Design Of Tsunami Detector Based Sort Message Service Using Arduino and SIM900A to GSM/GPRS Module

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Abstract: Tsunamis are one of the most unforeseen natural disasters, factors or signs of a tsunami occurring among others is the sudden reflux of seawater which is due to the broken plate of the underlying seafloor receding water, the plate fault is caused by seismic ground-based earthquakes, areas ever experienced a previous fault is likely to occur in the same quake place this is because the slabs can not coalesce or return like the original. for it needed a prototype system that can be detected the early detection of a tsunami that could cost many lives, The method used is Continuous Wave Method or Ultrasonic Echo Pulse Method.

Keywords: Ultrasonic, SIM900A, Tsunami

1. Introduction

The beginning of the idea of making this research is how the tsunami disaster can be avoided and overcome as quickly as possible with fast and accurate information. sending data remotely is the right answer, how to transmit data quickly remotely across GSM or GPRS Module device or use SMS Broadcast. design prototype made used waterproof coatings that cause rust. prototype placed on the shore that has been studied to what extent a standard or normal water debt. the layout of the prototype will be depicted in figure 5. as for hardware used in building prototype is Arduino UNO or DF-Arduino Board, SIM900A, Ultrasonic sensor HC-SR04 (4 Feet), 16x2 LCD, Buzzer 5 Volt, Potentiometer, Male-Female Wire, Male-Female Wire, Breadboard, USB Cable and Android Smartphone and the software used is Arduino 1.0.5 Free for IDE Arduino and build the C Language program , Fritzing for the Schematic and PCB Design layout and Notepad ++ for editing C Language program for IDE Arduino.

Sensor placement is at an estimated distance of 300 cm or 3 meters from sea level, on the prototype indicator there are 3 states that are safe, danger and out of reach (Pwrx.com).

When safe conditions mean seawater conditions are still in safe range according to the coding program, in this condition, there is no data sent to GSM SIM900A Module because it is the possibility of safe distance. In condition -2 that is a dangerous condition. This condition allows the transmission of sensor data to GSM Module SIM900A due to the position or condition of the drastic drastic sea water that triggers the possibility of a tsunami, after ultrasonic sensors read the sea water distance conditions in accordance with the coding program that has been entered, then the data sent to SIM900A for later sent to Smartphone. In the 3rd condition, the sensor does not read any normal distance or it is said out of the range. In this condition, the sensor does not provide any output at all and awaits the occurrence of

distance changes in the seawater in accordance with the program code processed by the Arduino under normal or legible conditions.

2. Hardware Required

The hardware and modules to create this prototype with include the Arduino Microcontroller, ultrasonic sensor, SIM900A module, LED indicator, Buzzer, and corresponding Board. An explanation of each hardware component will be grounded at each point in the next sub-chapter.
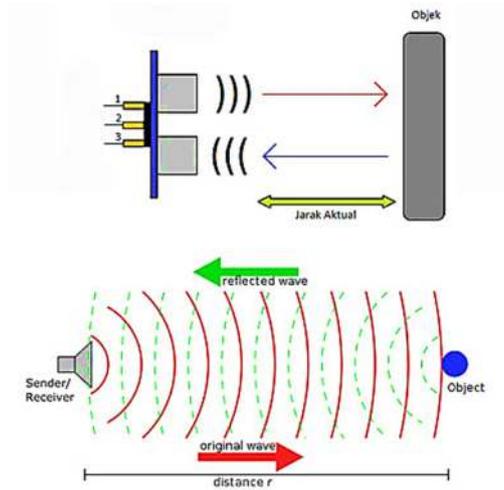
2.1 The ultrasonic sensor

