REMOTE WATER SAMPLE COLLECTOR

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A dissertation submitted in partial fulfilment of the requirements for the Bachelor of Science External Degree in Electronic and Automation Technology

Of the

University of Colombo, Sri Lanka

DECEMBER 2018

DECLARATION

I certify that this dissertation does not incorporate without acknowledgement, any material previously submitted for a Degree or Diploma in any university and to the best of my knowledge and belief it does not contain any material previously published or written or oral communicated by other person except where due reference is made in the text.

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A.A.N.V.Amarasinghe

ACKNOWLEDGEMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to Dr. Hiran Jayaweera, Mr. Sameera Viraj and Miss. Nimshi Fernando for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

I would like to express my gratitude towards my parents & family member for their kind co-operation and encouragement which help me in completion of this project.

I would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

ABSTRACT

There are many water sample collectors on the market. Currently available water samplers are function on manually, most of large and expensive and exists with limitations. The Remote water sample collector described here is small, lightweight, actuated by a microcontroller, and inexpensively and easily constructed. The sampler exist with five sample bottles, cleaning system and variable suction. This sampler exists with RF remote controller and GPS cracker so this device able to function remotely and the sampling volume can be change. This is user friendly device because this device able to react signal lost, able to detect damages, and exists with status update system. This sampler able to store samples in one push. Some environments where it could be used include lakes, large rivers, and estuaries.

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ABBREVIATIONS

GPS	– Global Positioning System
GSM	– Global System for Mobile
GPRS	– General Packet Radio Service
PWM	– Pulse Width Modulation
RTC	– Real Time Clock
RF	– Radio frequency
USART	– Universal Serial Asynchronous Receiver Transmitter
ASK	– Amplitude Shift Keying
IR	– Infrared
TX	– Transmitter
RX	– Receiver

1 INTRODUCTION

In many hydrologic systems[1], natural and induced changes in the chemical composition of water can provide information on flow paths and water-rock interactions[2]. Observations of these chemical changes require samples of water, but sampling can be complicated by a variety of logistical problems related to access to the water body or limitations in time. For example, sampling at high frequency in systems with rapidly changing conditions or across widely spaced regions may be impossible with limited personnel. Long-term studies may require numerous samples, which could be prohibitively costly and difficult to collect by hand in remote areas[3]. Sampling is commonly restricted by access to certain water bodies such as large lakes, rivers, estuaries[4], and water-filled caves . These complications can be alleviated in certain environments through automatic sampling[5] of the water with the use of a variety of commercially available or homemade samplers. Samplers that are currently available, however, are designed primarily for use on land, in the deep sea (e.g., Sholkovitz – 1970 [6]; Friederich – 1986; McKinney – 1997 [6]; Bell 2002 sampler[7]), or are manually activated (e.g., Broenkow – 1969 [8]; Heaney – 1974 [9]; Blakar – 1979 [10]; Cline – 1982 [11]).most of these samples are very large, expensive and so many limitations.

However in near future (September 4, 2013) UNL scientists have developed a drone that able to collect water samples from lakes, streams and ponds. The project has been awarded a $956,210 grant from USDA's National Institute of Food and Agriculture [12].

I describe here a new design of automatic water sample collector primary designed for collect water sample from watercourses (lakes, rivers, ponds, estuaries) by remotely. It has several benefits over previous designs including small size, robustness, user-friendly and ease of deployment and operation. Its small size makes it lightweight, easily transported and simple to construct. Mainly this sampler controlled by using two microcontrollers (Arduino mega and Arduino Nano).mainly aluminum material used to build body of sampler .roughly I spend about RS 15000 to construct this sampler.

2 BACKGROUND

To studies the quality of watercourse (lakes, rivers, ponds, and estuaries) may require numerous samples, which could be prohibitively costly and difficult to collect by hand in remote areas. There are many sample collectors but there are many limitations with these samplers, manual and more expensive.

Most close reason to select this topic was implemented method to collect water samples form Beira Lake because it was impossible to collect samples by hand.

Figure 2.1-1 Beira lake

2.1 Objective of project

The objective of this project is to develop a method to collect potentially dangerous water samples from difficult to access watercourses by remotely with the following targets.

- Collect multiple sample.
- Collect sample in multiple water level.
- Track GPS location which sample taken.
- Control the navigation through remote.
- Inexpensive.
- Light weighted.

