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Implementation of Data Acquisition System onto ARM for Intra Underwater System by using Bluetooth

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Abstract— **This paper presents an abstract model of Embedded Bluetooth Data Acquisition system which was designed using the ARM processor (S3C2440) as an embedded target and Bluetooth device which is connected to the ARM processor through a RS-232 serial port. In our implementation the ARM processor which acts as the Central Dta Acquisition System is used as the controlling system that controls the Bluetooth device connected to it and acquires the data from the different subsystems of a UUV.**

I INTRODUCTION

The application of wireless sensor networks to the underwater domain has huge potential for monitoring the health of river and marine environments. The oceans alone cover 70% of our planet and along with rivers and lakes are critical to our well-being. Monitoring these environments is difficult and costly for humans: divers are regulated in the hours and depths at which they can work, and require a boat on the surface that is costly to operate and subject to weather conditions.

A sensor network deployed underwater could monitor physical variables such as water temperature and pressure as well as variables such as conductivity, turbidity and certain pollutants. The network could track plumes of silt due to dredging operations or pollutants owing in from land, and it could monitor and model the behaviour of underwater ecosystems. Imaging sensors could be used to measure visible change in the environment or count, and perhaps even classify species.

1.1 Theme

In this system ARM 7 processor will act as central Data Acquisition system. AtMegaS processor i.e. 8-bit microcontroller will send the control signals to temperature sensor (LM35), & pressure sensor (HP03) & distance sensor PWM output to collect the related information from underwater, then sensor will collect the information & send it to 8-bit microcontroller. That micron roller is interfaced with ARM7 processor (LPC2148) ,which act as central DAQ ,which will collect the information & send it to PC through Blue Link Chip ,that provide wireless transmission of data to PC. Again some animals are present underwater that are harmful to human beings. So they are displayed on our computer by using wireless camera. So in this way pressure, temperature, distance & images that are present underwater are viewed on our computer for future predictions. We can design this project using two phases, first designing the program or the code which controls the embedded system i.e. the ARM processor and also allows the ARM processor to control the pressure and temperature sensor connected to it. The second deploying the developed program into the embedded system and running it. As per the following is the basic project design.

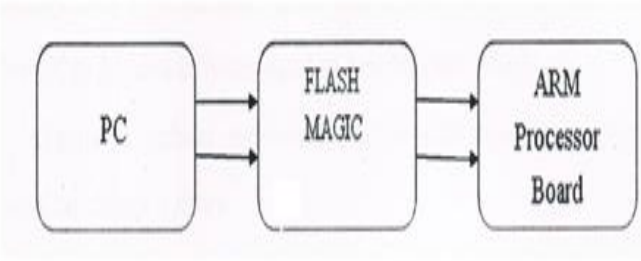

Figure 1.1: Basic Project Design

II LITERATURE REVIEW

2.1. Data Exchange System

A. The Functionality of the Data Exchange System

The total functionality of the data exchange system is such that it has to transmit/collect the control and data information to/from the different subsystems of the Underwater Vehicle for processing and storage. This functionality is achieved by using the Bluetooth modules one at each of the subsystem. The subsystem which requires data from a particular subsystem connects to that particular subsystem and receives the information Likewise if a particular subsystem wants to send the data to another subsystem or a group of subsystems in particular, it performs the task by connecting with them for the data transmission time required and later it releases the connection with the subsystems. This exchange of information between the subsystems is then reported by conventional

mechanisms to the Remote Monitoring Station (RMS) which monitors the entire functionality and performance of the Underwater Vehicle. The Remote Monitoring system will display and dispose the data for storage and later statistical analysis on the performance of the Underwater Vehicle. The Bluetooth module is the most important part of this data exchange system. An Embedded system using the ARM processor S3C2440 is programmed to control the Bluetooth module. The total module can be powered up by a simple battery setup and it can also be programmed to automatically accomplish the data/control information exchange. The ARM processor module sends the commands to the Bluetooth chip connected to it which in turn transmits/collects the data to/from the respective subsystems and transfers to the ARM processor module. This data is then transferred by other means to the RMS where it is displayed and stored for further processing.

