring, agriculture and wildlife observation, healthcare, smart homes etc. Many sensor nodes working together collect information from the environment and then transmitting this data to a base station forms the sensor network. A wireless sensor network is design for sensing and processing parameters like temperature, humidity, and sound. After sensing data sensor nodes sends it through wireless channels.

Wireless Sensor Network Due to advance recent technology the developed of small plus low-cost sensors became economically feasible and technically. The sensing node compute ambient situation connected to the environment close the sensor and transforms them into an electric signal. Processing such a signal reveals various properties concerning substance located and events happening in the vicinity of the sensor. A great amount of these disposable sensors able to the networked in most applications to require unattended functions. Hundreds or thousands of these sensor nodes contains by a Wireless Sensor Network (WSN) and all that sensors contain the ability to communicate any in the middle of every other or straight to an external base-station (BS). A larger number of sensors allows for sensing above big geographical regions with better accuracy.

Basically, each sensor node consists of sensing, processing, transmission, mobilize, position finding system, and power units. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station. A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data. The WSN is a structure comprised of radio frequency (RF) sensors, transceivers, microcontrollers, and power sources. Modern advances in wireless sensor networking technology include to the development of low cost, low power, multifunctional sensor nodes. Sensor nodes allow environment sensing collectively with data processing. Instrumented with a range of sensors, for example humidity, temperature as well as volatile compound detection which allow monitoring of dissimilar environments. Sensors can be network with other sensor systems in addition to exchange data with external users. Sensor networks are used for a variety of applications like machine monitoring, wireless data acquisition plus maintenance, environmental monitoring, smart buildings and highways, site security, safety management, and in numerous other areas. A WSN protocol consists of the transport layer, application layer, data link layer, network layer, physical layer. Also, WSN contains mobility management plane, power management plane and the task management plane.

Automation of irrigation system refers to the operation of the system with no or minimum manual interventions. Irrigation automation is justified where a large, irrigated area is divided into Small segments called irrigation blocks and segments are irrigated in sequence to match the discharge available from the water source. In this regard, the works that we have surveyed describe the different types of automatic irrigation techniques, how they have served the purpose and the primary difference between our project and those literatures that we have contemplated.On this detail, the existing works "Applied engineering in agriculture", "Data acquisition system and irrigation controller" and "Automation in Micro-Irrigation", employs subsurface drip irrigation using two drip tapes and are time-based systems in which irrigation time clock controllers, or timers, are an integral part of an automated irrigation system. A timer is an essential tool to apply water in the necessary quantity at the right time. Timers can lead to under or over-irrigation if they are not correctly programmed or the water quantity is calculated incorrectly. Time of operation is calculated according to volume of water required and the average flow rate of water a timer starts and stops the irrigation process. It automatically schedules irrigation at random events by using timers where in the automation for the system and displays were not implemented.

Employ volume-based systems. The pre-set amount of water can be applied in the field segments by using automatic volume-controlled metering valves. It is depicted that the volume control systems are more advantageous than time control systems. The amount of water these systems supply is fixed irrespective of continuous electricity availability, but still time-controlled systems are more popular as they are less expensive. Here volume meters are connected, which emits a pulse after delivering a specific amount of water and the controller measures these pulses to keep a check on the supply. The papers titled, "Irrigation and water use efficiency", "Presentation of an Irrigation Management Model for a Multi-cropping and Pattern Setting" and “Productivity of irrigation technologies”.

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2. BLOCK DIAGRAM AND ITS DESCRIPTION

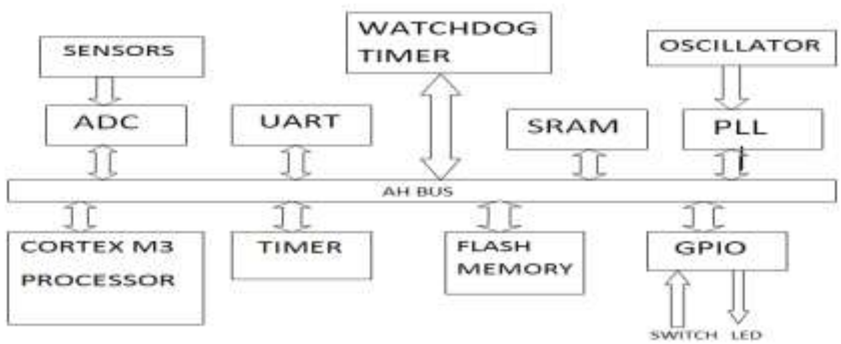

Fig. 1. Block diagram

ARM was founded in 1990 as Advanced RISC Machines Ltd., a joint venture of Apple Computer, Acorn Computer Group, and VLSI Technology. In 1991, ARM introduced the ARM6 processor family, and VLSI became the initial licensee. Subsequently, additional companies, including Texas Instruments, NEC, Sharp and ST Microelectronics, licensed the ARM processor designs. Nowadays ARM partners ship in excess of 2 billion ARM processors each year. Unlike many semiconductor companies, ARM does not manufacture processors or sell the chips directly. Instead, it licenses the processor designs to business partners. This business model is commonly called intellectual property (IP) licensing.