3 THEORY

3.1 Archimedes’ principle

Archimedes’ principle helps explain how objects float and sink. The classic illustration of Archimedes’ Principle is a boat on the water. The boat is designed so that it can float by not allowing water into the boat. If the boat becomes too heavy though, the boat would sink far enough into the water that eventually water would go over the edge and fill the boat causing it to sink. The amount of water the boat displaces depends on the weight of the boat. The heavier the boat is, the more water it will displace. The weight of the boat will displace an equal weight of water. The effect of this is that the boat will be farther in the water when it is heavier. The density of the boat and objects in the boat will impact how much water is displaced. Materials that have a density that is higher than water will displace a higher volume of water.[13]

3.2 DC Motor

A motor is an electrical machine which converts electrical energy into mechanical energy. The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left-hand rule [14] and it's magnitude is given by F = BIL. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.[15]

3.3 RF

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK) [16].

4 METHODOLOGY

The first idea was to use SIM900 module to control the navigation of sampler by using GPS. This was later given up due to various reasons including technical problem and unavailability of components. Later a choice was made to use an A7 GPRS/GSM/GPS Shield and RF module[17] which solved most of the problems pertaining to complexity. RF module was used to control navigation of sampler (**Remote water sample collector**) and A7 used to track GPS location and to kept connection with mobile-phone. Then these two modules were controlled by using Arduino Mega 2560 microcontroller. UTX and URX pins of A7 was connected to pin 19 and 18 of Arduino Mega 2560. The TX pin of RF module was connected to the IO pin 7 of the Arduino Mega microcontroller and AT commands was used to control A7 Shield.

Table 4-1 AT Command

AT Command	Description
AT + CGATT = 1	Return OK, attached to the network
AT + CGACT = 1	Activate the network, then you can use the tcp/ip command
AT + CIPSTART = "TCP" "121.41.97.28", 60000	TCPIP server connection
AT + CIPCLOSE	Close TCP/IP connection
AT+CMGF=1	Send a text message
AT+GPS=1	Open GPS
AT+GPS=0	Close GPS
AT+AGPS=1	Open AGPS
AT+AGPS=0	Close AGPS

