Khulna University of Engineering and Technology

Department of Electronics and Communication Engineering

Project Report (ECE 3200)

3rd Year 2nd Term

Names and Rolls of the Students:

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Project Title: Long Distance Wireless Arduino Based Walkie Talkie

Motivation:

When a catastrophic natural disaster strikes, an organized and effective rescue operation is essential to rescue those victims trapped under collapsed buildings or landslides as well as to relief massive survivals who lose their life support. However, communication systems were usually paralyzed by many causes. The loss of communication systems made rescue and relief operations extremely difficult, costing many lives unnecessarily.

A walkie-talkie device can be quite useful in the location where there is no cellphone coverage. Even in the cellphone coverage area it provides communication at very low cost. Currently the law enforcement and military personnel uses frequency modulation (FM) based walkie-talkie systems. The main goal of this project is to design and develop a low-cost walkie-talkie device that can be used by anyone other than the military and law enforcement personals.

Objectives:

-To ensure the safety of the victims during catastrophic disasters

- To aid health care workers' compliance with personal protective equipment in the fight against pandemics.

- To establish long distance communication wirelessly.

- Implement a walkie-talkie system leveraging Arduino microcomputers to enable portable and adaptable communication solutions.

- To Engineer signal enhancement techniques and error correction mechanisms to ensure consistent and reliable communication over extended distances.

Research Methodology & Implementation:

Components Required:

Name	Rating	Quantity
Microcomputer	Arduino Uno	2
Transceiver module	Nrf24l01+pa+lna	2
Voltage Regulator	AMS1117, 3.3V	2
Buck Converter	LM2596 DC-DC 5V	2
Audio Amplifier	PAM8403	2
Speaker	5W	2
Microphone Module	LM393, 5V	2
Battery	Li-ion, 3.7V	4
Battery Holder	2 slots	2
Breadboard	-	2
PTT Button	-	2
Capacitor	100nF, 100V, ceramic	2
Resistor	10k	2
Battery Charging Module	-	1
Jumper Wire	-	-

Block Diagram:

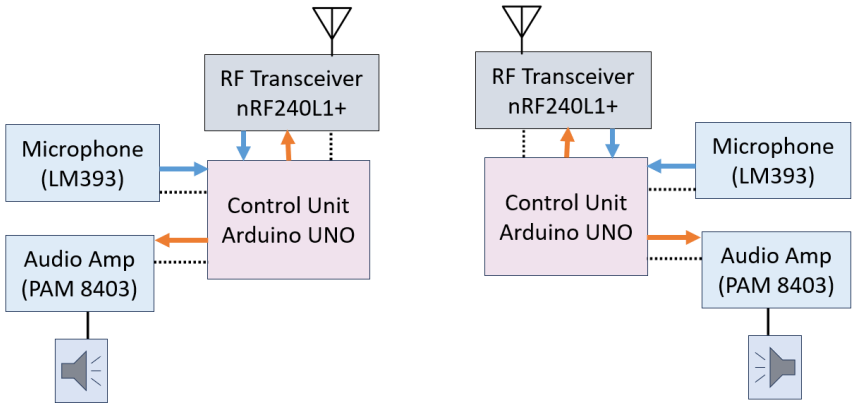
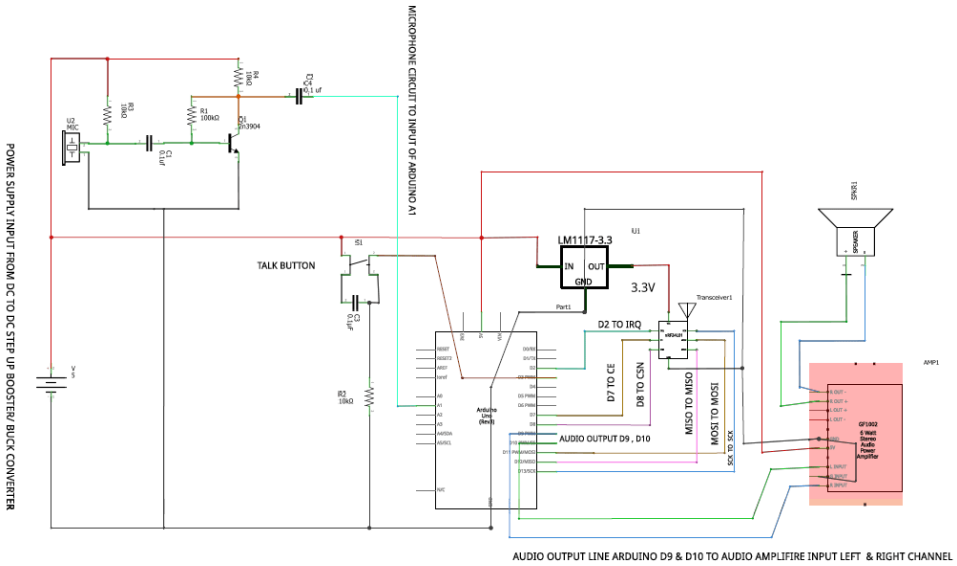
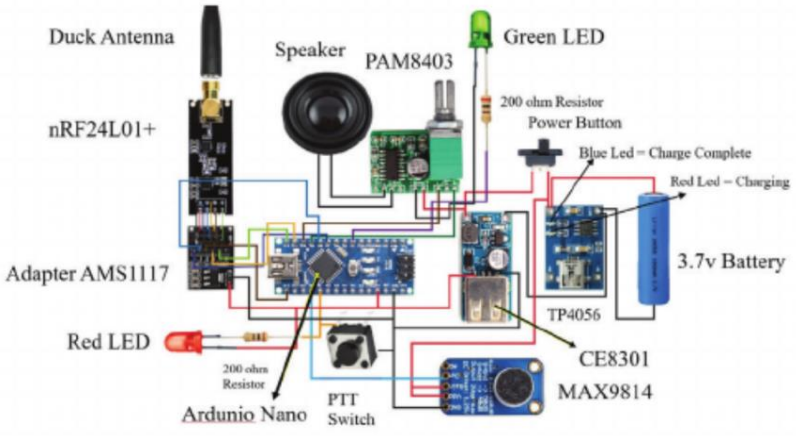