2.1 CORTEX M3 PROCESSOR

The Cortex-M3 processor is specifically developed to enable partners to develop high-performance low-cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors.The Cortex-M3 has predefined memory maps, which allows built in peripherals, such as the interrupt controller and debug components, to be accessed by simple memory access instructions.The predefined memory map also allows the Cortex-M3 processor to be highly optimized for speed and ease of integration in system-on-a-chip (SoC) designs.

3. HARDWARE ANALYSIS

This project is developed and tested on the F1200 FPGA based ARM kit. F1200 FPGA has the ARM processor, USB program & debug interface, 10/100 Ethernet interface, regulators, USB power& USB-UART interface, RVI header, OLED Display, Potentiometer, Debug IOs, UART header, I2C header, reset switch, Debug select, eight user LEDs, JTAG select, PU_N switch, SPI header, SPI flash memory, mixed signal header for analog & digital signals, 20MHZ crystal, 32,768 KHZ crystal, VAREFOUT/VAREF Header and VRPSM Voltage option.

3.1 FPGA Architecture

A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a designer after manufacturing, hence it is known as "field-programmable". The FPGA configuration is generally specified using a HDL i.e. hardware description language (HDL), similar to that used for an ASIC i.e. application-specific integrated circuit.FPGAs contain an array of programmable logic blocks, and a hierarchy of reconfigurable interconnects that allow the blocks to be "wired together", like many logic gates that can be inter-wired in different configurations. Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates like AND and XOR. In most FPGAs, logic blocks also include memory elements, which may be simple flip-flops or more complete blocks of memory.

Contemporary field-programmable gate arrays (FPGAs) have large resources of logic gates and RAM blocks to implement complex digital computations. As FPGA designs employ very fast I/O’s and bidirectional data buses it becomes a challenge to verify correct timing of valid data within setup time and hold time. Floor planning enables resources allocation within FPGAs to meet these time constraints. FPGAs can be used to implement any logical function that an ASIC could perform. The ability to update the functionality after shipping, partial re-configuration of a portion of the design and the low non-recurring engineering costs relative to an ASIC design, offer advantages for many applications.Some FPGAs have analog features in addition to digital functions. The most common analog feature is programmable slew rate and drive strength on each output pin, allowing the engineer to set slow rates on lightly loaded pins that would otherwise ring or couple unacceptably, and to set stronger, faster rates on heavily loaded pins on high-speed channels that would otherwise run too slowly. Another relatively common analog feature is differential comparators on input pins designed to be connected to differential signaling channels. Mixed signal FPGAs have integrated peripheral analog-to-digital converters (ADC) and digital-to-analog converters(DACs).

3.2 Kit Hardware components (OFF CHIP)

10/100 Ethernet Interface is used to connect the F1200 FPGA kit to the computer. User can develop an Ethernet application to transmit and receive the packets between the computer and the F1200 FPGA kit.USB Power & USB-UART Interface is used to power cycle the F1200 FPGA kit and to interact with the putty/HyperTerminal/Tera term serial communication software running on the host computer. A FTDI chip is used on the F1200 FPGA kit to convert the UART to USB and vice versa.USB Program & Debug Interface is used to debug the design running in the F1200 FPGA kit or to load the new design in to the F1200 FPGA kit or to update the existing design in the F1200 FPGA kit. This section is controlled by the software tools like Eclipse, FP etc.

If a user wants to debug the F1200 FPGA kit by Keil or IAR debugger, then the user can debug the F1200 FPGA kit via the RVI debugger. RVI stands for Real View ICE.RVI provides run-control debug functionality.OLED display can be interfaced to the ARM via the I2C, user needs to develop the OLED drivers & then display the messages on the OLED display by calling the correct sequence of functions. SSD0300 embeds with contrast control, display RAM and oscillator, which reduces the number of external components and power consumption. SSD0300 is suitable for many compact portable applications, such as mobile phone sub-display, calculator, and MP3 player, etc.

A mixed signal header is used by the analog section of the FPGA. ADC inputs to the F1200 FPGA can be routed to the mixed signal header pins. DAC outputs of the F1200 FPGA can be routed to the mixed signal header pins. F1200 FPGA kit has the separate analog and digital grounds. The F1200 FPGA kit is designed in such a way that the noise has minimum impact on the analog section. Even other services of the analog section like comparators, Analog Bipolar pre-scalars and operational amplifiers can be routed to the mixed signal header. Potentiometer is connected to the voltage monitor of the analog section. User LEDs can be used in the application development.

