High-Speed Data Collection for Wireless Seismic Sensor Networks

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Abstract- The purpose of this research was to set up wireless communication between nodes with development and testing of a data storage logger for seismic monitoring of ice sheets. Seismic data can provide a detailed picture of the nature of the ice at a given location. This is especially important in order to understand and predict the role of polar ice sheets in sea level change. The urgency of addressing the impact of climate change makes it imperative that the scientists receive data quickly. This project consisted of the development of a wireless sensor network with a removable device that would be able to store an abundance of data rapidly using a small platform. The development of a small embedded system that can be easily deployed, which stores data onto a USB drive was the main goal. Included in this design is the implementation of a data logger. The USB drive inserted into the data logger would inevitably be connected to a computer for viewing and analyzing of the seismic data collected. This research has also emerged from the need for high-speed data collection and storage of seismic data, which has resulted from the high collection rate of 240 Kbps per node being processed. Therefore, an inexpensively built platform that could support the high data rate was constructed. Implementing a wireless network with a USB connection for data storage instead of through a serial port will allow for more expedient data transfer, less maintenance, and will facilitate for more advances technologically.

I. INTRODUCTION

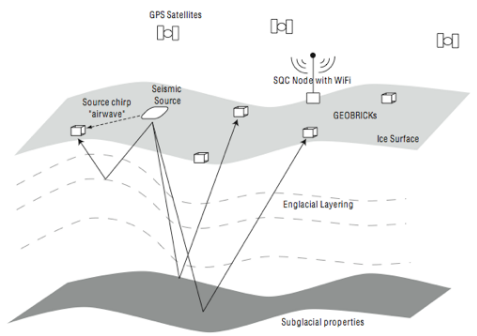
Global warming has had a significant impact on ice glaciers which are melting continuously at faster rates. The melting of ice glaciers can lead to dramatic sea level rising. As a result, coastal areas over time will flood. The Center for Remote Sensing of Ice Sheets (CReSIS), a Science and Technology Center with the mission of developing new technologies and computer models to measure and predict the response of sea level change to the mass balance of ice sheets in Greenland and Antarctica, utilizes different disciplines to address the impact of climate change and ice sheet mass balance. Seismic studies play a major role in the research being done to help solve the climate change issue. Seismic studies use sound waves to measure the properties of the ice. Tiny explosions are set off in the ice and instruments measure their echoes from internal structures and the ice-bed interface. A geophone sends vibrations though the ice and indicates bed and subbed conditions. The data received is used to aid in the prevention of further significant sea rising.

II. RELATED WORK

Related research efforts in the area of wireless sensor networks concentrate on activities for detecting events of interest, and they have contributed to a variety of applications, particularly in seismology. There has been a number of efforts to develop seismic sensors [3], [4], [5]; however, the focus of this prior work was not on high-rate, real-time monitoring of seismic data for ice sheet monitoring. Relevant work in data collection [6] utilized a USB data logger, which provided storage and high bandwidth transmission system capabilities for collecting data and is less expensive than other traditional data collection techniques, such as wired and powered data acquisition systems while wireless communications [7] relied on the low cost, low data rate Zigbee protocol (IEEE 802.15.4).

III. MOTIVATION

The research being implementing in this project is phase II of the GeoPebble Project. The purpose of the GeoPebble is to replace the current standard technique of multichannel seismic data acquisition. As of now the GeoPebble is expensive as well as time and labor intensive. Also, a multiconductor cable connecting the geophones together only allows for linear 2D surveys. Since glacier structures are 4D and complex the changes made in Phase II will compensate for these shortcomings. It will be inexpensive, less maintenance, wireless, and flexibility with geophone setup will be provided.



[1]

IV. MATERIALS

The Propeller Chip microcontroller and development software manufactured by Parallax Inc., along with the SpinStudio MainBoard, solderless breadboard, data logger (Figure 1), USB drive mulitmeter, soldering iron, and other necessary miscellaneous components were used in order to assemble and conduct this research project. Following is a list of the materials along with their uses:

- Propeller Tool v1.2: Development software to program microcontroller
- SpinStudio Mainboard: Platform for propeller chip
- Solderless breadboard: Development technique, platform for data logger
- Data logger: Allows for data recording
- USB drive: Allows for data storage
- Multimeter: (Range 5V; LCD 3V; Data logger 5V) Tests voltage
- Soldering iron: Soldering tool (applies heat to melt solder)
- Ribbon Cables and wires: Provides communication from circuit board to bread board.