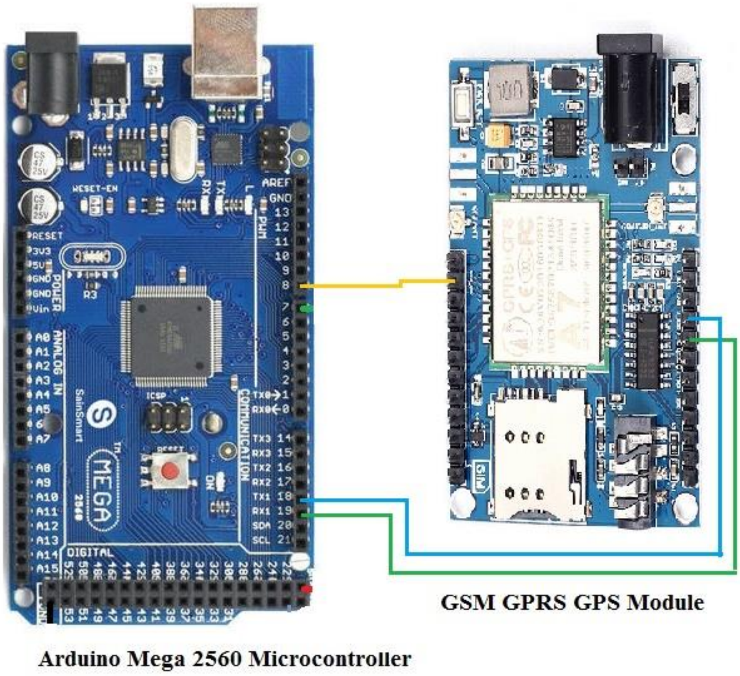

Figure 3.3-1 A7 with Arduino Mega 2560

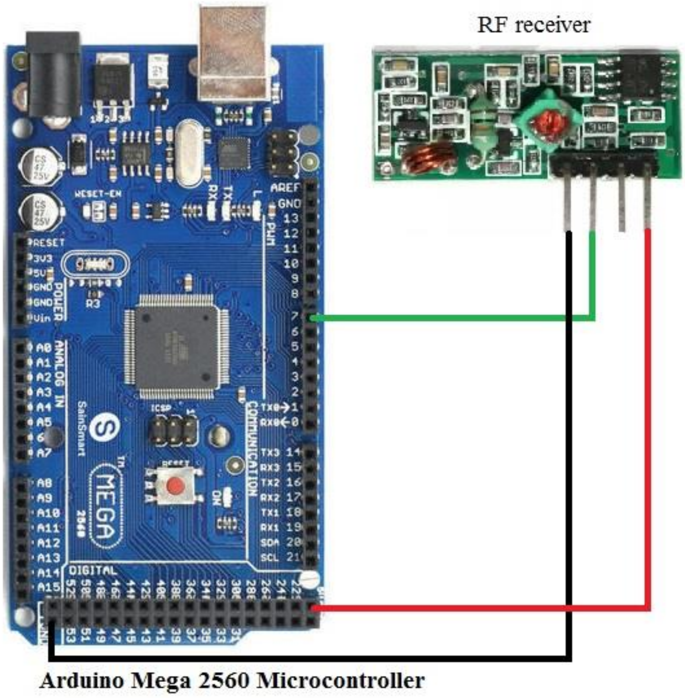

Figure 3.3-2 RF receiver with Arduino Mega 2560

According to the datasheet of Arduino Mega 2560 the maximum current flow through IO pins were 40 mA, so that was impossible to control all D.C Motors . Later a choice was made to use ST L298N [18] dual full-bridge motor driver which solved problem of controlling motors.

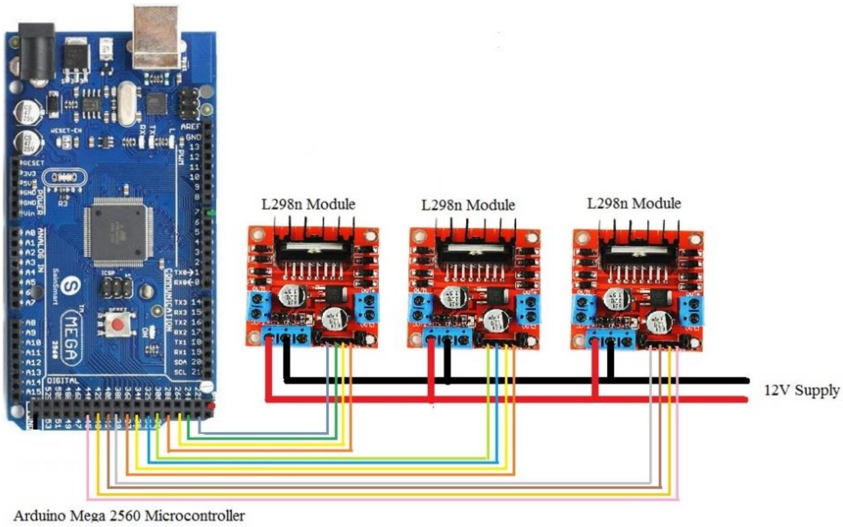

Figure 3.3-3 Motor controller with Arduino Mega 2560

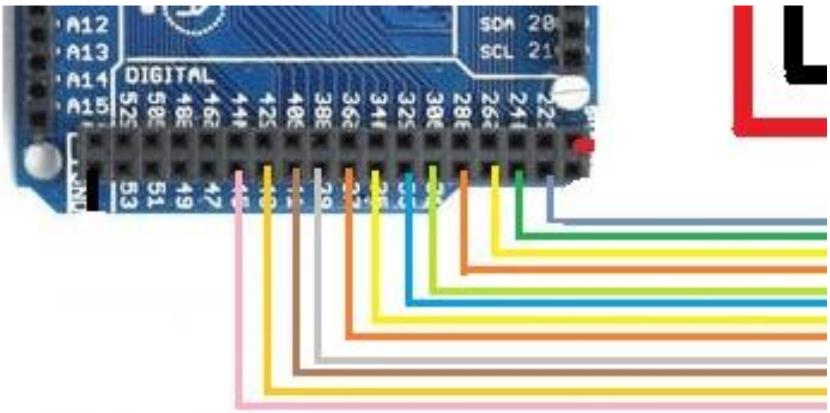

Figure 3.3-4 pin configuration of motor controller

Rotating disk with multiple sample bottles was used to complete multiple samples task and two IR switches were used to detect the sampling bottle number and a D.C. motor was used to rotate the disc. The movable arm was used to select the water flow path and also two IR switches were used to select the correct position of the sampling bottle. By using this part sampler able to clean the water flow path