3.3 Bluetooth

Bluetooth is a connective convenience. It is a high-speed, low-power microwave wireless link technology, designed to connect phones, laptops, PDAs, and other portable equipment together with little or no work by the user. Unlike infra-red, Bluetooth does not require line-of-sight positioning of connected units. The technology uses modifications of existing wireless LAN techniques but is most notable for its small size and low cost. The current prototype circuits are contained on a circuit board 0.9cm square, with a much smaller single chip version in development.The cost of the device is expected to fall very fast, from $20 initially to $5 in a year or two. It is envisioned that Bluetooth will be included within equipment rather than being an optional extra. When one Bluetooth product comes within range of another, (this can be set to between 10cm and 100m) they automatically exchange address and capability details. They can then establish a 1 megabit/s link (up to 2 Mbps in the second generation of the technology) with security and error correction, to use as required. The protocols will handle both voice and data, with very flexible network topography.This technology achieves its goal by embedding tiny, inexpensive, short range transceivers into the electronic devices that are available today. The radio operates on the globally available unlicensed radio band, 2.45 GHz (meaning there will be no hindrance for international travelers using Bluetooth-enabled equipment.), and supports data speeds of up to 721 Kbps, as well as three voice channels.The Bluetooth modules can be either built into electronic devices or used as an adaptor. For instance in a PC they can be built in as a PC card or externally attached via the USB port.Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters but can be extended to 100 meters by increasing the power.

3.4 Gyroscope

A gyroscope is defined as a rigid rotating object, symmetric about one axis. Generations of children, back at least to Greek antiquity, have found fascination in the behavior of tops, to give the gyroscope its common name. A number of eminent physicists have also found the complex behavior of spinning objects a matter of interest and a fit subject for detailed analysis. More recently, very carefully engineered gyroscopes were used for navigation because the axis of spin points in a nearly fixed direction when external torques are small. This makes the gyroscope a good replacement for a magnetic compass, particularly in regions where magnetic compasses are unreliable.

As with any mechanical system, the motion of a gyroscope can be understood completely by a systematic application of F = maa to all the particles of which the rigid body is made. It is much more efficient, however, to exploit the fact that most of the forces act between the particles of the body, and simply have the effect of making it rigid. The overall motion is then described by

$$\bar{\tau} = \frac{d\bar{L}}{dt}$$

We will simplify matters by considering the somewhat idealized example sketched in Fig Our toy is spinning about its axis with an angular speed, supported at one end on a frictionless bearing. Choosing the origin at the pivot, gravity will produce a torque about the origin because the center of mass is not necessarily above the pivot point, but there are no other external forces that can produce a torque because the bearing is assumed frictionless. Further, the total mechanical energy, including gravitational potential, must also be constant. The motion will still be interesting, but these conditions let us understand some qualitative features.

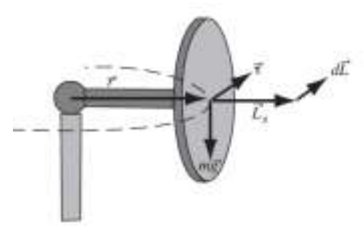

Fig. 2. A simple gyroscope, showing precession

To start the gyroscope, we will hold the axis fixed and set the rate of spin to the desired value. If we then move the axis at the precession speed and release it, the motion will be a smooth precession. If, instead, the axis is released from rest the tip will trace out small 'scallop' or looping motions, superimposed on the overall precession. This is called notation and arises from conservation of mechanical energy.

The processional motion represents additional kinetic energy, relative to the state with the axis fixed. The additional kinetic energy must come from a loss of gravitational potential. In other words, the center of mass must fall a little bit, tipping the axis of rotation, for the top to process. If the spin is rapid, the drop is small, and the precession is affected only slightly. Overall, the tip of the axis bounces up and down a little, and the processional speed varies a little. If the spin is not fast enough the character of the motion changes drastically, but that is a complicated story.

3.5 Light Sensor - MAX44009

A Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum. The light sensor is a passive devices that convert this “light energy” whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because the convert light energy (photons) into electricity (electrons). Photoelectric devices can be grouped into two main categories, those which generate electricity when illuminated, such as Photo-voltaic or Photo-emissive etc., and those which change their electrical properties in some way such as Photo-resistors or Photoconductors.

3.6 LM 35 precision centigrade temperature sensors

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

4. SOFTWARE ANALYSIS

The Eclipse compiler and debugger is used to compile and debug the ARM C code. User can set the break points and debug the application code to fix the bugs. First the application code is debugged from the RAM. After getting the expected results the code is programmed into the FPGAs on chip flash memory (i.e., 512Kbytes NVM) so that the application will be live at power up.