B. Bluetooth Overview

Bluetooth is a low-power, low-cost and short-range wireless communication technology in the 2.4 GHz ISM (Industrial, Scientific and Medical) RF band. Bluetooth uses FHSS (Frequency Hopping Spread Spectrum) scheme with hoping rate of 1,600 hops per second to minimize the effects of signal interference. The transmission range is 10 meters and can be extended up to 100 meters by providing a power amplifier. Bluetooth can offer a speed up to I Mbps. To identify the identity of a Bluetooth device, each Bluetooth device has a 48-bit BD (Bluetooth Device) address, which has the same length as the MAC (Media Access Control) address of IEEE 802.x family. Communication between Bluetooth devices follows a strict master-slave scheme. Each master device can have up to 7 active slaves and forms a so-called piconet. Between each master-slave pair, two different links can be provided. One is the SCO (Synchronous Connection Oriented) and the other is the ACL (Asynchronous Connectionless Link) link. The SCO link is typically used for voice communication and ACL link is used for data communication. For ACL links, a slave can transmit packets only after the master sends a packet addressed to it. Note that, slaves cannot transmit packets directly, i.e., the communication between slaves must go through the master Bluetooth device indirectly. The RF (Radio Frequency) defines the physical characteristics of the RF link, e.g., channel arrangement, permissible transmit power levels, and receiver sensitivity level. The base band specification defines the device discovery, link formation, and synchronous and synchronous communication with peer host. To provide a reliable wireless link, fast ARQ (Automatic Repeat Request), RC (Cyclic Redundancy Check) and FEC (Forward Error Correction) are combined with the frequency-hopping scheming Base band to detect and resolve packet errors or lose during transmission.

III SYSTEM DEVELOPMENT

3.1Block Diagram

Following figure shows the functional block diagram of underwater embedded blue tooth data acquisition system based on ARM processor.

In this system ARM 7 processor will act as central Data Acquisition system. ATMEGA8 processor i.e. 8-bit microcontroller will send the control signals to temperature sensor (LM35), & pressure sensor (HP03) &Distance sensor PWM output to collect the related information from underwater, then sensor will collect the information & send it to 8-bit microcontroller [6]. That microntroller is interfaced with ARM? processor (LPC2148), which Act as central DAQ which will collect the information & send it to PC through BlueLink Chip, that provide wveless transmission of data to PC. Agair some animals are present underwater that are harmful to Human Beings. So they are displayed on our computer by using wireless camera. So in this way pressure, temperature, distance & images that are present underwater are viewed on our computer for future perditions.

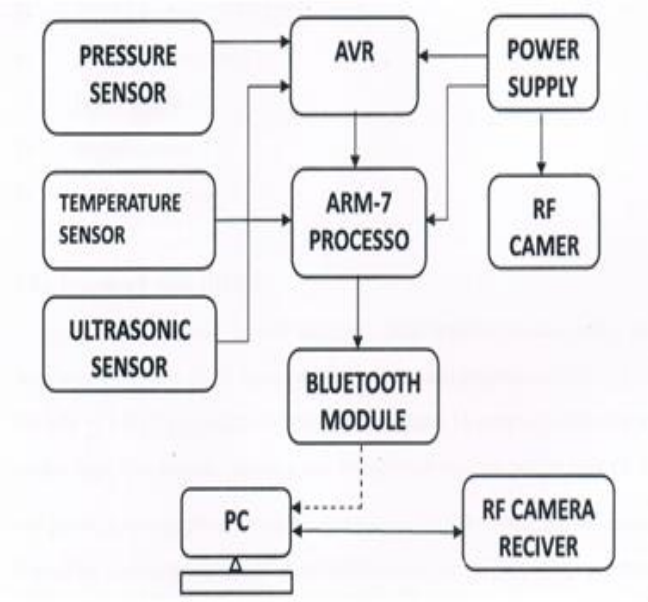

Figure 3.1: Underwater Embedded Bluetooth Data Acquisition System Based on Ram Processor

3.2 Hardware of the System

Under water Embedded Bluetooth consists of following blocks:

1) Pressure sensor (HP03)
2) Temperature sensor (LM35)
3) Ultrasonic Distance sensor(PWM output)
4) BlueLink chip
5) ARM 7 processor (LPC2148)
6) ATMEGA8 processor
7) Power supply22
8) Digital camera
9) Personal computer

Typical Application Circuit Diagram:

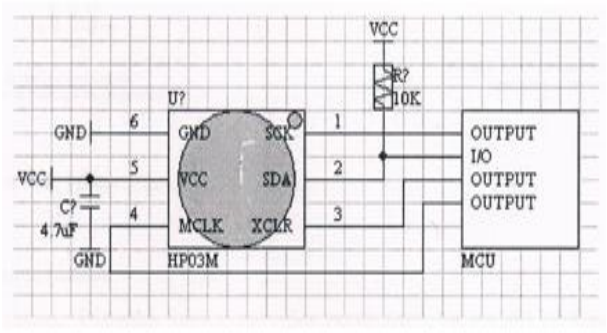

Figure 3.2: Typical Application Circuit Diagram Of Pressure Sensor

Block Diagram of Distance Sensor

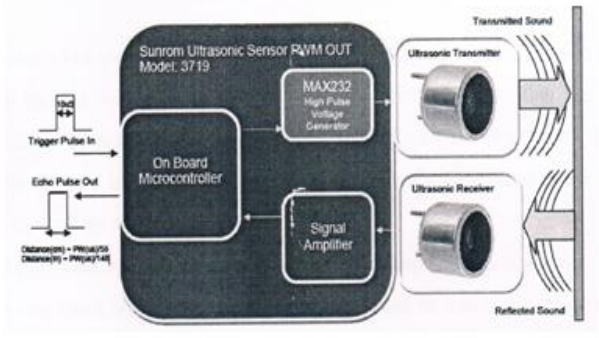

Figure 3.3: Block Diagram of Distance Sensor

How it works

You only need to supply a short l0uS pulse to the trigger input to start the ranging. The sensor will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo line high. It then listens for an echo, and as soon as it detects one it lowers the echo line again. The echo line is therefore a pulse whose width is proportional to the distance to the object. By timing the pulse it is possible to calculate the range in inches/centimetres.

3.3 Flow Chart of System

3.3.1 Flow Chart 1

Flow chart explains complete working of Underwater Embedded DAQ system based on ARM processor.Switch on the power supply, giving +5v dc supply to ARM? processor (LPC2148) AR7 processor sends control signal to Temperature (LM35) sensor, pressure (HP03) sensor, distance sensor (ultrasonic PWM output) to measure the temperature, pressure & distance from underwater. Sensor can measure temperature, pressure, distance & send this information to central DAQ Central DAQ can collect the information from different subsystems (sensors) & transfer it to computer system through BLULINK chip which provide wireless information transmission to computer system for display of information. If temperature pressure, distance sensor will unable to measure related information then Error Signal is send to ARM7 processor so whole process is started again.