The ultrasonic sensor is a sensor that uses sound waves to measure or know the distance of an object in this case, is sea water. ultrasonic sensors can also be called the SONAR (Sound Navigation and Ranging) sensor, ultrasonic sensor works by sending sound waves at a certain frequency (40 KHz), Please note that the sound waves move in the air about 344 meters / s or 1129 feet / s, then to calculate the total distance of sound waves emitted by the ultrasonic sensor to the object field ie sea water and back again received by the ultrasonic sensor is the delivery distance is multiplied by 2, so to measure the distance from the ultrasonic sensor readings to the plane of the object on 1 trip is distance= speed of sound x time taken / 2 or S = 344 x t / 2, explanation of distance can be seen in figure 2.The ultrasonic sensor used is using type HC-SR04 which has the following specifications, distance detection range is 2 cm - 500 cm, the best detection angle is 15 degrees, the voltage used is 5 Volt DC, Frequency 40 KHz, has 4 feet/pin namely Vcc, Signal (Trigger & Echo), and Ground. Ultrasonic sensor HC-SR04 dimension can be seen in figure 1.
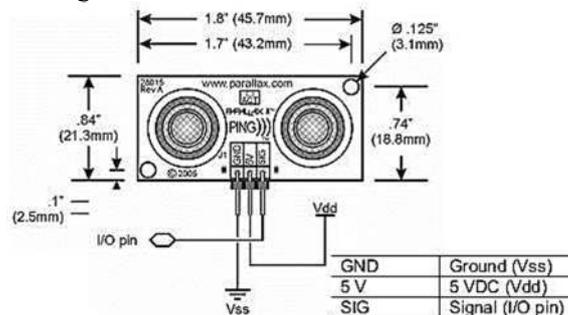
Fig. 1. Ultrasonic Sensor Dimension.

Water level measurements using ultrasonic sensors have been successfully tested, that the result is a change in water level can be detected by ultrasonic sensors in the range <=500m distance from the object ie the water surface. Based on figure 1 show the size of the ultrasonic sensor or ping sensor, for the dimensions of the ultrasonic sensor, the size used is as follows, for the length of the sensor is 1.8 inches (45.7 mm) for the width is 0.84 inches (21.3 mm). on the sensor Ping or ultrasonic sensor has 2 versions ultrasonic using 3 feet input and Output data and it is ultrasonic with 4 feet input output. the difference is on for Pin Signal is divided into 2 outputs ie Trigger and Echo. A trigger is used as a generator Ultrasonic and Echo signals are the pins used for indicators. This Ultrasonic type is HC-SR04, the other 2 pins are Pin Ground and VCC, Ground is O Volt Power Supply and VCC is Voltage 5 Volt.

**Fig. 2.** The Ultrasonic Sensor Actual Distance.

2.2 SIM 900A Modul

SIM 900A is GSM / GPRS module which is used to send message or phone. SIM900A features Quad Band 850/900/1800/1900 MHz and can be used on GSM networks in various countries, GPRS multi-slot class 10/8, GPRS mobile station Class B, Compliant to GSM Phase 2/2 +, Class 1 (1 W (AT) 1800/1900 MHz), Command AT Command - Standard Commands: GSM 07.07 & 07.05, Enhanced Command: SIMCOM AT Commands. Short Message Service (SMS), Embedded TCP / UDP Stack, RTC Support, Serial Port Selection (3.3 Volts and 5 Volts), There are Jack speakers and Headphones (on certain breakout board types), Low power consumption - 1.5mA (Sleep mode), and working at a temperature of -40 c to +85 C. SIM900A module is shown in figure 3.

Fig. 3. SIM900A Module.

Figure 3 shows the module SIM900A antenna version, in this mode do not use adapter power supply. Shape and specification of SIM 900A module as shown in figure 3. but SIM 900A module has input specification different outputs, at the input of the sim900a module I use using the VCC Pin input, Data, and GND, but there is a Module version SIM900A using RS232 output input type and adapter power supply of 9-12 Volt DC depending on SIM900A series used. for more details, SIM900A Module is described in the schematic on figure 4.
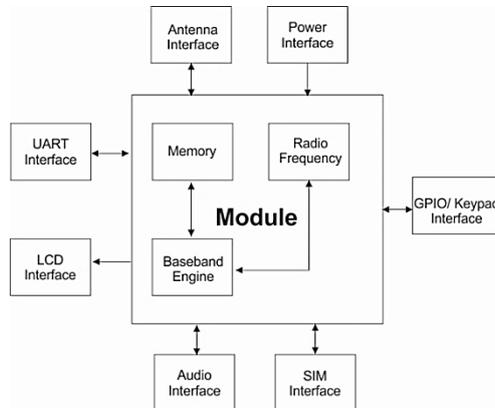
Fig. 4. SIM 900A Schematic.

2.3 Arduino Board

Arduino is also called Microcontroller ATmega 328P, because Microcontroller used on arduino board is ATmega 328P.Arduino board is very familiar to date used for various research projects with the combination of various sensors for example is an ultrasonic sensor to know the distance of an object. arduino board shown in figure 5.