4.1 STEPS TO DEVELOP THE APPLICATION CODE

Step 1:

Here after opening eclipse tool in project explorer we will find two folders one is CM3_app where we develop the application code and the other one is CM3_hw_platform which is given by the firmware engineers which has peripheral drivers like ADC, Timer, UART etc.

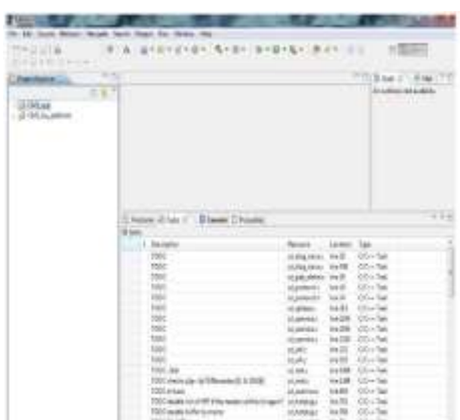

Fig.3. Application and hardware folders

Step 2:

This shows the folder structure of an eclipse project which consists of various sub folders. Here we can see a sub folder called main.c which is empty. This empty main.c consists of a main function and an infinite loop. Empty main.c is used to write the application code.

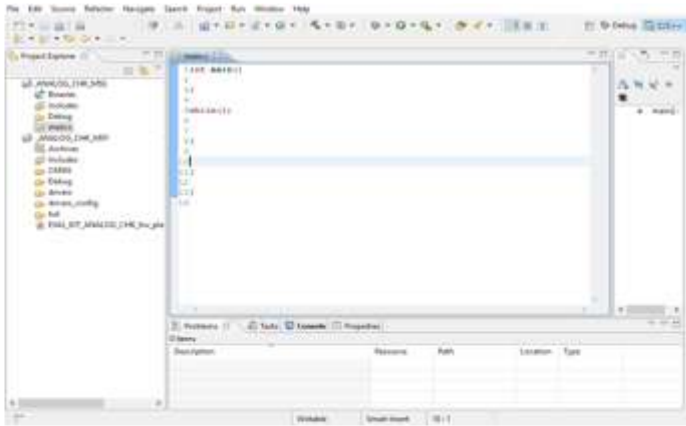

Fig.4. Folder Structure of Eclipse Project with empty main.c

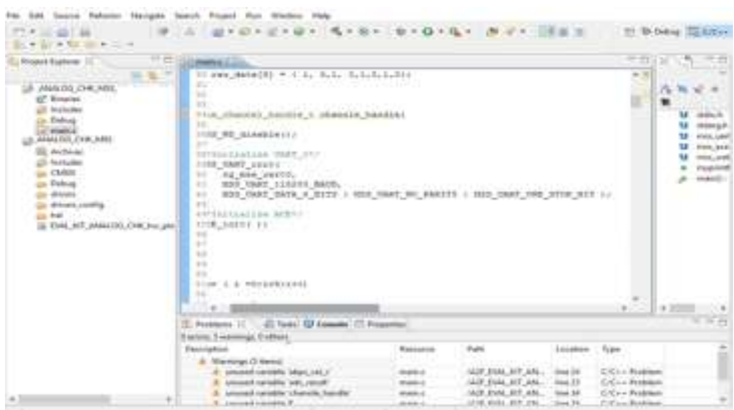

Fig. 5. Project code in main c

Step 3:

In order to generate the Intel hex file we need build the program. To build the program we need to press Ctrl+B.

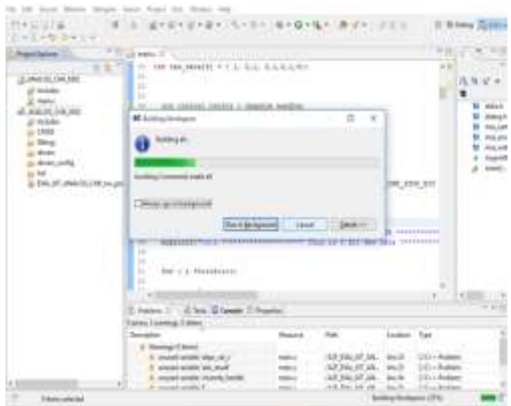

Fig.6. Building the code

Step 4:

After building the program a debug folder is generated. If we open that folder we can find the hex file(.hex).

