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Running head “iPhone Attachment For Stethoscope Recording”

NOTES  
Mention not just iphone, could be created for other devices easily

Explain better that I created the 3d file**iPhone Attachment For Stethoscope Recording**

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**Abstract**

With the ubiquity of smartphones and the rising technology of 3d printing, novel devices can be developed that leverage the “computer in your pocket” and rapid prototyping toward scientific, medical, engineering, and creative purposes. This paper describes such a device: a simple 3d-printed extension for Apple’s iPhone that allows the sound from a standard stethoscope to be recorded using the iPhone’s built-in microphone. 3d printing allows for easy sharing and updating of the attachment, for modification for other phones and devices, and for fabrication of a durable device without need for expensive, heavy, and specialized machining tools. It is hoped that devices like these – cheap to produce and easy to use – can be deployed in areas where access to more expensive and non-portable medical instruments are not available. Coupled with specialized smartphone software (“apps”), more sophisticated diagnostics may be possible on-site.

**Keywords**

iPhone, stethoscope, audio recording, 3d printing, STL, Shapeways, smartphone

**1. Introduction** (summary of theory and method described, outline major procedures involved)

The following is in some ways more of a “how to” than a laboratory procedure; this is worth noting for two reasons. First, 3d printing handles much of the heavy lifting, creating the complex part to interface the iPhone with the stethoscope. The finished part requires only minimal preparation for use, depending on the quality of the print. Second, my research is as a visual artist and this device is born out of that work. Originally created for making interesting, experimental audio recordings, this research is further evidence of something I believe strongly: that research in the arts can have practical and important applications in STEM fields.

**2. Materials**

1. Stethoscope head with fitting for standard 1/4” ID tubing

2. Standard stethoscope tubing (single lumen), 3/8” OD, 1/4” ID, at least 6” long (1)

3. Optional: Y-shaped tube fitting for simultaneously monitoring sound with standard stethoscope earpiece (2)

4. 3d-printed iPhone attachment

5. iPhone generation 4, 4S, or 5

6. Sound recording app for iPhone such as pre-installed “Voice Recorder”

**3. Methods**

This section describes 3d printing, assembly, and use of the stethoscope attachment. Please note that these instructions describe printing the attachment using the service Shapeways; if a 3d printer is available locally the attachment can be printed using a variety of alternative methods (see Notes for possible issues and suggestions).

**3.1.a. Printing The Attachment Using Shapeways 3d Printing Service**

1. Visit the following link to order a 3d-printed version of the stethoscope attachment: http://shpws.me/oQUX

2. Choose a material color from the “Material Options” dropdown menu – default is white (see Note 1)

3. Click the “Buy Now” button to order the printed model in the material specified (see Note 2)

**3.1.b. Alternatively, Print Using a Local 3d Printer**

1. Visit the project’s GitHub repository: https://github.com/jeffThompson/iPhoneStethoscopeAttachment

2. Download the stereolithography (STL) file by clicking the “Download ZIP” button in the right sidebar or by right-clicking and saving the “iPhoneStethoscopeAttachment.stl” file

3. Print using a hard material such as ABS or PLA plastic at 100% infill; other settings will depend on model of 3d printer (see Note 3)

4. Clean and sand/file printed model as necessary

**3.2. Prepare Stethoscope Tubing**

1. Cut the stethoscope tubing using a sharp knife or scissors below the fork to form a single tube. Length is variable but 15” (38cm) is comfortable without being too long.

**3.3. Assemble the Attachment**

1. Slide one end of the stethoscope tubing over the barb in the stethoscope head until secure

2. Insert the other end of the stethoscope tubing into the hole at the bottom of the 3d printed attachment; the tubing should fit tightly and stop about 4.5mm into the hole (see Note 4)

3. Slide the 3d printed attachment over the bottom of the phone; the half-circle cutout in the attachment should align with the “home” button on the iPhone; slide in until the bottom of the phone hits the bottom of the 3d printed attachment (see Note 5)

**3.4. Test and Record**

1. Turn on the phone and launch an audio recording app like Voice Recorder (see Note 6)

2. Press record and test the stethoscope; depending on your app’s sensitivity settings, loud sounds should be very clearly picked up (see Note 7)

**4. Notes**

1. Shapeways’ “Strong and Flexible” material is laser-sintered nylon plastic, resulting in prints that are very strong with some flexibility. They can be easily cleaned, are dishwasher safe, and are heatproof to 80C/176F. See the following link for more information: https://www.shapeways.com/materials/strong-flexible
2. While Shapeways offers a variety of other materials for printing; if you would like to experiment with different materials, please see the GitHub link to download and print your own (see Note 3)
3. Depending on your printer’s style and output material, specific settings may be required for a high-quality and durable print. For Fused Deposition Modeling (FDM) printing like the MakerBot, shrinkage may require re-engineering the model based on trial and error. Such considerations are not needed for laser-sintered nylon. Aside from shrinkage concerns, it is suggested that FDM printers are set to 100% infill with at least 2-3 shells.
4. The tubing should be firmly attached to the 3d printed attachment but no pushed so far in as to block the tubing’s hole. Since the attachment is designed to be taken apart and reassembled as needed, if there is an issue simply remove the stethoscope tubing and reinsert.
5. While every effort has been taken to avoid damage to the iPhone, it should be noted that the 3d printed attachment is pressure-fit to the phone’s body. Attachments printed using Shapeways’ laser-sintered nylon and MakerBot-printed ABS plastic both left no scratches on the phone’s surface, even at a tight fit and many installations/removals. However, use at your own risk.
6. Apple’s built-in Voice Recorder app is quite adequate for basic recording, but offers little manual control. Voice Record Pro (free, <https://itunes.apple.com/us/app/voice-record-pro/id546983235?mt=8>) offers manual quality adjustment (“high” is 44.1kHz/16-bit at a bitrate of 128,000) but is limited to the AAC/MP4/M4A compressed audio formats. Audio Memos ($9.99 USD with in-app upgrades, <https://itunes.apple.com/us/app/audio-memos-pro/id290160980?mt=8>) has a large level meter and allows recording in the uncompressed WAV format. Both apps can be set to auto-upload to Dropbox and similar cloud services.
7. Better-quality audio recording apps may have adjustable gain for microphone input. If audio level problems persist, check that the stethoscope tubing and hole from the base of the 3d printed attachment to the iPhone microphone are not blocked.

**5. References**

In the interest of accessibility and cost-savings, some alternative parts are suggested here, rather than from medical supply companies

1. “UV-Resistant Black PVC Tubing” from McMaster Carr  
   <http://www.mcmaster.com/#5231k83/=oainxw>
2. “Sanitary White PVDF Barbed Tube Fitting” from McMaster Carr  
   <http://www.mcmaster.com/#53055k155/=oailx5>

**FIGURE CAPTIONS**

*Note: figures can be placed anywhere in the text, though a large version of figure #1 at the start of the chapter would be ideal. Thank you!*

Fig. 1. The completed iPhone stethoscope attachment.

Fig. 2. A CAD rendering of the 3d printed attachment, which slides tightly onto the bottom of the iPhone. Note how the sound from the stethoscope’s tube is funneled directly into the phone’s built-in microphone. Shapes like this are difficult to manufacture; 3d printing is an ideal solution in such cases.

Fig. 3. Frequency analysis of a recording of a human heartbeat.