Fig. 5. Arduino Board.

Figure 6 shows The pins of the ATmega 328 P microcontroller used on the Arduino board, the ATmega 328p version visible to ATmega 8, which distinguishes the existing assembly code on different microcontrollers 8 and 328p to support the programming of C Arduino board.

Fig. 6. ATmega 328 P Pin.

2.4 Arduino IDE

Arduino programming is done through a software that is Arduino IDE (Integrated Development Environment) where the software is obtained in open source. The Arduino IDE makes it possible to program the languages that will be understood by Arduino in this case the C language. Figure 7 shows the Integrated Development Environtment of the Arduino Board.

Fig. 7. Arduino IDE.

3. Sistem Developments

3.1 Prototype

The prototype design stages are as follows: The basic wiring is the Arduino Board and SIM900A, shown in figure 8. On the 2nd wiring, we will connect the Arduino with LCD device, Ultrasonic Sensor, Buzzer and Potentiometer, shown in figure 9. The resulting prototype can be seen in figure 12. The prototype was first made using breadboard which then developed using PCB (Printed Circuit Board).
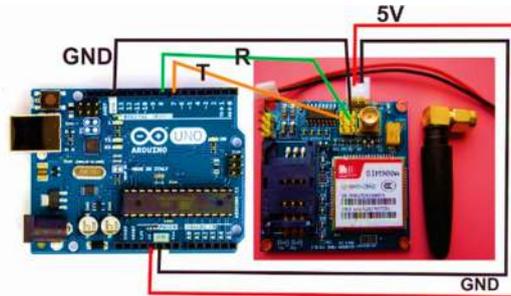
Fig. 8. The Arduino Board and SIM900A.

In Figure 8 shows the first step in connecting using SIM900A, there are 5 pins that will connect to the Arduino Board, the first T (Transmitter) to Digital Pin 7 Arduino, R (Receiver) to Digital Pin 8 Arduino, GND (Ground) to GND Arduino, and 5 v power supply to pin 5 Volt Arduino. In SIM900A Module there is SIM Port, SIM This port is used to place SIM card, Provider SIM card that can be used is TELKOMSEL, XL OR INDOSAT, Or other cards according to area or location you are. table 1 will explain in detail the connection between Arduino board and SIM900A along with the function of the connection. Next, is the setting of SIM900A can be seen in SIM900A configuration -1.

**Table 1.** Connection Table Arduino Board and SIM900A Module.

No	Arduino Board	SIM900A Module	Function
1	5 Volt	5 Volt Pin	Power Supply
2	GND (0 Volt) Power Supply	GND Pin	Grounding to SIM900A
3	GND (0 Volt)	Pin 6	Grounding to Pin SIM900A
4	Pin 8	Pin 3	Receiver
5	Pin 7	Pin 4	Transceiver
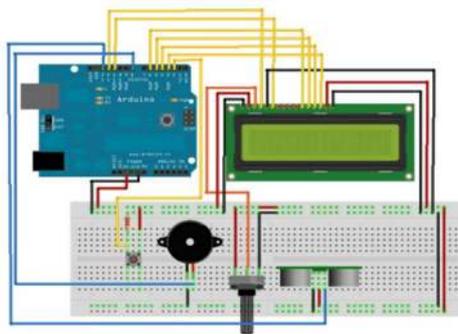
There are 2 settings in SIM900A Module which is set when to send Short Message Service (SMS) on AT-Command and Settings when receiving Short Message Service (SMS) on AT-Command. When sending using AT + CMGS commands and when receiving or viewing incoming messages using AT + CMGL commands.

After configuration on Arduino and SIM900A Microcontroller has been successful, immediately stored its program code such as AT-Command on SIM900A on IDE Arduino.

