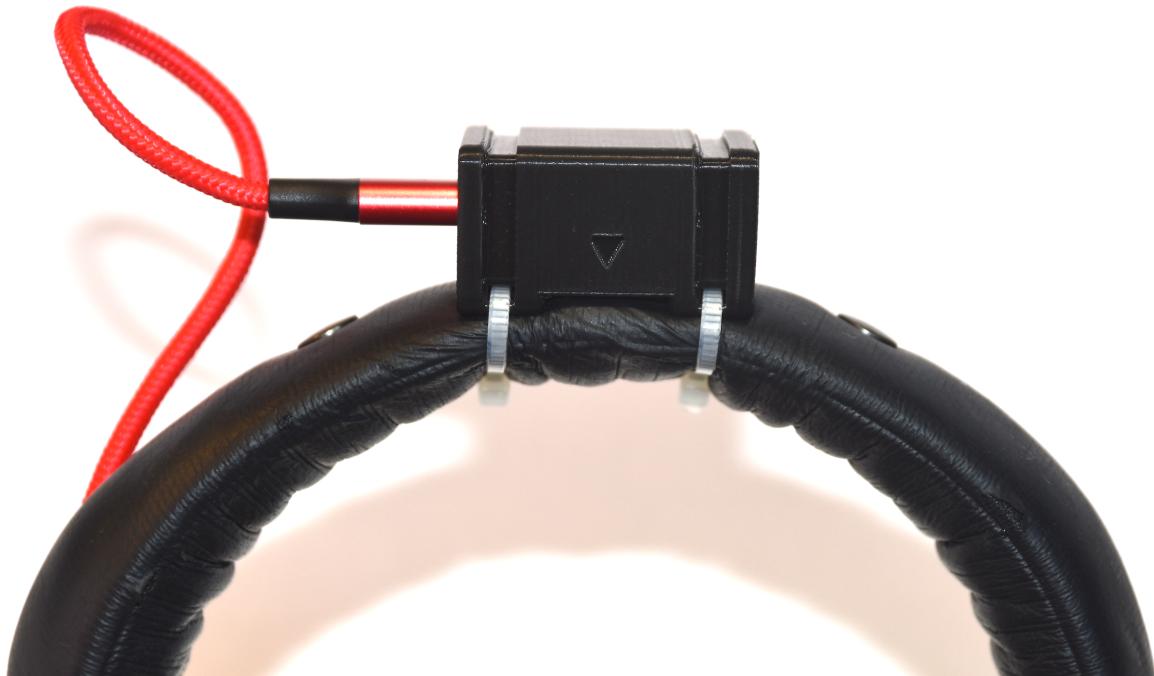


Headtracker



Assembly Manual

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Introduction

The HdM-Headtracker was a research project of Stuttgart Media University (HdM) in the summer term 2020. These instructions should enable you to build a low-cost headtracker, which is superior to most comparable solutions. It can be used in combination with the OSC-Bridge available as part of this head tracker project: <https://github.com/trsonic/nvsonic-head-tracker>

Required Components

Hardware:

1. **Arduino Pro Micro board 5V/16MHz with ATmega32U4**
2. **Adafruit BNO055 - 9DOF sensor (IMU-Sensor)**
3. **HDM-Tracker case with drawer (3D print instructions on GitHub included)**
4. At least two cable ties with a width of 3.5 mm / 0.137 inches
5. **Jumper wire or enameled copper wire ca. 30cm / 1 ft**
6. **Micro-USB cable ca. 2m / 6,56 ft**

