WIRELESS WATER LEVEL MEASUREMENT USING ARDUINO

Lina Rose [1] and Anitha Mary X [2],

Dept. of Electronics and Instrumentation, Karunya University, Coimbatore, India,
Email: [1] linarose@karunya.edu , [2]anithamary@karunya.edu

ABSTRACT
           Water is a primary resource which has its significant role in human existence. The rate at which the essential resource being used is exponentially increasing day by day. All living organisms need water for its survival. There are many water storage phenomenons where the major among them is ground water. As water is consumed, naturally subsequent amount of water will be added to the aquifer to reinforce human needs. This recharge capacity if measured will give anew eye opening to those areas which is facing severe drought conditions. This work is carried out on an embedded based sensor technology to determine the water level at various instances there by monitoring the recharging capacity of the water body under study**.**

Index Terms—Digital pressure sensor, ground water recharge, micro controller.

I. INTRODUCTION

Hydrologic processes of Groundwater recharge emphasis on the movement of water from surface to ground. In an aquifer that stores or has a capacity to store water, the primary method that water enters is recharge. The recharging usually occurs in the area below plant roots to the water table surface and happens both naturally and through anthropogenic processes. The continuous monitoring of ground water is essential to predict the water resource availability for future. So, it's necessary to log the data at regular intervals of time in a data base, thus enabling us to check and predict the area scarce of water. A micro controller interface along with a sensor technology is used to accomplish this task. A differential pressure sensor is used to measure the pressure exerted by the water body on the air column. This is converted to height or level of the water in the well which is prototype for this case. The water level measurements are acquired during particular intervals of time, and are viewed as an html data.

II. SIGNIFICANCE OF GROUND WATER RECHARGING

The Groundwater recharge is an important process for sustainable groundwater management. Problems with water are expected to grow worse in the coming decades, with global water scarcity, even in water rich regions which are currently considered better. The statistical analysis says that these problems calls out for a vast research to be done to identify robust metho-dologies of purifying water at lower cost and with less energy, while in the same manner minimizing the use of chemicals and reducing environmental impact. Thus the quality and quantity of water that the humanity uses has to figure out. In this chapter, various instruments involved in qualifying and quantifying water bodies are studied along with the challenges faced for each case. In this regard some of the science and technology is being developed to improve the monitoring and recording of water levels of different water bodies. There are efforts for safe re-use of wastewater to increase water supplies through them and efficient sensor technology for monitoring the quality of water that is available for the society. Our nation is blessed with many natural resources, among which the ground water is considered as most precious natural resources [1]. To indicate the status of this resource continuous monitoring has to be carried out. These logged data analysis have a significant role while evaluating the quantity and quality of ground water and its interaction with surface water. The objective of this study is to high-light the importance of measurements of ground-water levels and to enhance a more comprehensive and systematic approach to the long-term acquisition of these essential data. These mutual efforts will help the nation positioned in a better state in the coming decades to make wise use of its extensive ground water resources [2].

III. ESSENTIAL COMPONENTS OF WATER-LEVEL MONITORING PROGRAMS

The water level monitoring programmes falls under many categories depending on the device, nature of water body, availability of surface water flowing, amount of rainfall, duration of measurement etc [1]. The essential components of a water-level monitoring program include:

- Proper selection of observation wells
- Determination of water level measurements frequency
- Quality assurances implementation
- Establishment of effective methodologies for data storage.

IV. SYTEM DESCRIPTION

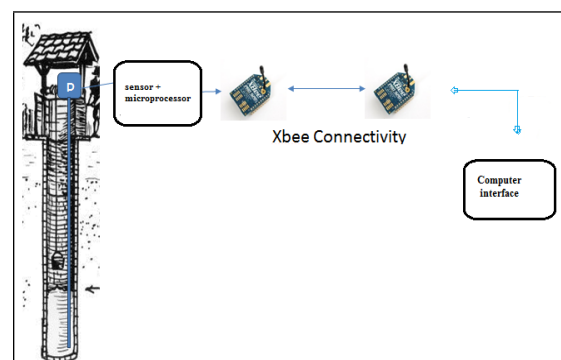The schematic of the proposed measurement set up is a s shown below.