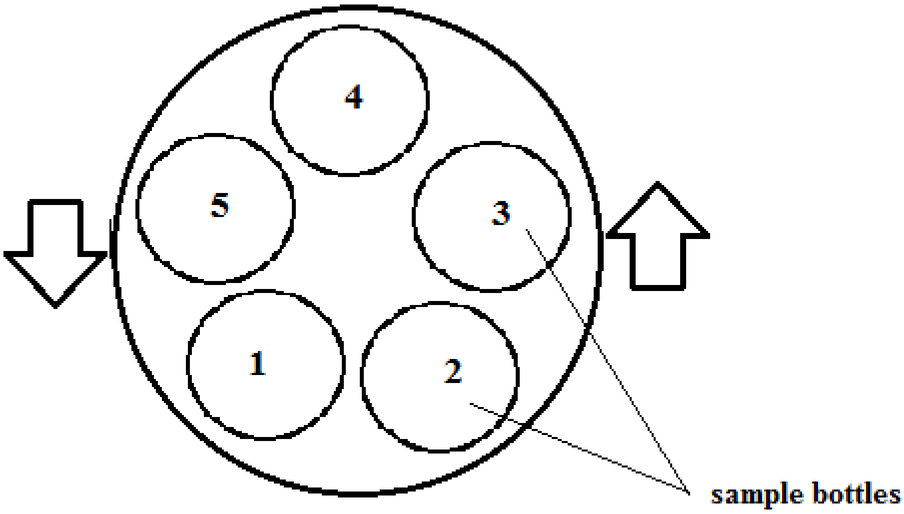

Figure 3.3-5 Rotating disk top view

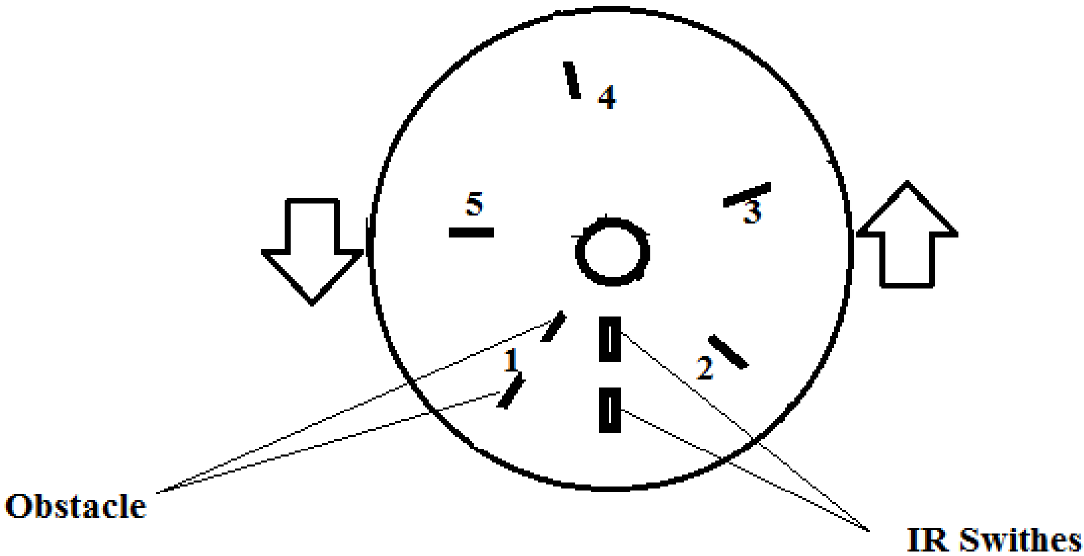

Figure 3.3-6 Rotating disk bottom view

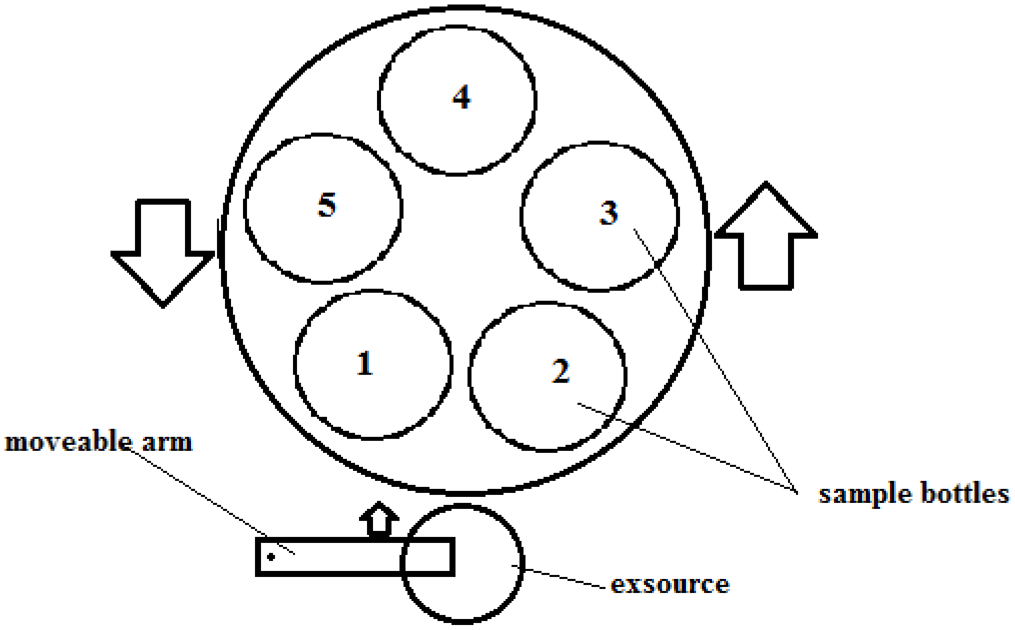

Figure 3.3-7 moveable arm

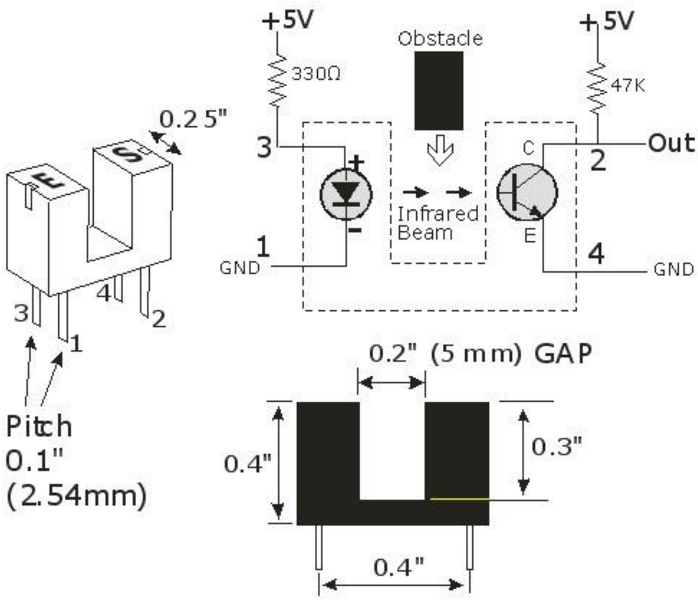

Figure 3.3-8 IR switch

The Arduino Nano microcontroller was used to function remote controller. Joystick shield was used to send forward, backward and turning command to microcontroller. X, Y pin were connected to analog 0 and 1 ports. KEY pin was connected to digital IO port 2 with software pull-up and other switch with external pull-up was used to send sample take the signal.