Then the next stage is the installation of 16x2 LCD as an indicator and ultrasonic sensor as a data giver distance. 16x2 LCD with a potentiometer to adjust brightness and Contrast from 16x2 LCD. Settings and Wiring can be seen in Figure 9.
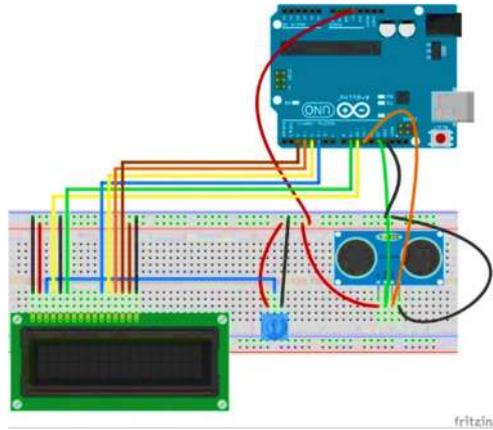
Fog. 9. Arduino Board Wiring, 16x2 LCD, and Ultrasonic Sensor.

The complete configuration between the pins of the 3 modules of LCD 16X2, Arduino Board and Ultrasonic sensor described in table 2.

To Sending SMS

AT+CMGS="+6282143634134" <ENTER>
v.2 to read SMS / Receive SMS
AT + CMGL = "ALL" <ENTER>
It will appear all incoming SMS, if you want only at certain times, eg 2, then written as follows:
AT + CMGR = 3 <ENTER>
The modem will list the single message:
+ CMGR: "REC READ", "+ 6282143634134" ,, "23/02 / 18,15: 56: 02 + 07"
Test message 3
OK

Configuration 1. AT-Command Configuration By SIM900A Modul

Fig. 10. Arduino Board, 16x2 LCD, Ultrasonic Sensor and Buzzer Wiring.

Table 2. Description Connection between Arduino Board, LCD 16x2 and Ultrasonic Sensor.

Arduino	LCD 16 x 2	Potensiometer	Ultrasonic Sensor	Function
Pin 2	Pin 14	-	-	Configuration or Setting LCD 16x2
Pin 3	Pin 13	-	-	Configuration or Setting LCD 16x2
Pin 4	Pin 12	-	-	Configuration or Setting LCD 16x2
Pin 5	Pin 11	-	-	Configuration or Setting LCD 16x2
Pin 9	Pin 6	-	-	Configuration or Setting LCD 16x2

Pin 10	Pin 4	-	-	Configuration or Setting LCD 16x2
Pin 11	-	-	Echo	Receiver/ Indicator
Pin 13	-		Trigger	Signal Generator Ultrasonik
GND	GND	GND	GND	Grounding 0 Volt Power Supply
VCC 5 Volt	VCC 5 Volt	VCC 5 Volt	VCC 5 Volt	Power Supply 5 Volt DC
-	Pin 3	Pin data (center pin)	-	Manual Setting LCD 16x2 (Brighness and Contrast)

3.2 Add an Sound indicator on the prototype

After the installation and program code in Figure 9 is completed, added again Buzzer as voice indicator. The buzzer is used as an indicator when distance indicates unsafe state, for that besides 16x2 LCD as an indicator, Buzzer is expected to increase the Indicator's complexity on a prototype. Installation of buzzer shown in figure 10, Buzzer used has a voltage of 5 volts, buzzer or piezo has 2 pins that are GND and Data, for Data entry on Digital pin 8 Arduino Board. for wiring in figure 10 there is no change like figure 9, the difference is the addition of voice indicator piezo or buzzer 5 Volt. The function of the buzzer is as a complement to the prototype, although the buzzer function here is not too important because there is already a SIM900A role as a data sender or a very important indicator. On table 3 explain about Description Connection between Arduino Board and Piezo or Buzzer.

Table 3: Description Connection between Arduino Board and Piezo or Buzzer.

Arduino	LCD 16 x 2	Potensiometer	Ultrasonic Sensor	Buzzer	Function
VCC	-	-	-	-	5 Volt DC Power Supply
GND	-	-	-	GND	0 Volt Power Supply
Pin 8	-	-	-	Pin Vcc	Sound or Buzzer

Buzzer or Piezo Specification used is Type B27M2 which has a current consumption of 15 mA With a voltage of 1.5 to 27 Volt DC.

