

Design for Pulmonary Acoustic Sensory Telemetry Array (PASTA)

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INTRODUCTION

Background

- Over 1 billion people diagnosed with respiratory diseases, and over 6.6 million die annually [1].
 - Pneumonia is the leading cause of death among children under 5, while asthma affects 14% of all children [3].
- Respiratory diseases can cause coughing, wheezing, and other abnormalities, resulting in decreased lung function or even death.
- Most COVID-19 deaths are caused by severe respiratory failure

Problems

- Only provide a preliminary diagnosis, and require physicians to be physically present next to patient [2].
- Auscultations are non-continuous and can leave conditions undetected

Need

- Physicians need a non-invasive diagnostic tool that is highly accurate, inexpensive, and does not utilize radiation to detect respiratory illnesses in children.

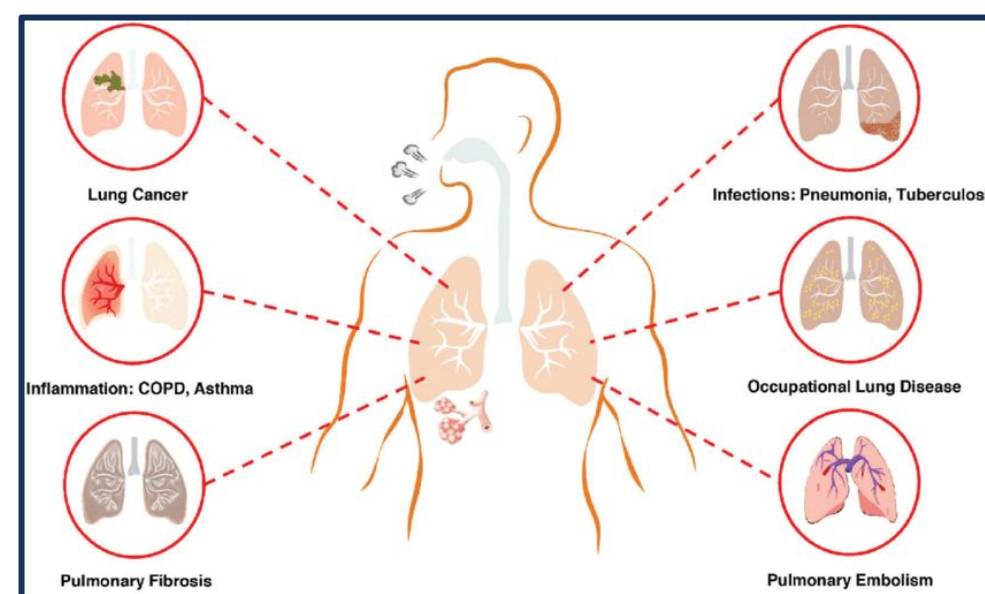


Figure 1. Diagram of various respiratory diseases and how it affects the lungs [4].

DESIGN CRITERIA

Criteria	Requirement
Less expensive than current prototype	Less than \$400
Improve data transfer aspect	No USB or external file transfer protocol to transfer collected data
Patient Safety	Non-invasive
Improvement in diagnostic accuracy	Over 95% accuracy
Usability	Non-pulmonologists should be able to use the system
Remote monitoring	Should be able to collect audio signal data remotely

STANDARDS

- P11073-10428 - discusses how electronic stethoscopes should communicate with other devices
- ASTM F3127- outlines how medical devices can be cleaned during the manufacturing process.