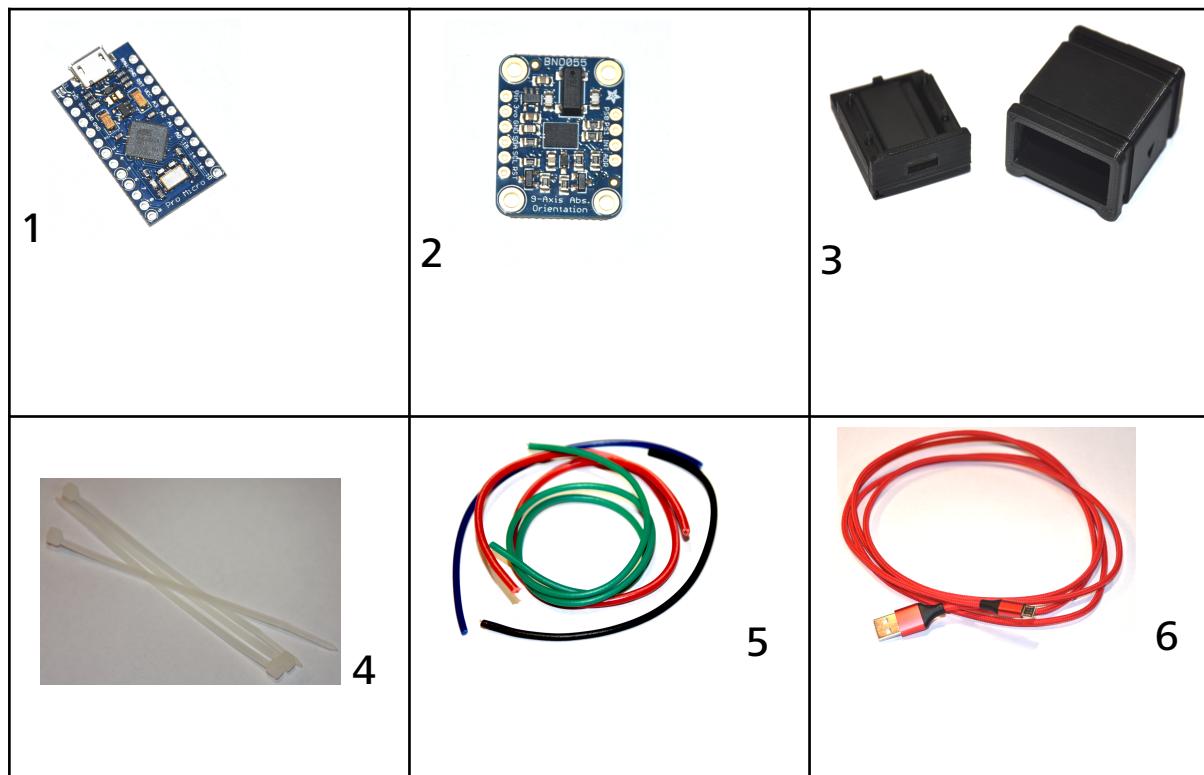


Figure 1: Required hardware components

Software:

Arduino IDE with the following libraries:

1. Adafruit BNO055 library
2. Adafruit Sensor library (only for releases prior to version 10.8.)

Additional Tools:

1. **Soldering equipment** (Soldering Iron, solder and desoldering strand)
2. Third-hand Tool
3. **Wirecutter** / wire stripper
4. **3D Printer**
5. Flat screwdriver, lighter
6. Nail file / sandpaper
7. M3-Hex key/Allen key or similar

Building instructions

Step 1: Download the Github repository

Under the following link you will find all required files for the construction and operation of the HdM-Tracker:

https://github.com/melchior-hdm/HdM_Tracker

When clicking on the button “Code” a drop-down menu will appear. Click on “Download ZIP” to download the repository to your computer. When the download is finished, unzip the folder and store it on your computer.

Hardware (Part 1):

Step 2: Print the HdM-Tracker case and drawer

For smooth production, it is ideal to manufacture the case and drawer first, so the electronic components can be installed immediately after soldering. In the downloaded folder, you will find each of the two required print files under the following path:

./Case/

Make sure that your 3D printer is calibrated and set up correctly. Otherwise inaccuracies may occur, which potentially make it impossible to assemble the case and drawer. With most 3D

printers, small inaccuracies are likely to occur. If so, these can be mended with a nail file or sandpaper.

Caution!

Most 3D printer filaments are very sensitive to heat. If you leave the case lying in direct sunlight for too long, it might deform slightly, making it impossible to close or reopen.

To achieve a perfect print result, the parts to be printed should be arranged as seen in Figure 2.

If you use a *Prusa i3 MK3* printer, you will find the print-ready files in the 3D print folder. For any other printers you have to convert the .STL- files into the corresponding printer format.