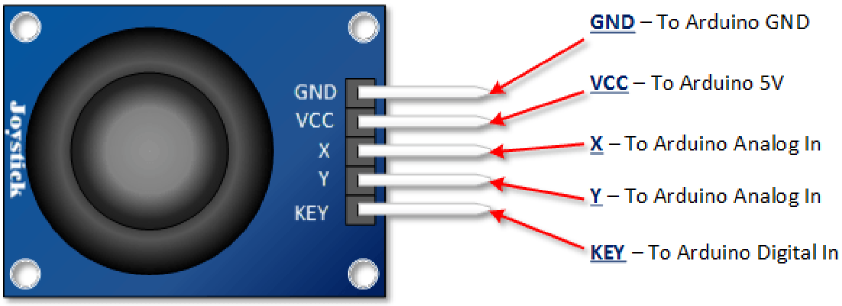

Figure 3.3-9 configuration of Joystick

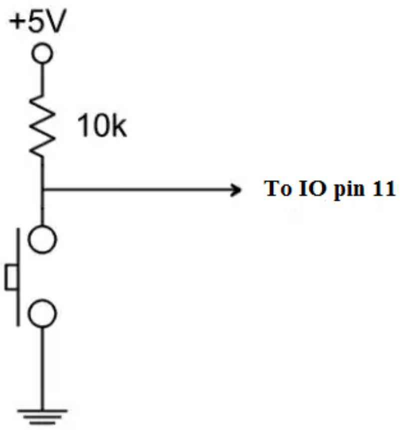

Figure 3.3-10 Switch pull-up

The TX pin of RF module was connected to IO pin 5 of Arduino Nano micro controller, because IO pin 5 was used to send Encoded data to RF module. The Arduino language was used to program microcontrollers.

Aluminium material was used to build all the moveable parts and body of sampler. This was case to get more strong and light weighted body for the sampler.

5 RESULTS AND ANALYSIS

5.1 Final creation of Sampler

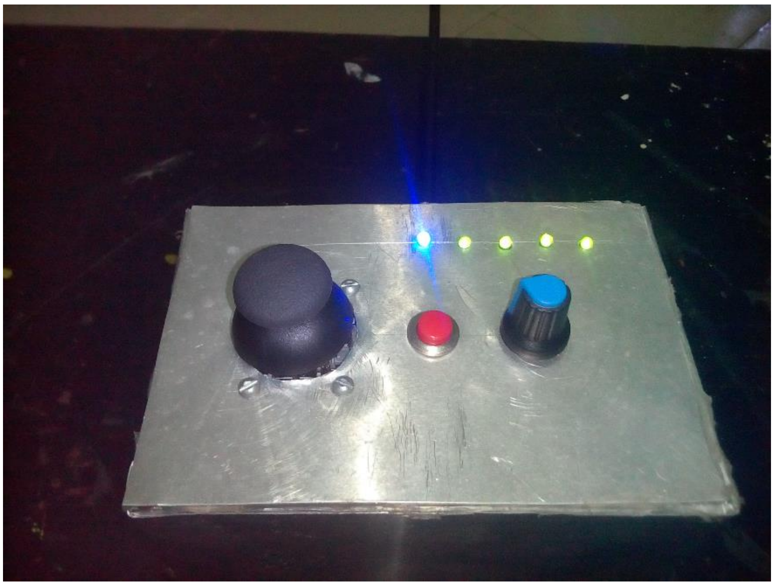

Figure 5.1-1 Remote

Figure 5.1-2 suction system

Figure 5.1-3 moveable arm

5.2 Specifications

- Weight: 1.5Kg
- Volume: 50cm×24cm×18cm
- Power Source: 12V
- Number of Samplers: 5 (in one run)
- Remote access distance: 500m - 600m.
- Maximum suction: 30cm.

5.3 React to the signal lost

When signal lost while moving forward it automatically moves backward until signal reach. When signal lost while moving backward it automatically moves forward until signal reach.