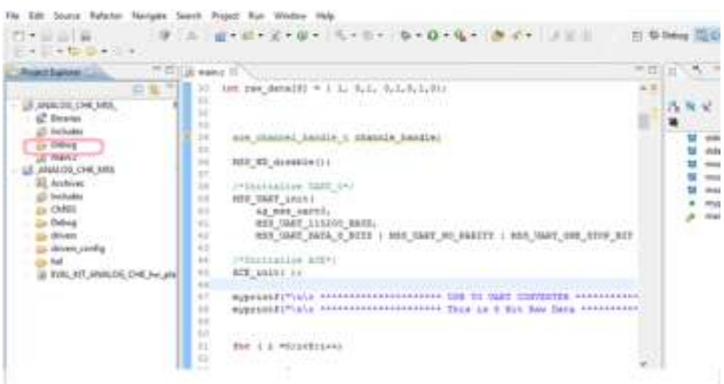

Fig.7. Debug Folder

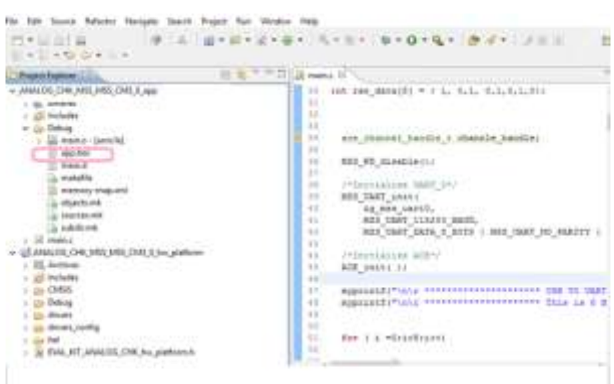

Fig.8. Intel Hex File

4.2 INTEL HEX FILE

Intel HEX is a file format that conveys binary information in ASCII text type. It is commonly used for programming microcontrollers, EPROMs, and other types of programmable logic devices.

In a typical application, a compiler or assembler converts a program's source code (such as in C or assemblylanguage) to machine code and outputs it into a HEX file. The HEX file is then imported by a programmer to "burn" the machine code into a ROM or is transferred to the target system for loading and execution.

Format:

Intel HEX consists of lines of ASCII text that are separated by linefeed or carriage return characters/both. Each text line contains hexadecimal characters that encode multiple binary numbers. The binary numbers may represent data, memory addresses, or other values, depending on their position in the line and the type and length of the line. Each text line is called a record.

Record structure

A record (line of text) consists of six fields (parts) that appear in order from left to right:

1. Startcode, one character, an ASCII colon ':'.
2. Byte count, two hex digits, indicates the number of bytes (hex digit pairs) in the data field. The maximum byte count is 255 (0xFF). 16 (0x10) and 32 (0x20) are commonly used byte counts.
3. Address, four hex digits, representing the 16-bit beginning memory address offset of the data. The physical address of the data is computed by adding this offset to a previously established base address, thus allowing memory addressing beyond the 64 kilobyte limit of 16-bit addresses. The base address, which defaults to zero, can be changed by various types of records. Base addresses and address offsets are always expressed as bigendian values.
4. Recordtype, two hex digits, 00 to 05, defining the meaning of the data field.

00 - Data

01 - End of File

02 - Extended segment address

03 - Start segment address

04 - Extended linear address

05 – Start linear address

5. Data, a sequence of n bytes of data, represented by 2n hex digits. Some records omit this field (n equals zero). The meaning and interpretation of data bytes depends on the application.
6. Checksum, two hex digits, a computed value that can be used to verify the record has no errors.

Step 5:

To load the program right clicks on the project and select debug as and then select debug configurations.

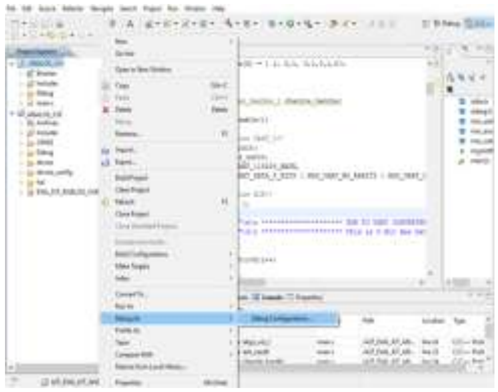

Fig.9. Procedure to load the code

Step 6:

You can see this window after launching a debug session click on yes.

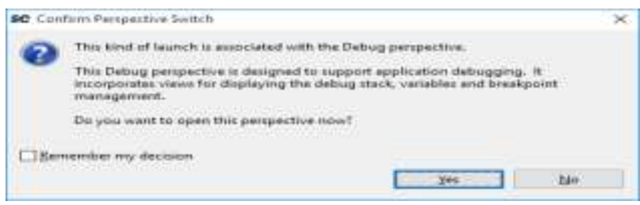

Fig.10. Debug Session Window

Step 7:

Later you can see a resumed debug session (that is running the code from memory to cortex m3 which is loaded by the debug session). Then after completing this we can see the output in the windows serial communication app.