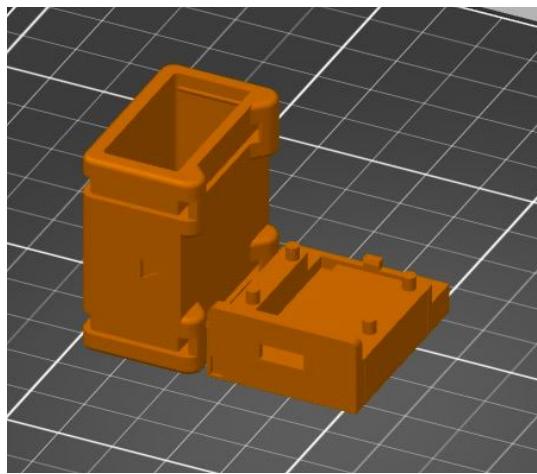


Figure 2: Arrangement of the parts to be printed

Step 3: Check if the Arduino and the sensor fit into the case

Caution!

Before working with electrical components, make sure that you are not electrostatically charged. Touch either the metal of a tap or heater before touching any electrical components!

After printing, check if the Arduino and the sensor fit nicely into the case. Figure 3 shows the assembled headtracker.

The Arduino Pro Micro has to be placed with its flat side on the bottom of the drawer and the sensor mounted on the four cylinders above the Arduino. The sensor should fit perfectly on the four provided mounting pins.

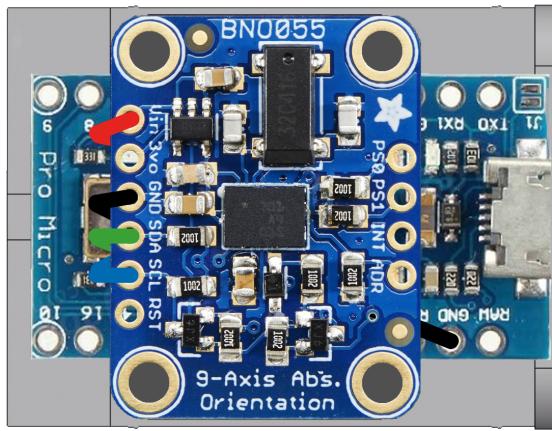


Figure 3: Illustration of the finished arrangement of the electrical components in the case

Step 4: Cut and dismantle jumper wires

Jumper wires are used to connect the sensor to the Arduino. In order to fit correctly into the case, each wire should have a length of roughly 30 millimeters. Dismantle approximately 3 millimeters on each end.

Step 5: Connect the sensor to the Arduino

A third-hand tool helps you to clamp the components during soldering. Tin the stripped wires with solder. Solder the IMU sensor (BNO055) to the Arduino Pro Micro according to the circuit diagram (Figure 4).

Notice! The cables should run between the Arduino board and the sensor. Make sure that you do not use too much solder on the soldering points, otherwise it might not fit correctly into the case.

Tip: Use the color-coding shown below (Figure 4) to avoid confusion.

- Connect the power input of the sensor (Vin) to the Arduino's power supply (VCC)
- Connect GND to common power/data ground GND
- Connect the SDA pin of the sensor to the I2C data SDA pin on your Arduino (digital 2)
- Connect the SCL pin to the I2C clock SCL pin on your Arduino (digital 3)

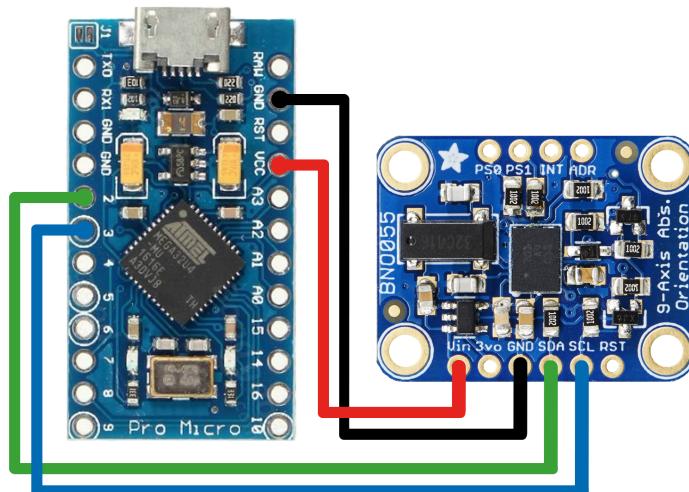


Figure 4: Arrangement and cabling of the electrical components

Step 6: Mount the electronic components to the drawer.

The Arduino and the sensor fit into the drawer as shown in Figure 3.

Notice! Before closing the case, it is important to perform a functional test. For that reason, we continue with the implementation of the software before we put the drawer in the case and close it.