Fig.1. Schematic of the proposed system

The study system consists of a differential pressure sensor whose data is read by a Xbee module transmitter. This data is a serial data which requires a clock for transmission. Since an Aurdino microcontroller has both inbuilt SPI interface as well as clock generation, the same was used for the purpose of interfacing Xbee with pressure sensor. At the receiving end the Xbee receives the data (pressure values) which was send by the transmitter, and this was viewed via Hyper Terminal.

The differential pressure sensor Manufactured by Honey Well Technologies, HSC series is been used. The pressure sensor is digital; This will nullify the need of a signal conditioning circuit that is anticipated in all real time data acquisition plat forms. The output of the pressure sensor cannot be given directly to the Xbee module. A clock pulse is needed to send the data serially from pressure sensor to Xbee module. An ordinary microcontroller cannot send serial data as such. This limitation will lead to select an advanced microcontroller which supports serial communication also. With this regard an Audio microcontroller was chosen to have both serial communication and delivering of clock pulse [3].

V.   DIFFERENTIAL PRESSURE SENSOR

There are many types of serial communication platform for transfer of information. Serial Peripheral Interface (SPI) is a synchronous, simple bus system for communicating between devices. It can be a master and one or more slaves. This operates in half-duplex or full-duplex mode, which allows the devices to communicate in either both directions or in only one direction. The master generates clock and control signal and also starts the information transfer. Slave devices are selected using slave select lines which are controlled by the master and are active only when selected. Honey well pressure sensors which are used here with SPI output, enhance data transfer between the devices in one direction only, i.e. half duplexed which is from slave to master. For this data transmission three lines need to be used.

- Slave Select (SS)
- Signal Clock (SCLK)
- Master In - Slave Out (MISO)

The TruStability High Accuracy Silicon Ceramic (HSC) Series offers a ratiometric analog output for reading pressure over the specified full scale pressure span. This is a piezoresistive silicon pressure sensor and is also used in monitoring wide temperature ranges. The HSC Series has significant features of accuracy since it is calibrated and also temperature compensated for sensor offset, sensitivity etc. Its other requirements as precision temperature effects and an on-board Application Specific Integrated Circuit (ASIC) non-linearity also have been checked. The pressure output values after calibration are updated at 1 kHz approximately. The calibrated temperature range for HSC Series is of 0 C to 50 C [32 F to 122 F]. The sensor is characteristic operation of sensor varies from either 3.3 V_{dc} or 5.0 V_{dc} single power supply. These pressure sensors are capable of measuring gage, differential and absolute pressures. The absolute sensor versions generate an output proportional to absolute pressure that also has a reference as an internal vacuum. Where as in case of differential and gage versions of pressure, the former allows application of pressure to either side of the sensing diaphragm and later versions provide an output proportional to pressure variations from atmosphere and are refered to atmospheric pressure. The TruStability® pressure sensors have the properties as a sensor with non-corrosive as well as non-ionic gases, such as air and other dry gases. These sensors are also extended to work on to non-corrosive, non-ionic liquids.

The communication with Honeywell SPI pressure sensors starts by selecting the SS line. At that instant, the pressure sensors will strat sensing data when ever clock is given information. Therefore from that point the pressure sensor no longer waits idle, but actively participates in transmission. This process lasts till the master gives a next clock signal as soon as activating Slave select line thus giving an output value at the compensated pressure reading. The sensor thus transmits 4 bytes of data to the receiving or slave device. In the send data, the compensated pressure output occupies first two bytes, and the compensated temperature output will occur at the second two bytes. To stop the process of transmission of information as clock and to deactivate the SS line, master is again initiated with information for termination.

VI. MICROCONTROLLER INTERFACE

Arduino works a both hardware and software which is easy-to-use. This is an open-source prototyping platform based on which enable the boards to work both as input and output such as read inputs as light on a sensor, a finger on a button, or a Twitter message and turn it into an output, activating a motor, turning on an LED, publishing something online etc. The information can be given to the board on what data to be transferred and tasks while sending a set of instructions to the microcontroller on the board. To do these tasks two methods can be adopted. Either to use the Arduino programming language (based on Wiring) or based on Processing the Arduino Software (IDE). For many years Arduino has been used for thousands of projects, which ranges from everyday objects to complex scientific instruments. A worldwide community including people from all streams as makers - students, hobbyists, artists, programmers, and professionals has gained the advantages of this open source system, contributes their information to an incredible amount of accessible knowledge which is is used by the community.

