

Developing Pillow Speaker Using Conductive Thread for E-Textiles Applications

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Abstract

This paper focuses on earlier ideas and current developments of pillow speaker for wearable electronic textiles (e-textiles) application using conductive thread. At present Copper wire is frequently used to make pillow speaker. It creates a higher sound level and easy to hear. But sometimes it creates unwanted vibration and responsible for health issues for prolonged time listeners. Hence, in this paper, an alternative solution is suggested to use conductive thread instead of copper wire. Here conductive stainless steel sewing thread is used to eliminate the use of copper wire. As these conductive threads are sewable and can be embedded in textile much easily. A Bluetooth device and battery (0.04W) are also added to turn the whole setup into a wireless form. Upon creating and activating a magnetic field a sound level of 44.8 dB was achieved. It also proved the fact that it is possible to make sound with conductive thread promoting e-textiles for further applications. It is also discussed that with the increase of conductivity and closer coil density, the intensity of the sound level also increased.

Keywords: E-textiles, Conductive thread, Wearable textiles, Conductivity, Sound.

1. Introduction

The term E-textiles means “Electronic Textiles”. E-Textiles, are interconnected and incorporated between textiles and electronic devices for functional or decorative wearable electronic textiles. It refers to materials such as yarn, thread or fabric that integrate conductive properties and electronic elements which is currently one of the fastest-growing field [1]. Such e-textiles, functioning as multifunctional wearable human interfaces, are today considered relevant promoters of progress and useful tools in numerous fields [2]. The field of e-textiles holds a variety of applications; one inexpensive and practical application lies in creating unobtrusive pillow speaker [3]. Pillow headrests possess speakers incorporated therein are not new in the art [4, 5]. Several studies have been done for making pillow speaker [6, 7]. Many research and patents have been published on this topic [8, 9]. But the present invention relates generally to Sound delivery and transmission Systems, and more particularly to speaker Sound Systems installed in pillows using copper wire not conductive thread [10]. Conductive stainless steel sewing thread is usually thin, strong, smooth that is suited to build wearable products. Stainless steel fiber yarn can produce into different kind of electromagnetic shielding fabrics, and in producing permanent shielding and conductive products [11, 12]. Most effective conductive threads have a strong, flexible, artificial polymer inner core with one or more outer metallic layers or shells deposited on the exterior surface [13].

In this current work, conductive sewing thread is used for sound generation and to eliminate previously used copper wire. The main purpose of using conductive thread and remove copper wire is to make the speaker works in sewing condition which is not possible in copper wire [14]. Thus it takes little space as compared to copper wire to make a speaker and gives more flexibility to use the pillow than before. Sewing conductive thread is used as a speaker with a Bluetooth circuit, power source, and magnet and produce sound when a sound source is connected with the Bluetooth circuit. It produces a little amount of sound but which is enough for hearing song before sleeping time. This pillow speaker can be useful for who is suffering insomnia, patient admits in the hospital or people who have a habit of hearing song in the sleeping time. They can be benefited using this pillow speaker [15]. Moreover, it can reduce the bacterial attack causes by using head phone for longer period of time.

2. Methodology

2.1 Materials

2.1.1 Conductive Stainless Steel Sewing Thread

For our current project work, we have used Stainless Metallic yarn (Brand Name: QL Fiber, USA). This fiber was from high tenacity and strength. Yarn count was 11/2.

2.1.2 Magnet

Ceramic magnets (also known as ferrite magnets) are a low-cost alternative to metallic magnets. They are composed of iron oxide and strontium carbonate. It is the first choice for most types of DC motors, magnetic separators, magnetic resonance imaging and automotive sensors [16]. In this work, we have used ceramic magnet (Brand Name: JIADI METAL, China) without any special coating having a diameter of 70 mm and thickness of 10 mm.

2.1.3 Pillow

A regular nonwoven pillow is used here. It is very soft and easy to use and diameter of the pillow was 33 mm². Total wt. of the pillow was 400 gm.

2.1.4 Bluetooth Circuit With battery

A regular DC 3.7 V power supply Bluetooth speaker circuit is used here. It can directly promote the headset, can also be connected to the post-amplifier. With three audio input modes: Bluetooth reception/ USB decoding playback/ TF card decoding playback easy to connect the Bluetooth. Provide a variety of sound effects.

2.2 Tools

2.1 Digital Multimeter

A digital multimeter also known as a VOM (volt-ohm-milliammeter) is used to measure the electricity passing through the conductive thread.