Device software:

Step 7: Download and Install Arduino IDE software:

Under the following link you will find the download of the Arduino software:

<https://www.arduino.cc/en/Main/Software>

Download the software and follow the instructions given by the installer program.

If you have never used the Arduino before, you will find examples to test the features of the Arduino under the following link:

<https://learn.sparkfun.com/tutorials/pro-micro-fio-v3-hookup-guide#example-1-blinkies>

This website also provides you with a tutorial, which shows you how to use the Arduino on Windows or Mac.

Tip: Copy Example1: Blinkies! and upload it to the Arduino Pro Micro to test the basic functionality.

Step 8: Download and install the required Arduino libraries

Notice! The library should only be downloaded from the Arduino library manager. Libraries should not be stored separately on your computer.

Open Arduino IDE's library manager (Figure 5).

Step 8.1: If you are using an Arduino IDE version prior to 10.8., search for the "Adafruit Sensor library" and install it. For newer releases of the software, this action is not required.

Step 8.2: However in any case you have to search and install "Adafruit BNO055 Library for Absolute Orientation Sensor".

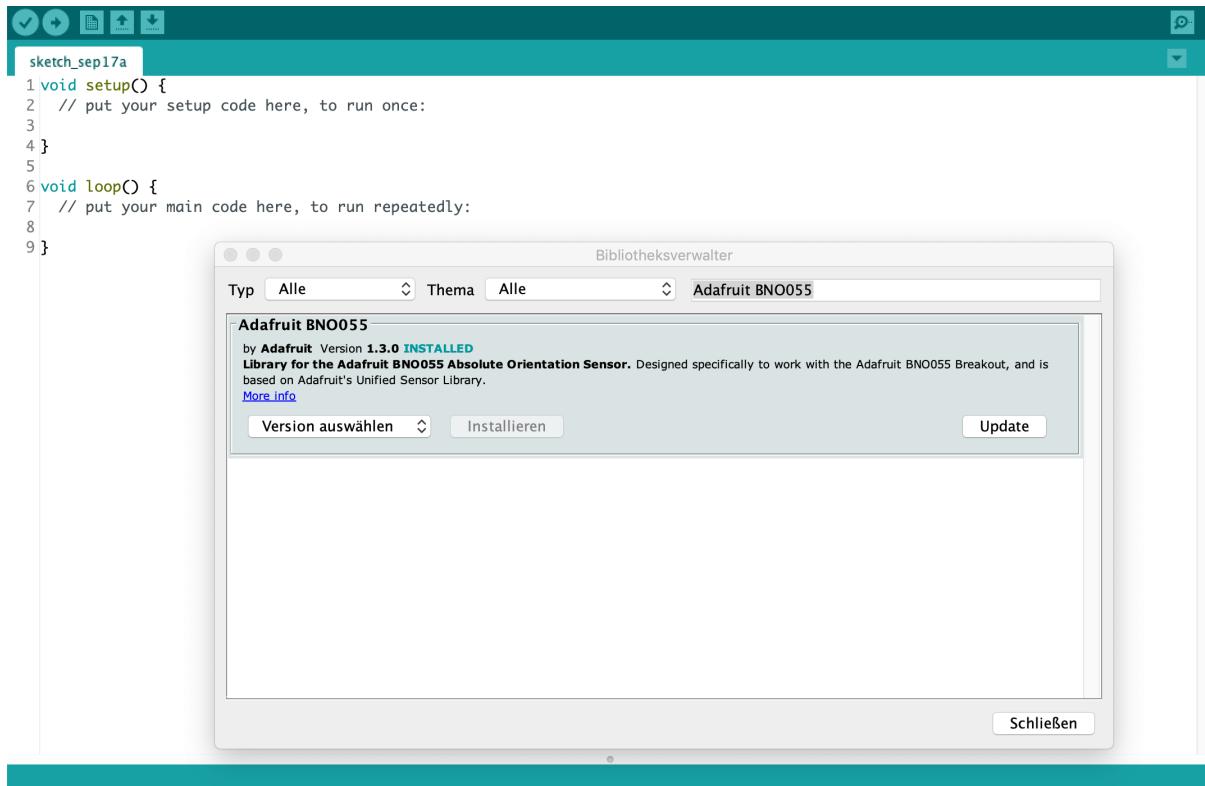


Figure 5: Arduino IDE's library manager

A tutorial on Arduino library installation can be found under the following link:

<https://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use>

Step 9: Programming the Arduino

Step 9.1: Connect the HdM-Tracker to your computer with the Micro-USB cable.