The Institute of Interaction Design Ivrea, launched Arduino as an easy tool for fast prototyping. This in major focused on students with lack of knowledge in electronics and programming. But this didn't last for too long since it started to be used for wide range of applications. This varies from products that can send 8-bit for IoT applications, embedded systems, wearable monitors for medical application, 3D printing

technology and so on. All Arduino boards both hardware and software are completely open-source, that involve users to build them independently and subsequently adapting to the specific needs of the community. The reason for the enormous use of Arduino boards is their simple structure and ease of practical demonstrations.

The software part of the board is easily accessible for beginners, thus enough suiting for advanced users. It can runs on operating systems as Mac, Windows, and Linux. Mainly Arduino boards are used by the higher class of students who belongs to the beginner's category to prove the fundamental theory which they have studied. Also its used by designers and architects in building interactive prototypes for construction, the media group as musicians and artists use it for installing and experimenting with new musical instruments.
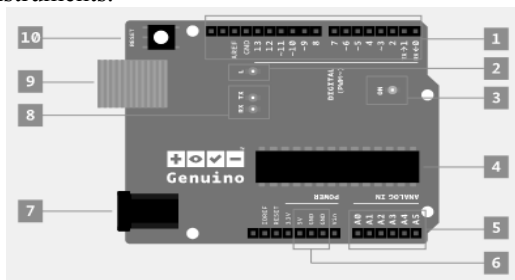

Fig.2. Arduino microcontroller board

PIN SPECIFICATIONS
1. Digital Pins
2. LED for indication
3. Power LED
4. Atmega microcontroller
5. Analog input
6. Ground and 5V pins
7. Power connector
8. TX and RX LEDs
9. USB port
10. Reset Button

The physical computing parameter is not restricted to theses developmental boards but also there are many other microcontrollers and microcontroller platforms available. The same functions are added by others as Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board etc. The disadvantage for these types of microcontrollers is its messy constructional behaviors and tricky programming language. Arduino is more advantageous compared to others in following specifications:

• Inexpensive
• Cross-platform
• Simple, clear programming environment
• Open source and extensible software
• Open source and extensible hardware

The same purpose of Arduino boards is used for this study. It is used to communicate between Xbee and the pressure sensor. The data from the sensor can be gained only through the reception of a clock pulse. Sufficient clock information is provided from the Arduino software programming there by empowering

the interfaces. The Arduino section consists of Digital pins among which digital Read (), digital Write (), and analog Write (). analog Write() are the pins which will work only with the PWM symbol. It have Atmega microcontroller board which acts as the heart of Arduino Receiving and transmitting pins for data transfer between the sensors master/slave, power connectors, USB ports and analog inputs if analog sensors are used. The programmes written on Arduino platforms using IDE programming software are called a s sketches. These are written on editor window which can be cut/copy/paste to main directory file for programming which is cannot be edited a s such [3,4].

The pins on Arduino can be configured either as input or output. Thus when it receive signals from pressure sensor it acts as a slave and receive inputs, But while connected to Xbee module it acts as output provider. This uses the property of pulse width modulation to enhance the effect of digitizing t5he analog inputs. The PWM signals are also given priority because it forms the major part in delivering the clock signal from the master device so as to enable transmission. As stated earlier, the simulation of an analog output in digital domain needs a PWM signal, to generate clock signal as a pulse or square wave triggering the master device that is the pressure sensor in controlling and transmitting data to the storage/ output device[4].

VII. XBEE TRANSMISSION MODULE

Xbee module accepts those pressure data serially and is transmitted to its receiver section through a wireless based technology. Xbee comes under the family of RF modules wireless technology that found to be easy and cost-effective. The advantages of selecting a Xbee communication module is that it allows multiple protocols and RF features which are available, in giving customers enough flexibility to adapt to their changing needs. Xbee is one among radio communication proto-cols that enhance wireless data transfer. Xbee allows transmission on a long distance through its different the mesh and routing capabilities by passing the data between intermediate nodes if needed to transmit to more distant ones. The Xbee protocol defines three types of nodes: Coordinators, Routers and End Devices. The only requirement for Xbee to work is of one Coordinator per network. Even if all nodes can send and receive data, the specific functions they do differ. Among the three node types Coordinators are the most capable ones. Each network consists of coordinators which establish the network originally. A coordinator also stores information about the network, such as security keys. This cannot go idle or sleep mode but because it is the coordinator that should store the packets for end device nodes.