Figure 1: Block diagram of the proposed circuit

Circuit Diagram:



(a)



(b)

Figure 2: a. Circuit Diagram pinout of each components b. Visualization of the circuit

Circuit Explanation:

In this circuitry, whenever the push button is pressed, the microphone generates an audio signal from the voice signal given to it, which is converted from analog to digital (ADC) by microcontroller, Arduino uno. The converted digital signal is then transmitted by the transceiver, nrf24l01 by GFSK modulation. The other walkie talkie circuit receives the modulated signal and amplifies it in the built in low noise amplifier, PAM8403. After amplification the signal is digital to analog converted (DAC). The audio amplifier amplifies the signal and then sends it to the speaker. The speaker then converts the demodulated signal to sound.

About the transceiver module:

The nRF24L01+pa+lna wireless module supports a 2.4 GHz worldwide ISM frequency band. It consists of 125 RF Channels and has a common RX and TX interface. Data transmission is carried out through GFSSK modulation. The data transfer rate is configurable and be set up to **250kps, 2Mbps** and **1Mbps**. The bandwidth is of 1Mhz.

For Maximum Range: Sample rate 16000Hz, Rf speed 250Kbps

For Maximum Quality: Sample rate 44000Hz, Rf speed 2Mbps

Coding Section:

The libraries needed for the purpose are:

- NRF24 library
- SPI.h library
- NRF24 Audio library

The RF radio pins were chosen 7 and 8. The microphone input was taken from A0. In code:

```
RF24 radio(7,8);

RF24Audio rfAudio(radio,0);
```

Inside the setup function, we set the serial monitor at 115200 baud rate for debugging. Then initialize the ppt button connect to pin 3 as an interrupt pin.

```
void setup() {
  Serial.begin(115200);
  printf_begin();
  radio.begin();
  radio.printDetails();
  rfAudio.begin();
  pinMode(talkButton, INPUT);
  attachInterrupt(digitalPinToInterrupt(talkButton), talk, CHANGE);
  rfAudio.receive();
}
```

Next, we have a function called talk() which is called in response to interrupt. The program checks the state of the button if the button is pressed and held it enters transmit mode to send the audio. If the button is released it enters receive mode.

```
void talk()
{
  if (digitalRead(talkButton)) rfAudio.transmit();
  else rfAudio.receive();
}
```

Outcome Analysis:

Voltage Responses of the Walkie-talkie:

Components	Walkie Talkie-1	Walkie Talkie-2
Switch Resistor	4.23V	4.84V
Nrf24l01 module input	3.23Vin	3.2Vin
3.3 voltage regulator	4.95Vin, 3.23Vout	4.94Vin, 3.2Vout
Buck converter	7.8Vin, 4.95Vout	7.8Vin, 4.95Vout
Microphone	4.2V	4.9V
Audio Amplifier	3.6V	3.7V

Measured Current:

Components	Walkie Talkie 1(mA)	Walkie Talkie 2 (mA)
Nrf24l01 module	0.52	0.54
Arduino	0.23	0.27
Audio Amplifier	0.97	0.91
Microphone Module	3.2	3.5

Signal Specifications:

The sampling rate used in the coding section is 24kHz. Otherwise, we can also get,

Data Transfer Rate	Sampling Rate
250kbps	13-20kHz+
1Mbps	24-44kHz+
2Mbps	higher

Frequency Band: 2.4Ghz

Modulation Type: GFSK modulation

Bandwidth: 1MHz

Circuit Response:

The individual circuit components in both the walkie talkies worked satisfactorily when those were checked. The nrf24l01+pa+lna transceiver module implements Simplex and Half Duplex communication when separated.