Step 9.2: Open the Arduino sketch “headtracker_Micro_BNO055” in Arduino IDE. You will find the sketch under:

HdM_Tracker-master/Arduino/headtracker_Micro_BNO055

Step 9.3: To program the Arduino Pro Micro, choose the Board “Arduino Leonardo” in the tools section (Figure 6).

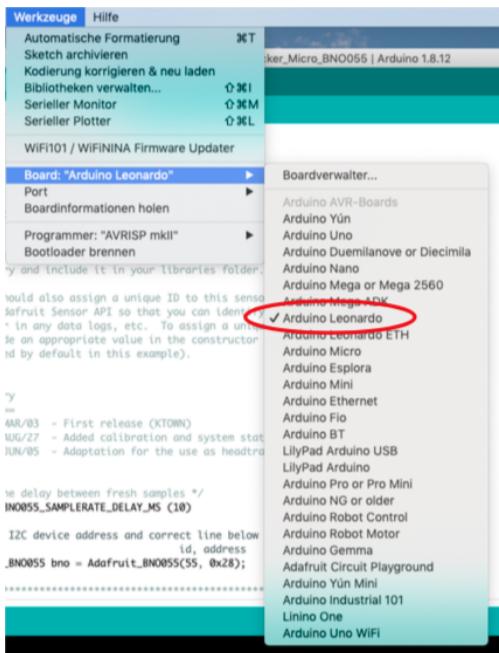


Figure 6: Board selection “(Arduino Leonardo)”

Step 9.4: Choose the belonging Port “(Arduino Leonardo)” in the tools section (Figure 7).

Step 9.5: Check and upload the sketch to your device. Once the sketch is successfully uploaded, two red LEDs will flash on the Arduino board once the setup process is complete and any functional tests are successful, we go on with assembling the hardware.

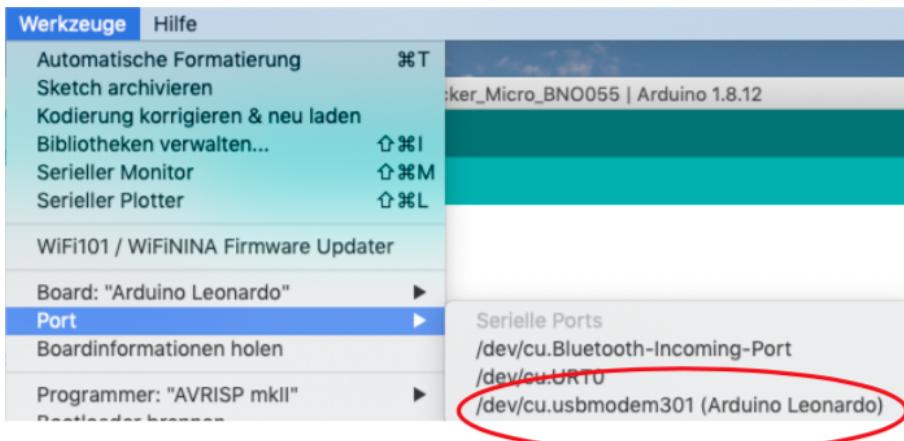


Figure 7: Port “(Arduino Leonardo)”

Hardware (Part 2)

Step 10 (optional): Attach the sensor to the drawer

If you made sure that everything works correctly and you don't need to touch up or change anything on the board in the future, you can melt the four fixing pins above the Arduino with a hot object to attach the sensor to the drawer.

Melt the four fixing pins above the Arduino with a hot object, for example the tip of a flat screwdriver, which was heat up with a flame. Press the tip with the flat side onto the four fixing pins (*Figure 8*).