3.3 Completed Prototype

After the addition of buzzer to the prototype successfully completed, the next step is to combine the schematic in picture 1, 3 and 4 so that can be seen schematic in Figure 8. Figure 8 describes the merger between GSM Module SIM900A device with an ultrasonic sensor that has been combined in one module.
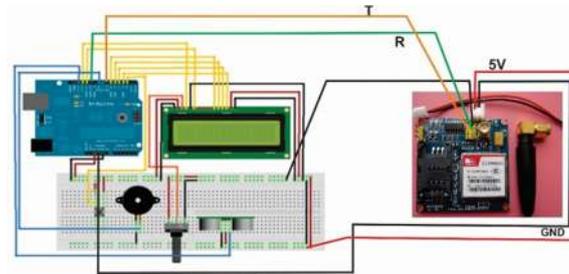
Fig. 11. Wiring with all SIM900A devices and GSM Shield.

For the wiring explanation of the prototype in figure 11, it is shown in tables 1, 2 and 3. In figure 11, R should be at pin 8 and T at pin 7, because pin 8 is used buzzer so in connect to pin 9 for R its. It is the same, has no effect. Stay changed on Source code alone. Similarly, the original source code uses Arduino 1.0.5 of the no.4 circuit above, for the buzzer to be at pin 12. TX, RX is on pins 7 and 8. The next step is to do testing and coding then do the test directly, Figure 12 shows the prototype testing. the first way of testing is to detect ultrasonic sensors with object areas such as water or walls, by placing large variables on the Arduino language program eg 30 Cm is a dangerous distance that will give the sound indicator sounds and sends a signal to GSM Module to be sent to Smartphone or handphone for more details, the schematic in Figure 13 will explain how the relationship between Atmega 328p microcontroller with SIM900A, buzzer, 16x2 LCD and other components.
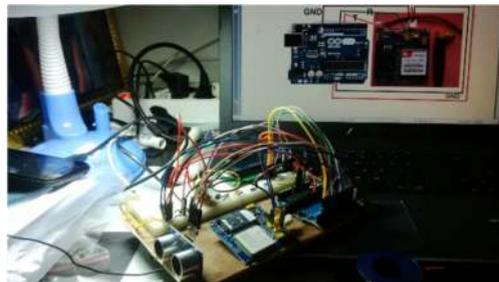
Fig. 12.: Prototype Tsunami Detector.
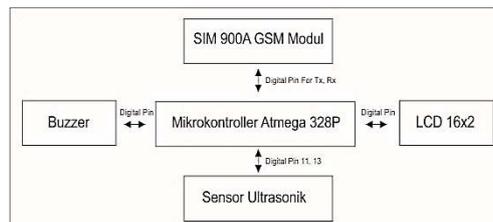
Fig. 13 . Prototype Schematic.

3.4. Flowchart

The flowchart in Figure 14 shows how the prototype works when it starts up to send data of distance from echo Pin to mobile phone. The method used is Continuous Wave Method or Ultrasonic Echo Pulse Method, consisting of Refraction and diffraction Using Ultrasonic Sensor to measure the distance of seawater at a certain distance which has been determined by

Microcontroller AT mega 328p so that when the distance of sea water is in accordance with the distance that has been determined at a distance > = 200 && <= 300, then Prototipe will send the sea water receding data to the module SIM 900A and turn on Buzzer as an indicator of danger.
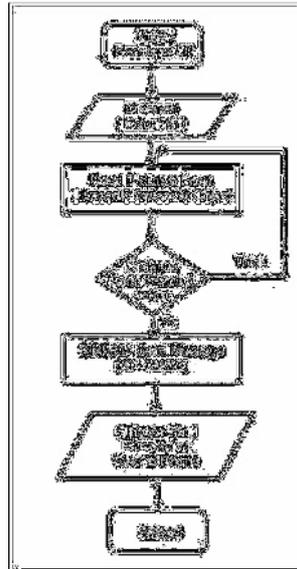

Fig. 14. Flowchart of Prototipe.

4. Performance And Evaluation

The first stage of testing is a prototype to detect high low sea water causing prototype will take the initial conclusion that the possibility of tsunami occurrence. In this test confirmed the distance is read by the ultrasonic sensor, for example in the range of 1 meter, ultrasonic sensors can still read any distance changes. The next stage is from the data provided by ultrasonic sensors will then be sent to the Smartphone via GSM Modem SIM900A module. Here is the ultrasonic sensor testing of distance, the maximum distance of the ultrasonic data pulse is 319 cm or 3, 19 m. above that ultrasonic range cannot read, the data read by ultrasonic is the high low of sea water.