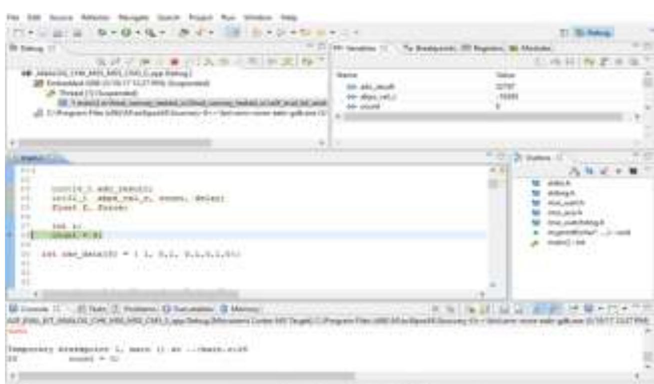

Fig.11. Resumed Debug Session

This is the design flow of any FPGA based project:2 Steps are:

1. Hardware Development
2. Software Development

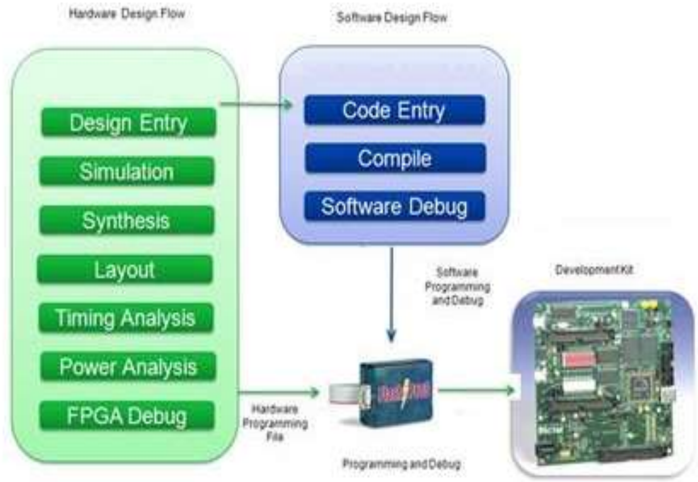

Fig.12. FPGA based design flow

5. APPLICATION DEVELOPMENT

Real time data on field helps to achieve real time monitoring, data collection and control at fields from remote location. Farming efficiency and production can be improved by precision agriculture if the WSN technology can be ready to make the farms. Wireless Sensor Networks has the potential to complete this. Wireless Sensor networks can be used for monitoring pressure, temperature, soil moisture, and reporting best options to the agriculturist. Having such information at regularly would be a big help for him. In sequence to region of the adverse conditions which challenge the agriculturists, automatic actuated devices can be used to control agriparameters. The Precision agriculture system performing following functions like: 1. Sensing agricultural parameters. 2. Identification of sensing location and data gathering. 3. Transferring data from crop field to control station for decision making. 4. Actuation and Control decision based on sensed data. Following figure shows the Architecture of WSN system in Precision Agriculture to monitoring the agri-parameters.