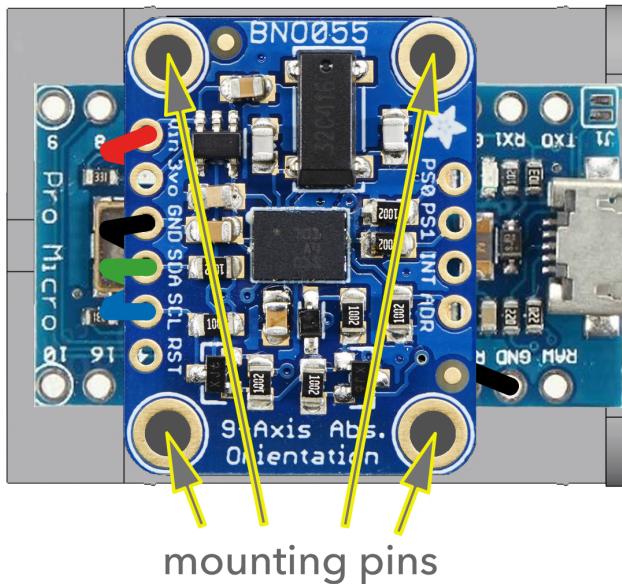


Figure 8: attachment points

For a perfect fit the cables should run between the Arduino board and the sensor

Step 11: Insert the drawer into the case

Slide the drawer into the housing until you hear a click (*Figure 9*). The drawer is then firmly secured.

If you want to remove the drawer from the case, you will find an opening on the opposite side of the USB-port. Use a suitable tool, such as an M3 Allen key or similar, and push it strongly into the opening. This should open the drawer again.

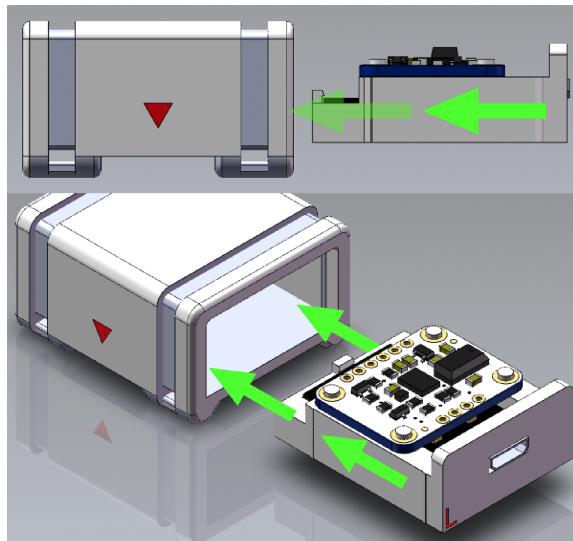


Figure 9: Image of drawer being built into the case

Step 12: Mount the HdM-Tracker onto your headphones

Please make sure that the headtracker is correctly attached to your headphones.

The opening of the USB connector has to be located to the left side of the headphones (*Figure 10*), so that the USB cable can be attached to the headphone cable.

Pull the cable ties through the holes provided in the feet of the headtracker and adjust them around the headphones bracket. After that you should be able to tighten the cable ties.

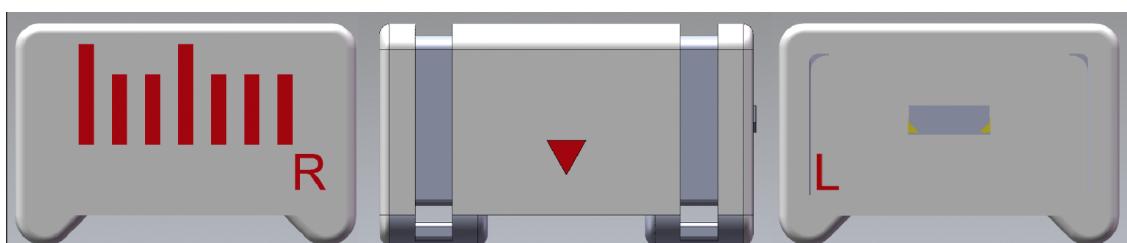


Figure 10: Labeling for correct direction for the HdM Headtracker

Notice! Before you tighten the cable ties, make sure the little arrow in the middle of the case sits directly in the middle of your headphone bracket (*Figure 11*).

Step 13: Attach the USB cable to your headphone cable

To avoid disturbances, the USB cable should be tightly attached to your headphone cable. You can fasten the USB cable onto your headphone and headphone cable by using cable ties or shrink tubes (Figure 12). The diameter depends on the used headphones. For the cable of the Beyerdynamic DT-770/DT-990 the shrink tube should have a diameter of Ø17mm and when tightened the diameter should be about Ø5mm.

To protect the head trackers USB port, a strain relief should be provided.



Figure 12: USB cable strain relief

Tip: If your headphone has a spiral cable you can place the USB-cable in the center (Figure.13).



Figure 13: spiral cable