5.4 States Update

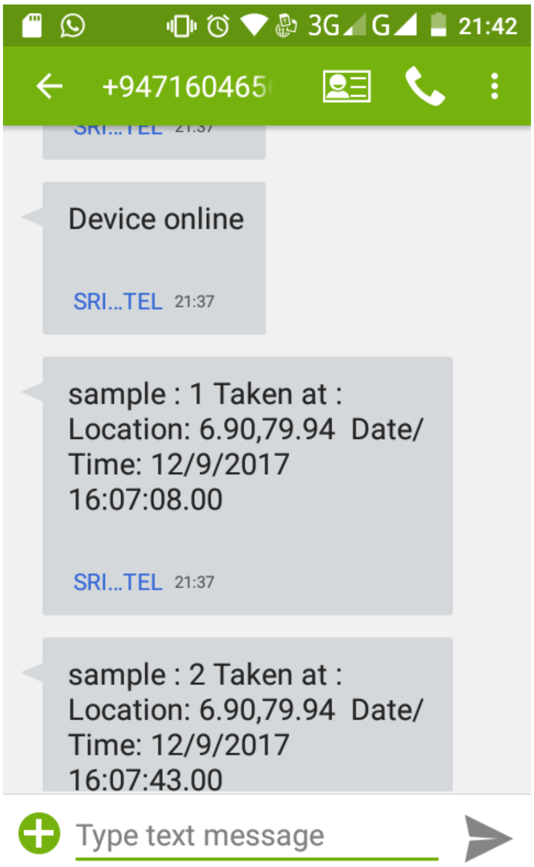

Figure 5.4-1 screenshot of messages

5.5 GPS location

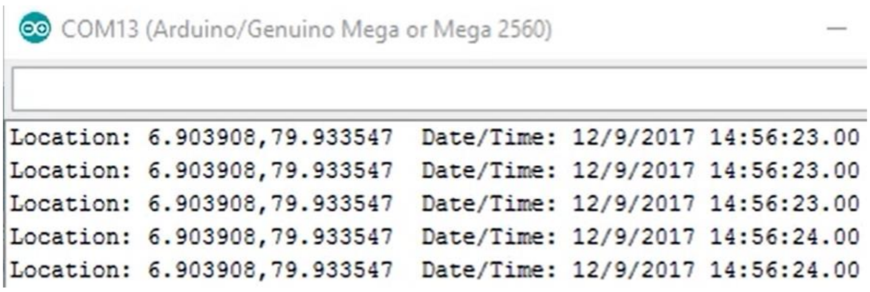

Figure 5.5-1 GPS location

6 DISCUSSION

How could the new sampler be useful?

There are many natural watercourses in Sri Lanka (lakes, rivers, ponds, and estuaries) among these most of are world-famous.so we have to pay attention for these watercourse, to complete this task we have to take care about quality and chemical composition of water. Observations of these chemical changes require samples of water, but sampling can be complicated by a variety of logistical problems related to access to the water body or limitations in time.as the solution we can use a mechanical system to do this, but most of the sampling devices are very large and more expensive. So it’s very hard to buy thousands of devices for developing countries like Sri Lanka. As the solution for this problem we can use “**Remote water sample collector**”. Because this sampler has been solved most of the common problems of water samplers and exist with new features.

7 CONCLUSION

Several types of automated water samplers are currently available, both as published designs and commercially. These samplers are designed primarily for sampling from developed environments, from deep marine systems, or require manual actuation to collect the samplers. The advance of the sampler described here stems from increasing sophistication in electronic controllers. The sampler’s advantages are its simplicity, small size, low weight, ease of deployment, and low cost. These advantages allow its widespread applications, thereby expanding the range of environments that could be sampled and provide greater access to a wider range of research projects. Although many environments that could be sampled using this sampler are large rivers, lakes, ponds, etc.

7.1 Specifications

- Weight: 1.5Kg
- Volume: 50cm×24cm×18cm
- Power Source: 12V
- Number of Samplers: 5 (in one run)
- Remote access distance: 500m - 600m.
- Maximum suction: 30cm.
- Sampling volume: depend on user.

7.1.1 Other features

- React to the signal lost.
- Send GPS location to the mobile.
- Detect damages.
- Able to reset remotely.

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9 APPENDIX

9.1 Data sheet of ICs

9.1.1 Arduino Nano

- http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P_Datasheet.pdf

9.1.2 Arduino Mega 2560

- http://www.atmel.com/Images/Atmel-2549-8-bit-AVR-Microcontroller-ATmega640-1280-1281-2560-2561_datasheet.pdf