2.2 Soldering iron

We have used a soldering iron with output temperature of 300°C-350°C (Brand: Hushun)

2.3 Hot Glue Gun

Brand: STAINLEY (origin: USA) Voltage: 3.7V, Power: 10W, Pre-heat Time: 3-5 Min, Battery Capacity: 1800MAh, charger time: 2 hour, Running Time: 45 Min

2.4 Sewing Needle

A long slender hand sewing needle (Stainless Steel) is been used for making the couching.

2.5 Sound measuring meter app

A digital sound measuring app is being used to measure the decibel value of the surrounding sound created by the pillow. (Range: 0-120 dB)

2.3 Methods

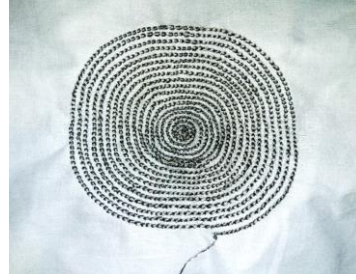
2.3.1 Process flow chart of the pillow speaker making

First, the mentioned pillow is selected. Then marking in specific position is done by a pen, where sewing by hand stitching will be done. A round Archimedean spiral shape like design is made. Then sewing is performed by conductive thread over the markings and make sure there should be an adequate gap between them so that they can't cross or touch each other. This embroidery technique is called "couching". If the conductive sewing thread is touched one another then it will not work because it has no insulation. Magnet is placed inside of the pillow just underneath the couching. It is very important to make the magnet placement in accurate position for magnetic field generation and great care is taken so that it does not change it.

Pouch is sewn to hold Bluetooth circuit and power source (battery). Its placement is done securely in the opposite side of the sewing conductive thread so that it is placed below the pillow and doesn't make any problem to the listener.



Marking on Pillow



Spiral Shape embroidery



Magnet Placement

Now all the connection is made correctly. Here the connection is made very carefully so that it will not disconnect easily. The hot glue gun is used to make the connection more secured.

Now pillow speaker is made perfectly. If we connect the sound source like mobile, mp3 or laptop with the Bluetooth circuit then sound will be produced.

3. Result

3.1 Resistance test of conductive thread

Machine used: Digital Multimeter

Sample size: Length -1 Feet

Twist: S Twist

Yarn Count: 11/2

Test Result: Resistance 30 ohm/feet

3.2 Voltage test of power supply

Machine used: Digital Multimeter

Test Result: 4 Volt

3.3 Electricity measuring Test

Machine used: Digital Multimeter

Test Result: 0.1 Amp

3.4 Sound Measuring Test of Pillow Speaker

Machine used: Android phone (sound measuring app)

Test Result: 44.8 dB

4. Discussion

From this current work, it is found that it's been possible to produce sound using conductive sewing thread and magnetic resonance, instead of copper wire. Though it is produced little sound because of the high resistance of conductive thread. But it produces a sound level of 44.8 dB, which is still enough for hearing comfortably in the sleeping time without disturbing the person sleeping next to the listener. This Bluetooth pillow speaker can be used as a speaker to hear a song as well as a regular pillow for resting our head while in sleeping time.

The battery can support or run it up to 8 hours if the battery is fully charged. Its voltage is 4 Volt. The current passes through the circuit is 0.1 Amp.

The Bluetooth range depends on the sound source and Bluetooth circuit uses. If a normal phone is used for sound source then nearly 10 meter or 33 feet distance is the maximum distance for Bluetooth working in normal condition. But the Bluetooth circuit range is below 5 meters. So, it is advisable to keep the sound source within 5 meters of distance for high quality sound.

In this Bluetooth pillow speaker, a very little sound is produced because of conductive thread high resistance, low density of sewing, low current passing (0.1 Amp). So conductive thread resistance should be minimized first, and then, density of sewing thread should be increased by sewing compactly with the help of conductive sewing embroidery machine. And finally, the current passing should be increased.

4. Conclusion

The present invention relates generally to sound delivery and transmission systems and more particularly to speaker sound Systems installed in pillows provided for use as a headrest. Here, copper wire replacement is done with conductive thread for generating sound. Though conductive thread resistance is high sound volume is low but sound can hear perfectly in before sleeping or resting time. There are some lacking present so that expected sound-generating is not possible. But further work will be done to enhance the sound quality.

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