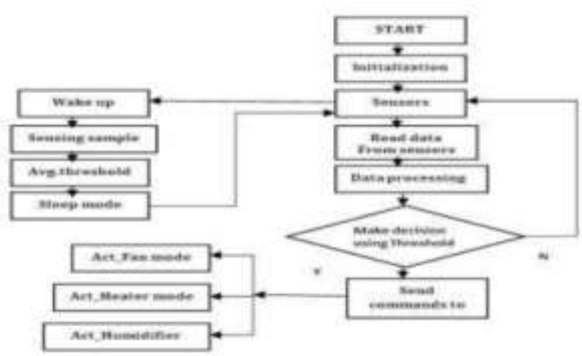

Fig. 13. Architecture of WSN system

5.1 RESULTS

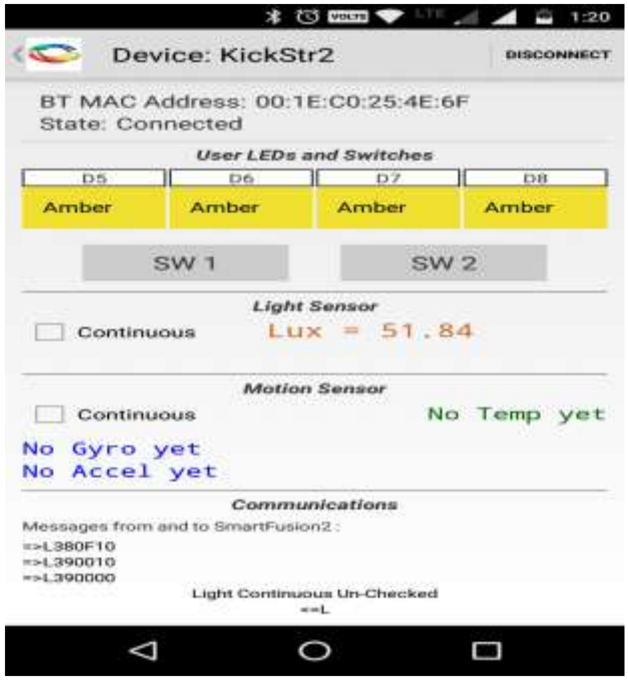

Fig.14. Light Sensor and Motion Sensor

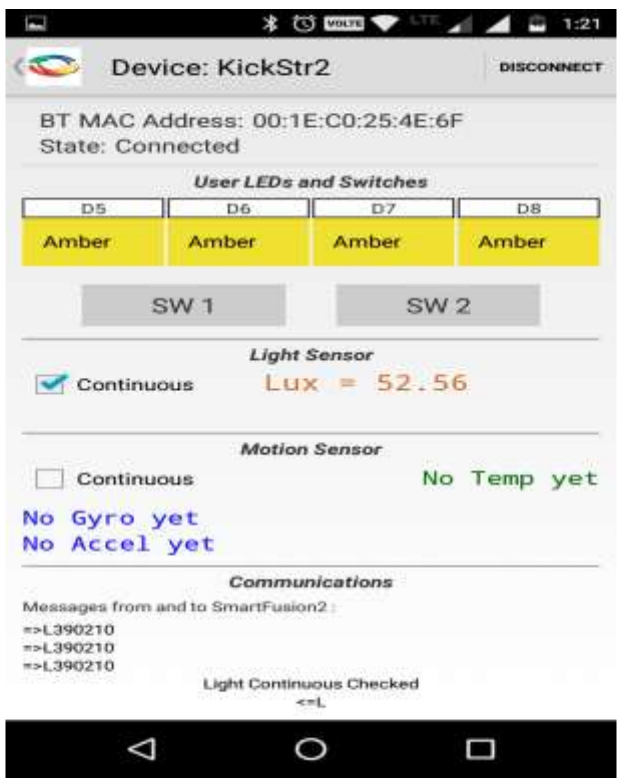

Fig.15. Light Sensor with Continuous Monitor

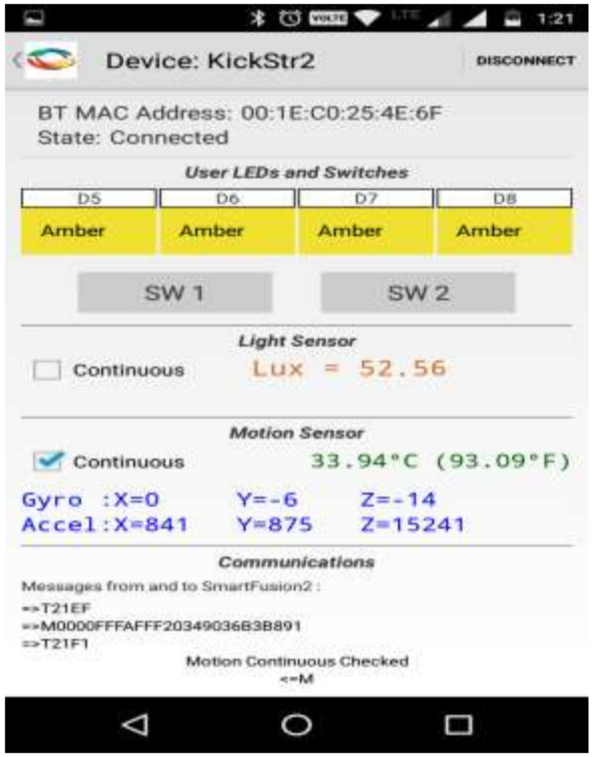

Fig.16. Motion Sensor & Temperature with Continuous Monitor

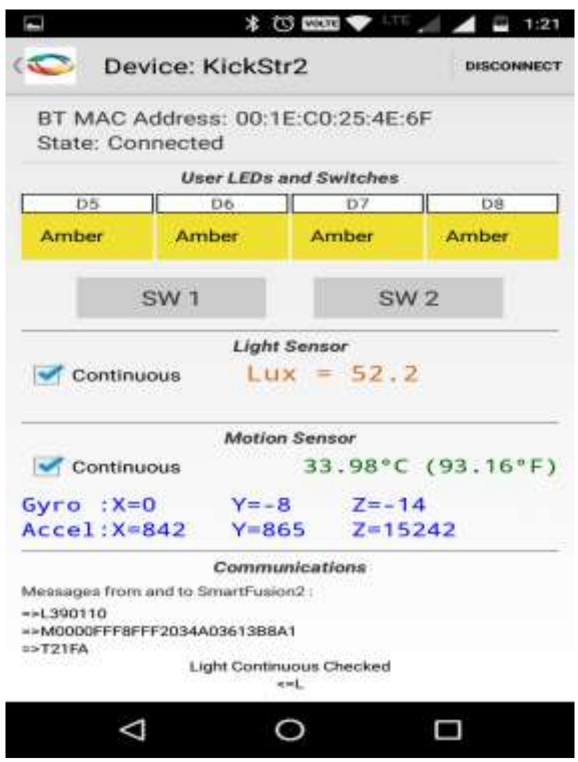

Fig.17. Both Light and Motion Sensor with Continuous Monitor

5.2 APPLICATION AREAS

This section reviews common sensors of recent smart phones. Sensors are a device that measures a physical quantity and converts to a signal which can be read and used by other devices. An example of the traditional sensors is the thermometer which converts how hot or cold the environment is into a number, which is called the temperature. There are many kinds of sensors available nowadays, and many mainstream smart phones are equipped with various sensors, including accelerometers, GPS, light sensors, temperature sensors, gyroscope, and barometer.The sensors embedded in smart phones can be classified into three categories: motion sensors, environmental sensors, and position sensors. The first category, motion sensors, provides acceleration force and rotational force measurements. Examples of motion sensors are accelerometers, gyroscopes, gravity sensors, and rotational vector sensors. The second category, environmental sensors, provides measurements of the surrounding environments. This ranges from ambient air temperature from a thermometer and pressure from a barometer to illumination from a photometer.

The third category, position sensors, provides measurements of the device's physical position. Such sensors include magnetometers, GPS, and orientation sensors. Table 1describes the common Smartphone sensors. For the purpose of this review, we exclude communication channels (e.g., WIFI, Bluetooth, 3G, and NFC) and display channels from the sensor list.Since smart phones in the literature may be referred to by many terms such as "mobile phone(s)" or "mobile device(s)," we devised a set of words which can describe smart phones. The set of keywords are the following: "mobile application," "mobile app," "Smartphone," "mobile device," and "mobile phone." With our goal of reviewing usage of Smartphone-based sensors in agriculture, the previous set of keywords became search criteria in conjunction with the keyword "agriculture." Specifically, the phrase (("Smartphone" OR "mobile device" OR "mobile phone" OR "mobile app" OR "mobile application") AND "agriculture") was entered into SCOPUS search engine. The search terms focused on the terms related to smart phones and agriculture. The result set from this search was then systematically reduced to only articles featuring sensors in smart phones and their use in agriculture by exclusion criteria.

5.3 ADVANTAGES AND DISADVATAGES