Despite of all this, the circuit appears to encounter difficulties in processing the audio signal, which subsequently prevents successful transmission and reception. This processing bottleneck is likely causing the lack of output in the system.

Further analysis is required to pinpoint the exact source of this impediment and implement corrective measures to enable proper audio signal processing within the circuit.

Challenges Faced During This Project:

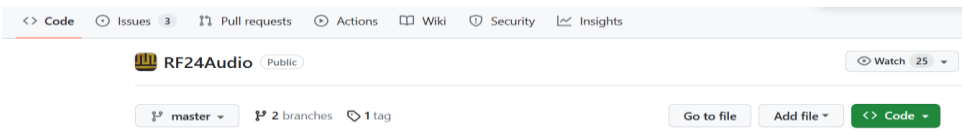
Our main goal was to transmit **audio** signal through the nrf24l01 which is known for **only** transmitting and receiving data strings by doing GFSK modulation. The main challenge of this project was to make it learn to transmit the audio signal, which we have failed several times.

The data transmission was very straight forward using ARDUINO IDE, as we had to just upload a transmitting code from the EXAMPLES already available in the Simulation software and it started transceiving (if the transceiver is not faulty).

Here is a serial monitor response of TMRH20 Library's transmitting code (from one transceiver):

Figure: Serial Monitor Response of Transceiver

We added RF24Audio library (github link in the reference section) which has only one version available. We programmed using the functions stated in this library. However, modifying our program did not see any success.



We believe that the code for the modulation of audio signal, which is a bit tricky, was responsible for the failure of this project. Further knowledge of both modulation in depth must be assured to master is process.

Work Timeline:

Project Selection and Initialization	1 week
Proper Components and Resources Finding	1-2 weeks
Learning the necessary skills	2-4 days
Breadboard Implementation of the project	6 weeks
PCB or Veroboard Implementation	pending

Cost Analysis:

Name	Quantity	Price (bdt)
Microcomputer	2	840/-
Transceiver module	5	350*5/-
Voltage Regulator	3	50*3/-
Buck Converter	3	180*3/-
Audio Amplifier	7	140*7/-
Speaker	4	350*2/-
Microphone Module	2	150*2/-
Battery	4	85*4/-
Battery Holder	2	130/-
Breadboard	4	340/-
PTT Button	4	14/-
Capacitor	5	6/-
Resistor	5	5/-
Battery Charging Module	1	130/-
Jumper Wire	3 sets	100*3/-
	Total Cost	6535/-

Impact on Society and Environment:

Positive Impact:

The most important lessons we learned from numerous disasters are that mobile communication systems are very vulnerable, and the loss of communication system may have a catastrophic consequence. In that sense, the designed walkie talkie can be an extraordinary tool to fight disasters and help factory employees and workers to execute their tasks smoothly in the workplace.

Negative Impact:

If not properly disposed of electronics can contribute to environmental pollution. We have had some casualties while implementing this project which led to the wastage of electronic components. Although these components are functional, they have a Carbon Footprint. These are harmful for the environment. So, ensuring proper disposal or recycling of old devices is crucial to mitigate this impact.

Conclusion:

In this project, we have attempted a design which is affordable and available for people in general. The circuit components' output voltage and current was measured and they were checked thoroughly so that none of them are non-functional. Despite the individual functionality of the walkie-talkie circuit modules, a systemic problem hinders processing of audio signals, resulting in a non-operational circuit. Further investigation and troubleshooting are recommended to identify and address the root cause of the issue.

References:

-(PDF) Design and Development of a Low-Cost 2.4 GHz GFSK Modulation based Walkie-Talkie (researchgate.net)

-Identification of Walkie-Talkie Individual Based on Precise Measurement of Frequency and Discriminant Analysis (researchgate.net)

-Wireless Communication using a Walkie Talkie | Request PDF (researchgate.net)

-Long Range Arduino Based Walkie Talkie using nRF24L01 (circuitdigest.com)

-nRF24/RF24: OSI Layer 2 driver for nRF24L01 on Arduino & Raspberry Pi/Linux Devices (github.com)

-nRF24/RF24Audio: Arduino library for streaming data/audio from analog inputs via NRF24L01 modules (github.com)

-"Walkie talkie circuit diagram long range," javascript hit counter. https://masterpdf.pro/download/4330427-walkietalkie-circuit-diagram-long-range

- M. Mahbub, "Design and Implementation of Multipurpose Radio Controller Unit Using nRF24L01 Wireless Transceiver Module and Arduino as MCU", International Journal of Digital Information and Wireless Communications, vol. 9, no. 2, pp. 61-72, 2019.

Signature of the Students and Date:

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