[1]http://www.psice.psu.edu/GeoPebble.htm (diagram: setup of GeoPebble)

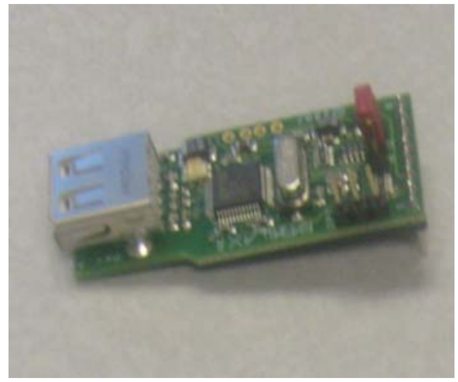


Figure 1: Data Logger

V. METHODS

The first steps taken were to assemble the hardware as show in Figure 1.1. The SpinStudio Mainboard, which is a pressed circuit board, was used. Soldering was the method used to assemble all the pieces that came in the kit. Pieces in the kit are shown in Figure 1.2. A solderless breadboard that laid out a circuit to be tested was also used. It served as a design model and testing tool as shown in figure 1.3. Ribbon cables were assembled using a vice which would inevitably connect the two boards. And the cutting and stripping of wires were necessary to test the circuits. The power supply was then built and soldered to the circuit board to test as shown in Figure 2. Then the boards were connected together after testing was successful. To test the boards we used a multimeter. Now that the boards were tested and proven to be working correctly it was time to use the Parallax Software for the Propeller Chip (microcontroller) which is connected to the circuit board. The Propeller Chip is what has to be programmed in order to receive a desired result.

Figure 1.1: Assembling of hardware via soldering

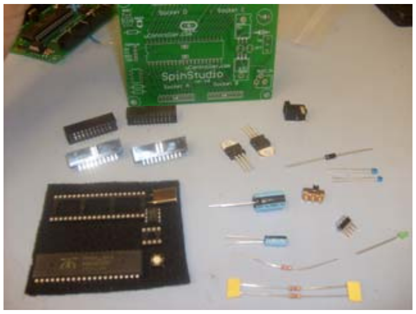


Figure 1.2: SpinStudio Mainboard before assembled

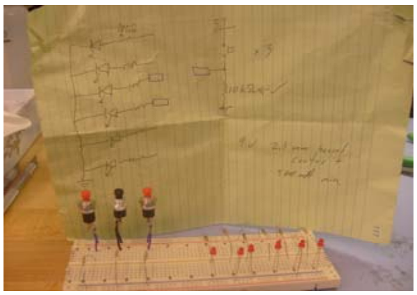


Figure 1.3: Schematic of breadboard along with hardware

Figure 2: Circuit board testing

VI. PROCEDURE

Implemented first was the building of a small platform that could support large quantities of data quickly as shown in Figure 3. Once the platform was constructed, using the Parallax Software, the Propeller Education Lab Series were utilized. These labs helped investigator become familiarized with the software as well as educate on the different coding techniques that were needed in order to successfully program the device as shown in Figure 4. Once this was established, investigator then created code that enabled data to be written on the USB drive.

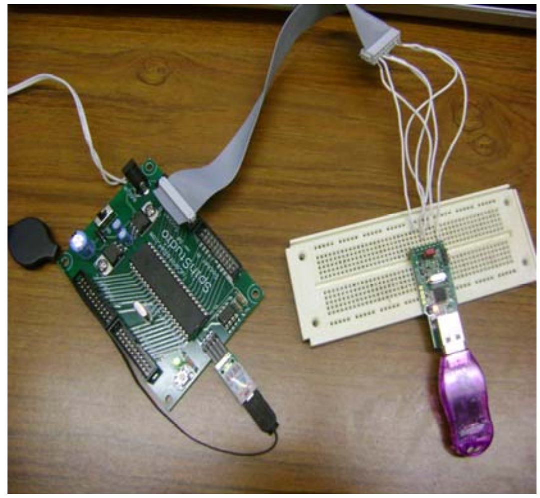


Figure 3: Hardware setup

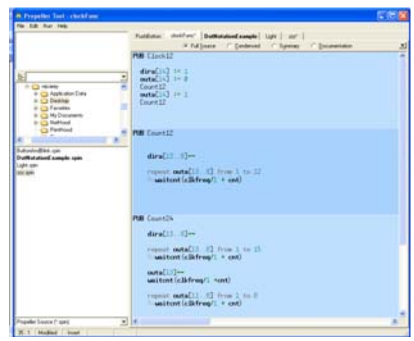


Figure 4: Program and code testing

VII. CONCLUSION

The urgency of addressing the impact of climate change makes it imperative that the scientists receive data quickly. Implementing a wireless sensor node with a USB connection for data storage instead of through a serial port allows for more expedient data transfer, less maintenance, and will facilitate for more advances technologically. This research project will not only benefit CReSIS but will inevitably aid (among others) scientists, researchers, and the general public.

VIII. FUTURE WORK

In the future lossless compression algorithms will be developed for allowance of more data storage on the USB drive. An actual USB removable hard drive may also be implemented. Using energy efficient storage options such as an SDC or MMC will be a focus. A system integration that consists of a single board, which will minimize hardware, will also be put into practice.

IX. ACKNOWLEDGEMENTS

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[8] www.parallax.com Copyright 2008 by Parallax, Inc.

[9] http://www.psice.psu.edu/GeoPebble.htm