Data from other devices are relayed by the routers which act as the intermediate nodes. Similar to coordi-nators routers also cannot be battery powered or sleep mode when working with coordinators. Routers can connect to other devices and with the coordinators, should also store the packets for end devices [3,5]. The extension of networks cannot be done by coordinators

even if they are present in the node. This task is done by the router. End devices may be sensors or output devices which are mostly battery powered devices. In this case, HyperTerminal in PC which is a battery powered device act as storage of information from the sensor connected via Xbee. The end devices cannot retrieve data directly from other devices, but are permitted to talk/communicate with parent devices only as coordinators and routers [6]. This will reduce the cost because of its reduction in functionality.
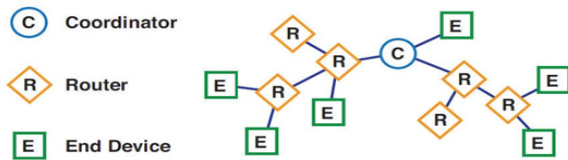

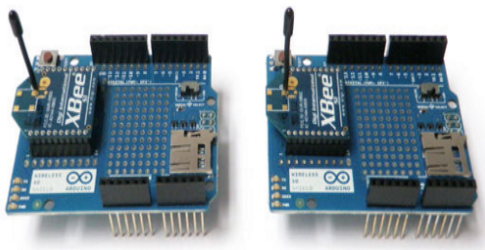Fig.3. Topology example of a Xbee network

Fig.4. Xbee transmitter and receiver

VIII. EXPERIMENTAL RESULTS AND DISCUSSIONS

Table 1: Experimental data From the HyperTerminal

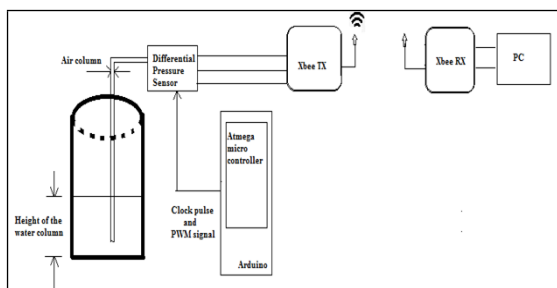| Sl No.	Period	Level data read in HyperTerminal (m)
1	10/11/2015	9
2	20/11/2015	9
3	30/11/2015	8.6
4	10/12/2015	8.5
5	20/12/2015	8
6	01/01/2016	7.3
7	10/01/2016	7
8	25/01/2016	6.7
9	02/02/2016	6.6
10	17/02/2016	6.3

Fig.5. Experimental setup of the water level monitoring system

The experiment was done on a daily basis. For a day the pressure sensor data have to be read at every one hour. So a clock pulse from Arduino is given to read the digital pin data of pressure sensor that acknowledge the activity of microcontroller by sending a pressure value in return. These values were transferred through Xbee transmitter through Arduino interface. The Xbee transmitter sends this data serially to the receiver which is kept at a distance from the proto-

type water body under measurement. The receiver part was with the PC setup where the output data was read in the HyperTerminal. The experimental data stored for a period of three months is been shown below. The experiment starts from early November 2015 and was measured till mid February 2016. The particular period was chosen because that was seemed to be the best time where it includes the offset of winter ans the onset of summer. During this time the water kevel goes down drastically since the atmosphere is dried up.

IX. CONCLUSION AND FUTURE WORK

The research deals with measurement of level using a pressure sensor and logging data continuously at regular intervals of time. A well nearby the area of research was identified for the purpose of study whose resource is consumed for domestic uses. Pressure measured from the well is converted to height or level of water in the well. These data are stored for the research of ground water recharging. Subsequently for years of study theses measurements are noted for detecting the recharge or water availability in that particular area or aquifer.

The study of recharge capacity in one well can be extended to many wells or other water bodies in a particular locality can be implemented in future so that the chances of draught can be eliminated by construction of rain water tanks etc.

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