9.2 Pin Configuration

9.2.1 Arduino Nano

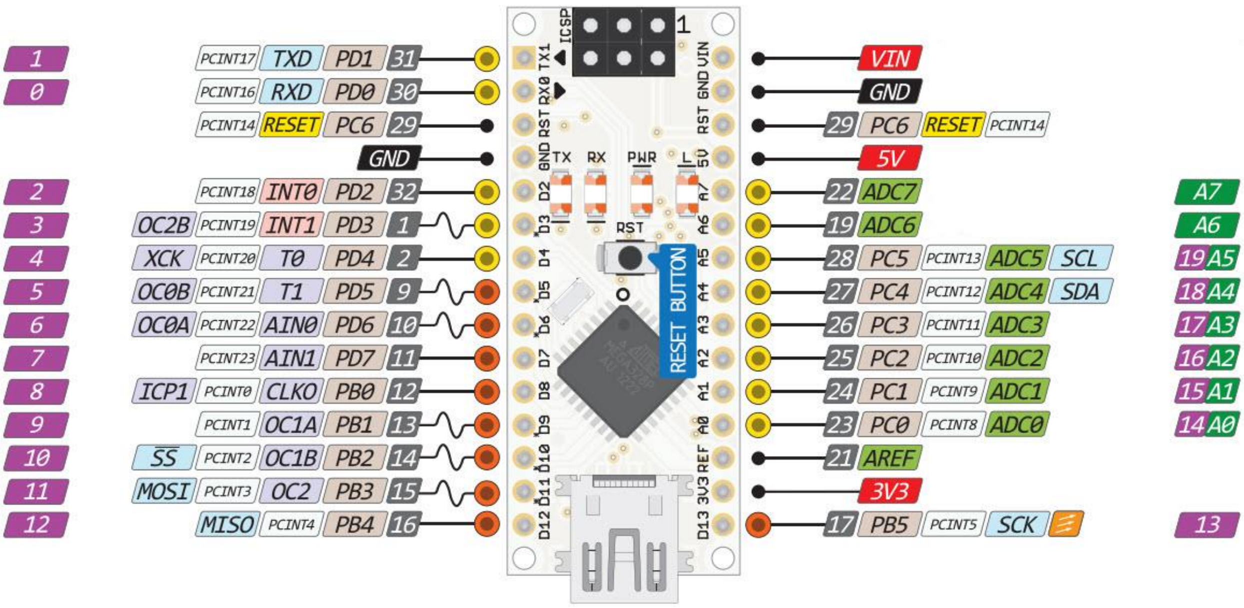

Figure 9.2-1 9.2 Pin Configuration of Nano

9.2.2 Arduino Mega 2560

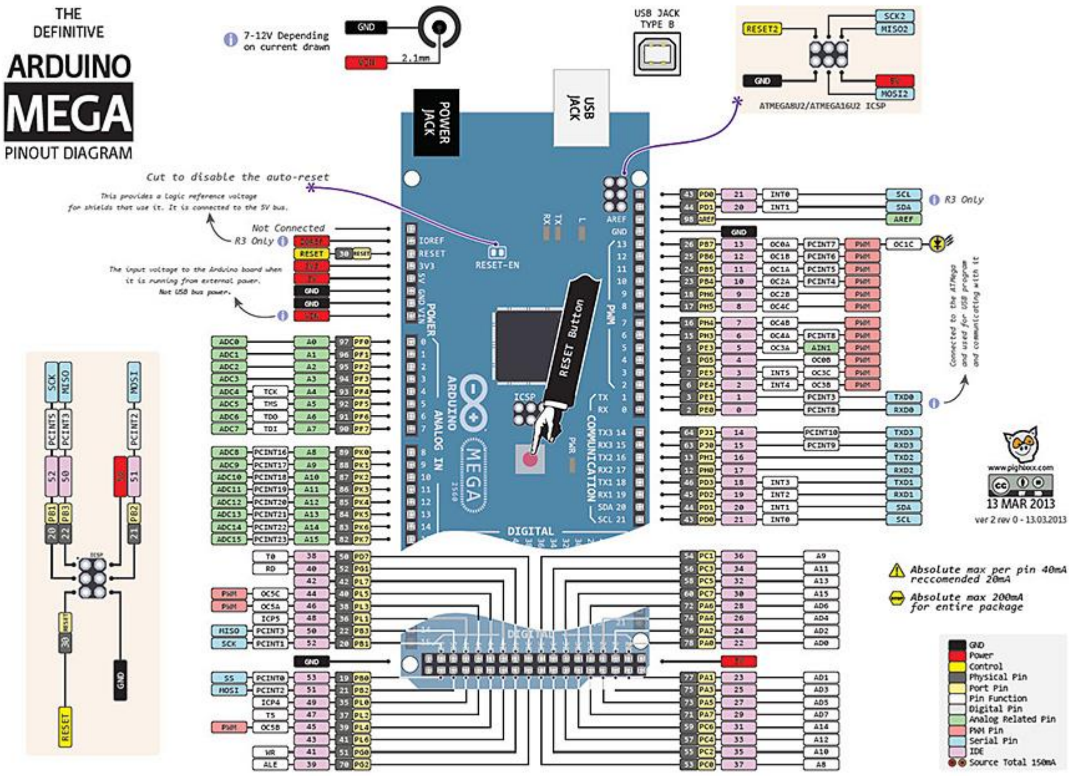

Figure 9.2-2 9.2 Pin Configuration of mega

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