Tabel 4. The condition of the seawater on sending data to the GSM module SIM900A.

| No	the distance of the sensor to the water (cm)	Delivery of data to GSM SIM900A Module	Buzzer Condition on Prototype
1	Distance >=1 & <=199	No	off
2	Distance >=200 & <=300	Sending Message Warning	On
3	Distance >= 319 || <= 0	Out of ranges	Off

The reading of ultrasonic sensors to the distance to the sea water is expressed in percentage shown in the graph in figure 15.
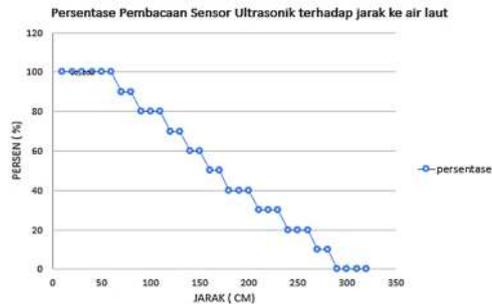
Fig. 15. Graph of percentage ultrasonic sensor readings against distance to sea water.

The prototype design that will be installed on the shoreline is depicted in Figure 16, there are 4 possible conditions during the tsunami. The first condition is a safe or normal situation, in which case the position of the seawater and the sensor is the safe position shown in Table 4. The second condition is the breaking of the plates which makes the waves, after this slab is broken seawater conditions are shown in the next picture is receding or drastic receding conditions so that the sensor directly read the sea water range conditions and sensors that are not normal so that the sensor send SMS and alarm alert sounds. next condition is a tsunami condition where the water overflows to the coast.

In the latter case, the toughness of the sensor in resisting the onslaught of the overflowing ocean waves depends on how the designs are made, ranging from a prototype protective box that must be waterproof and a prototype buffer pole strong against large wave shocks. However, in this research, we need to add more variables that can be used to conduct research or research on the tsunami, not only the receding water and vibration due to earthquake based on the sea that is detected by the sensor.
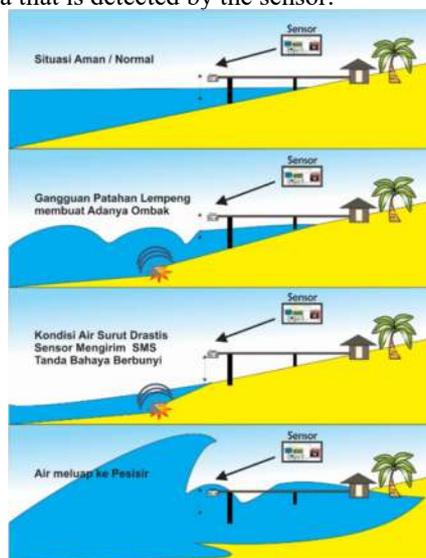
Fig. 16. Prototype Process Works and Tsunami condition.

5. Conclusion

This prototype successfully tested and run well, the next step is to put the prototype on the beach with sea water level and sensor <= 319 cm. because beyond that range or larger, the sensor cannot read the object that is sea water. So it is necessary to have specific data about seawater conditions and the resulting vibration.

From the prototype made it is expected to reduce the death of coastal populations due to a sudden tsunami and no sign of any so that with this prototype can provide information as soon as possible using prototype made based on early indications of the tsunami disaster.

Acknowledgements

References

[1]   Bahga, Arshdeep; Madisetti, Vijay; *Internet Of Things A hands- on Approach*, Universities Press, India. 2015.
[2]   Oppenheim Alan V, Willsky Alan S, Sinyal dan Sistem Jilid 1 Edisi ke 2, Penerbit Erlangga, Jakarta, 1997.
[3]   Purdum, Jack; " Beginning C for Arduino, Learn C Programming for the Arduino", Second Edition, Technology in Action Press, 2015.
[4]   Boloor Jagadish Adith, " Design and build fantastic projects and devices using the Arduino platform ", Packt Publishing Ltd. India, 2015.
[5]   Adith Jagdish Boloor, Samarth Shah, Utsav Shah, Marco Schwartz; " *Arduino: Building LED and Espionage Projects* "; Packt Publishing Ltd, India, 2016.
[6]   Samarth Shah, Utsav Shah; "*Arduino BLINK Blueprints*"; Packt Publishing Ltd, 2016.

[7]   Marco Schwartz, Oliver Manickum; " *Programming Arduino with LabVIEW* "; Packt Publishing Ltd, India, 2015