PROTOTYPE

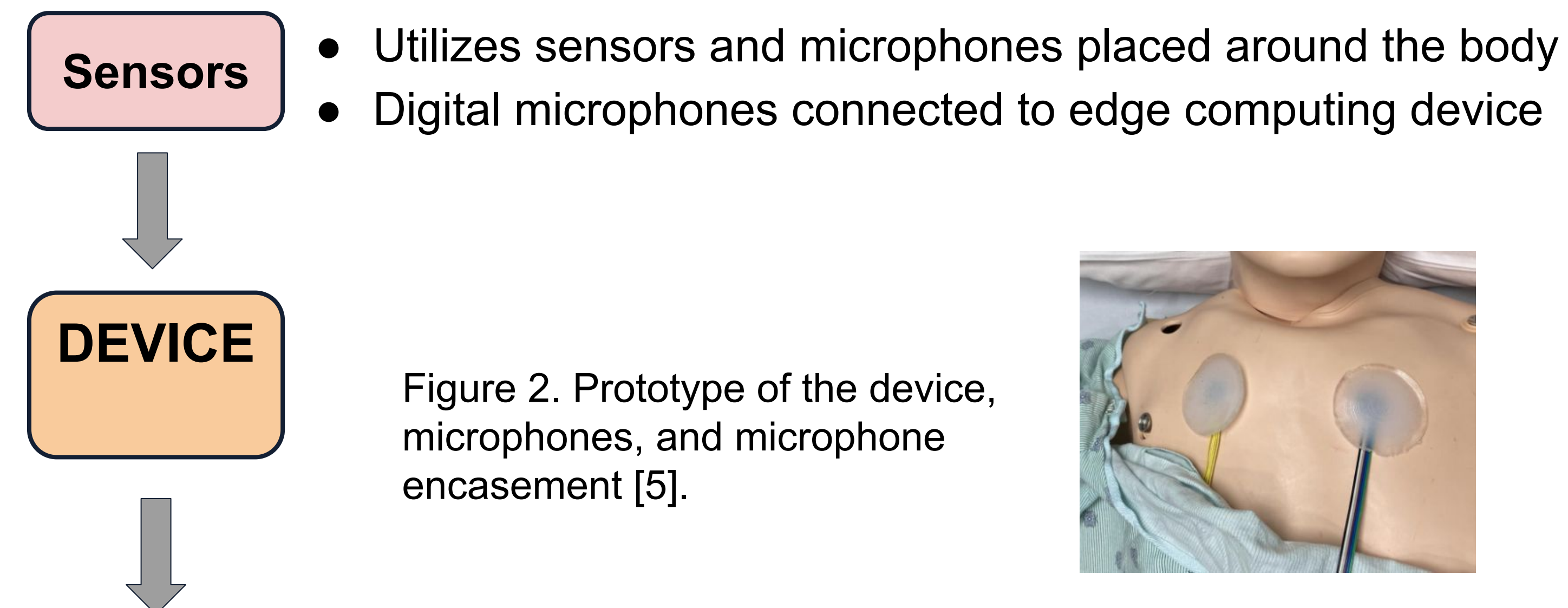


Figure 2. Prototype of the device, microphones, and microphone encasement [5].

Data Transfer

- Audio data collected on edge computing device and converted to WAV file
- Transfer WAV file to server
 - Python Flask framework
 - HTTPS
- Physician can listen to WAV file remotely and in near real-time