A. Reduced Employee and Cost: As the irrigator is not required to constantly monitor to check the progress of irrigation, the irrigator is available to perform other tasks – uninterrupted. Because of that, the farmer is able to be away from the property, relax with the family and sleep through the night. In addition to, the reduces for the running costs of vehicles are used to constantly check progress down the bays being irrigated.

B. More Timely Irrigation: Irrigators with automation systems are more inclined to irrigate when the plants need water, not when it suits the farmers. This the difference between hand watering and automatic system, it can take substantial time and early morning and evening watering rituals take away from family and effort. Automatic plant irrigation systems have timers that can be preset for daily or weekly watering so the farmers do not need to check the watering because the timer shuts the water off when it has finished.

C. Helping In the Management Of Higher Flow Rates: Many farmers are looking to increase the irrigation flow rates they receive through installing bigger channels and bay outlets. Such flow rates generally require an increase in employee as the time taken to irrigate a bay is reduced thus requiring more frequent change over. Automatic plant system irrigation allows for these higher flows to be managed without an increase in the amount of employees.

D. More Accurate Cut-Off: Automatic plant irrigation system allows cut-off of water at the appropriate point in the bay. This is usually more accurate than manual checking because human error can occur if the operator is too late or too early in making a change of water flow.

E. Reduced Runoff of Water and Nutrients: Automation can help keep fertilizer on farm by effectively reducing run off from the property. Using automatic plant irrigation system produces smaller droplets, helping to preserve nutrients and reducing runoff of water. Retaining fertilizer on farm has both economic and environmental benefits.

5.4 The Disadvantages of Automatic Plant Irrigation System

Highly Cost: There are costs in purchasing, installing and maintaining automatic equipment of irrigation systems. In addition to, there is a need to increase maintenance of channels and other tools to ensure the system work correctly every time. Channels should be fenced to protect the automatic units from stock damage therefore a lot more costs to maintain perfect growing conditions.

6. Conclusion

Wireless sensor Networks are important for the research purpose. Agriculture monitoring system using WSN is an efficient and reliable system for effectively monitoring environment parameters. Wireless applications can reduce the human power, but it requires to check updates or changes in it. System require to focus on tools and developing devices to alert, manage and display the disaster or weather warning using wireless sensor network.

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