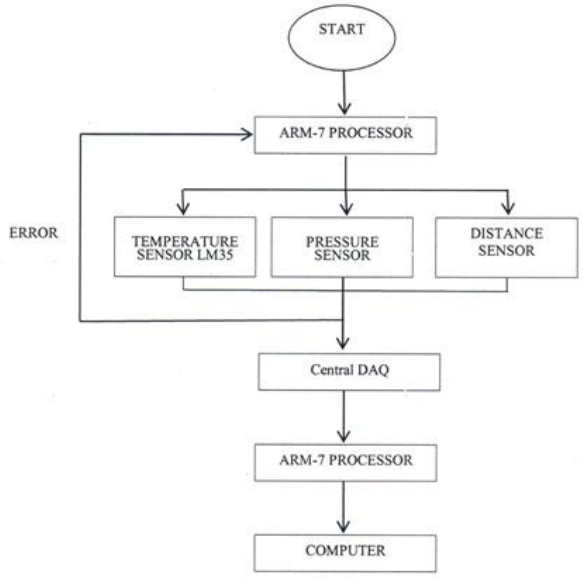

Figure 3.4: Flow-Chart of Sensors

3.4 System Hardware Diagram

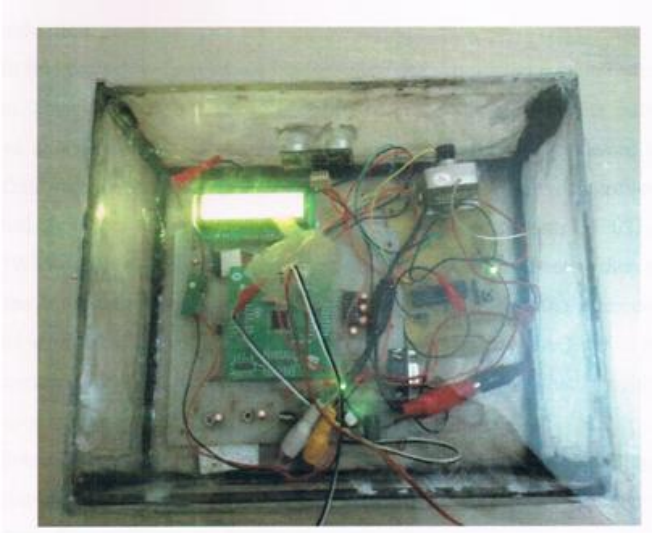

Figure 3.5: System Hardware Diagram

IV PERFORMANCE ANALYSIS

In this project we implement Underwater Data acquisition system based on ARM processor. Data acquisition system is product or process used to collect information to document or analyse some phenomenon. In this system ARM 7 processor will act as central Data Acquisition system. AtMega8 processor i.e. 8-bit microcontroller will send the control signals to temperature sensor (LM35;, & pressure sensor (HP03) &Distance sensor PWM output to collect the related information from underwater, then sensor will collect the information & send it to 8-bit microcontroller that the microcontroller is interfaced with ARM? processor(LPC2148),which act as central DAQ which will

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4.1Theoretical Analysis of Underwater Data Acquisition System

4.1.1 Theoretical Calculation of Distance

For computation of distance we can use the following formula

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

Distance in (inches) = (Pulse Duration in microsecond)/148

Description

For theoretical calculation of distance we can use ultrasonic Distance sensor-PWM output. The sensor transmits an ultrasonic wave and produces an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to target can easily be calculated.

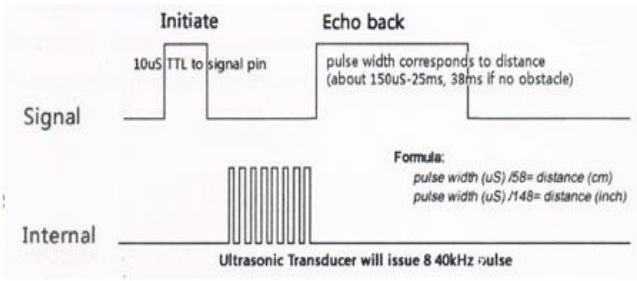


Figure 4.1: Ultrasonic Waves of Distance Calculations

4.1.1. Observed Parameter

1) Pulse duration measured is: 1160microsecond

Therefore by using formula calculated distance is

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

= (1160)/58

=20 cm

Distance=20cm

2) Pulse duration measured is: 1740 microsecond

Therefore by using formula calculated distance is

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

= (1740)758

=30 cm

Distanced =30cm

3) Pulse duration measured is: 2320microsecond

Therefore by using formula calculated distance is

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

= (2320)/58

= 40cm

Distance=40cm

4) Pulse duration measured is: 2900microsecond

Therefore by using formula calculated distance is

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

= (2900)/58

=50cm

Distance=50cm

5) Pulse duration measured is: 3480 microsecond

Therefore by using formula calculated distance is

Distance in cm (centimeter) = (Pulse Duration in microsecond)/58

= (3480)/58

=60 cm

Distance=60cm

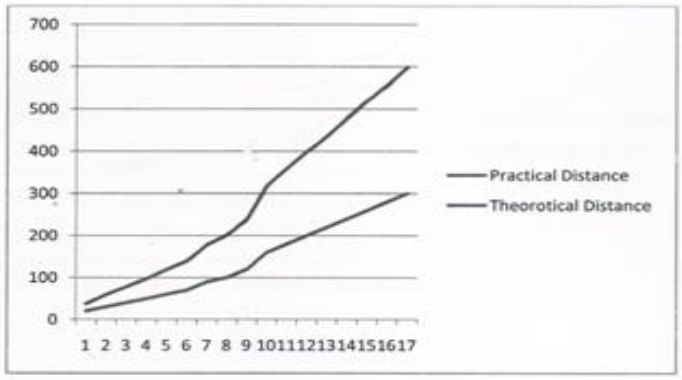
By doing this similar calculation we can make the following observation table.

Table 4.1: Observation Table 1 for Distance

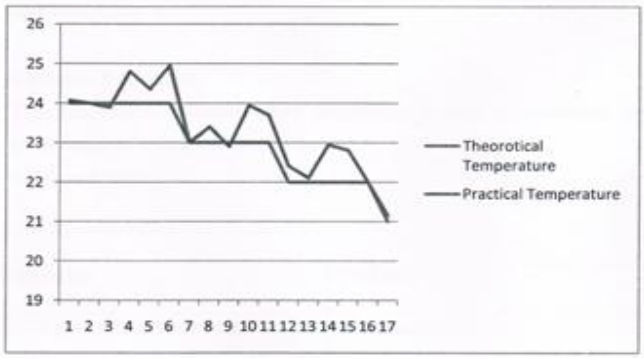
Sr. No.	Pulse Duration in microsecond	Distance in Centimeter
1	1160	20
2	1740	30
3	2320	40
4	2900	50
5	3480	60
6	4060	70
7	5220	90
8	5800	100
9	6960	120
10	9280	160
11	10440	180
12	11600	200
13	12760	220
14	13920	240
15	15080	260
16	16240	280
17	17400	300

4.2 Comparison of Theoretical Values & Practical Values by Graphical Methods

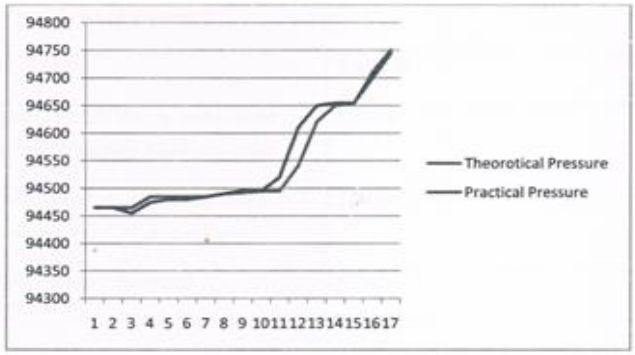
4.2.1 Theoretical Distance Vs Practical Distance



4.3.2Theoretical Temperature Vs Practical Temperature



4.3.3. Theoretical Pressure Vs Practical Pressure



From this above graph we can say that theoretical & practical values are approximately same, but the calculation of theoretical values of distance, temperature & pressure are very complex & time consuming. Practical readings are easily displayed without any complexity & error.

4.4 Performance Evaluation

The Embedded Bluetooth Data acquisition system is evaluated based on simulation parameters which are stated below:

Simulated Parameters

Table 4.1: Simulated Parameter

PARAMETERS	VALUE
DISTANCE FACTOR a in previous module	0.5 meter(50cm)
Data rate attained in previous module	1.1 Mbps
Minimum Data rate Required	1.2Mbps

Observed Parameters

Table 4.2: Observed Parameter

PARAMETERS	VALUE
DISTANCE FACTOR a in underwater DAQ system Based on ARM processor	3 meter
Data rate attained in underwater DAQ system Based on ARM processor	2 Mbps
Minimum Data rate Required	1.2Mbps

As shown in the above table, for the efficient functionality of the underwater system 1.2 Mbps minimum amount of data rate is required. The previous model could provide a data rate nearly enough for the system communications, but at the. cost of complexity. The proposed model is highly secure compared to the previous model and provides much better data rates than required and also simplifies the role of data acquisition system.

4.5 Advantages

1) Less human interface: - As the central DAQ system (ARM7 processor) can send the control signal to the different subsystem to measure the reading & send the data to DAQ. That means complete work is automatic, there is no need of person to go underwater & take readings thus there is less interface during the process.

2) Easy to use:-As our system is very compact in size & it is easily deployable into water, therefore it is easy to use.

3) Low maintenance cost: - Since software running at the server is the mainstay of this technique the cost of maintenance is low.

4) Saves time and energy of the user: - Since for the user there is no need to go under water for taking readings, thus it saves the time and energy of the user.

5) Fast result: As we are using ARM 7 processor it gives fast readings, that means this system gives fast result

6) Automating the underwater readings provides safeness to human beings.

7) Protects your financial investment.

4.6 Limitation

This system can be implemented using Bluetooth module. It is used for wireless data transmission. But it has limited range of transferring data over the system can be easily deployable up to 3 meter underwater.

V CONCLUSION

Wireless embedded systems are taking a very high in development and a wireless data acquisition system is perhaps the most widely used and needed system which is currently used in the industries. There are various technologies used for the development of wireless systems which include Bluetooth, Zigbee, RF Band, Wi-fi. Depending upon the range requirements, one selects the technology for its particular application. A wide application and potential development of embedded system has become hotspots in the 21st century. This method of designing and implementing the Data Acquisition System using the Bluetooth medium achieves a maximum of 1.9Mbps of data rate against required 1.2 Mbps. The controlling data sent by the ARM processor for the data acquisition cannot be shown exactly as it will be received by different subsystems but for convenience of understanding the data is represented by considering a standalone PC to be all the subsystems and the data is received in the HyperTerminal through all the Bluetooth devices.

Future Scope

- Acknowledgement based Automation System Design during sending & receiving data from central data acquisition system to PC. And in this problem with the help of delivery report the system may be automated. Real time GPRS based monitoring and controlling thus we can operate the system online by using only one window.

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