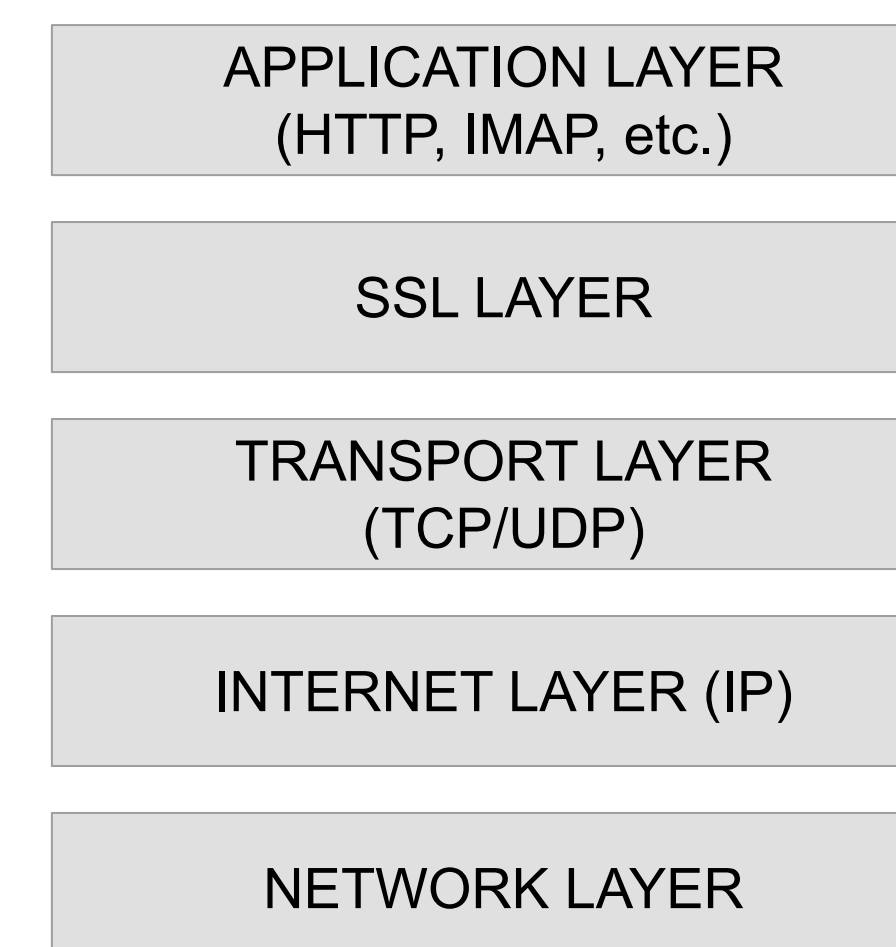


Figure 3. Depiction of the networking layers.

Local Communication

- Client & server both on laptop
- Use localhost IP and port configuration

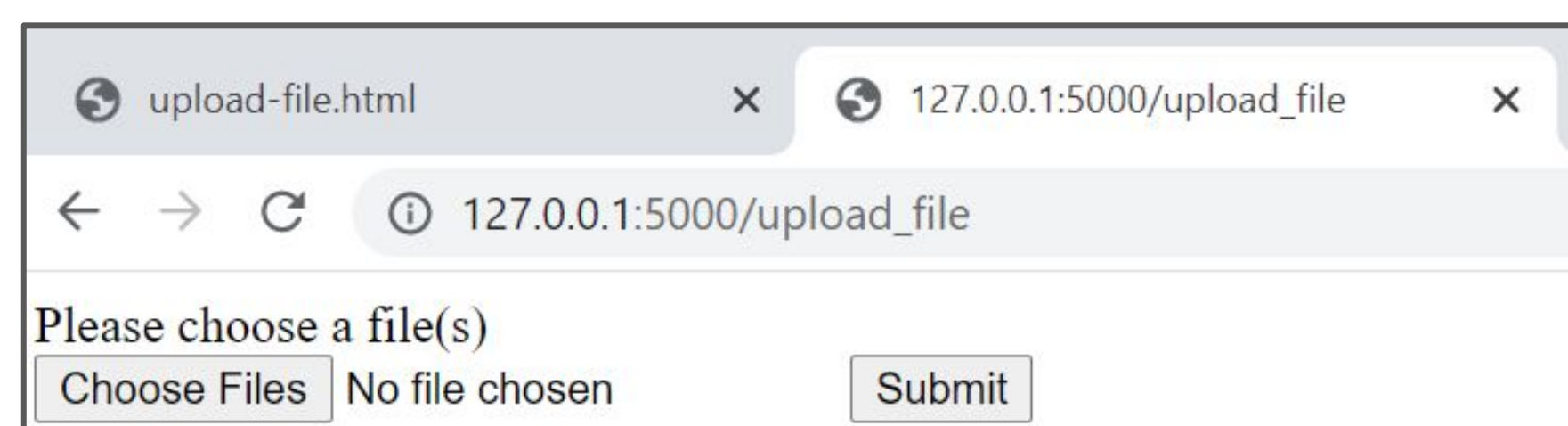


Figure 4. Web page deployed on local client and server.

Communication Between Device and Central Server

- Run server on domain hosting service
- Device browser (client)
- Use laptop to SSH into host and access uploaded files
 - SSH client such as WinSCP
- Set up HTTPS and domain name to get SSL certificate

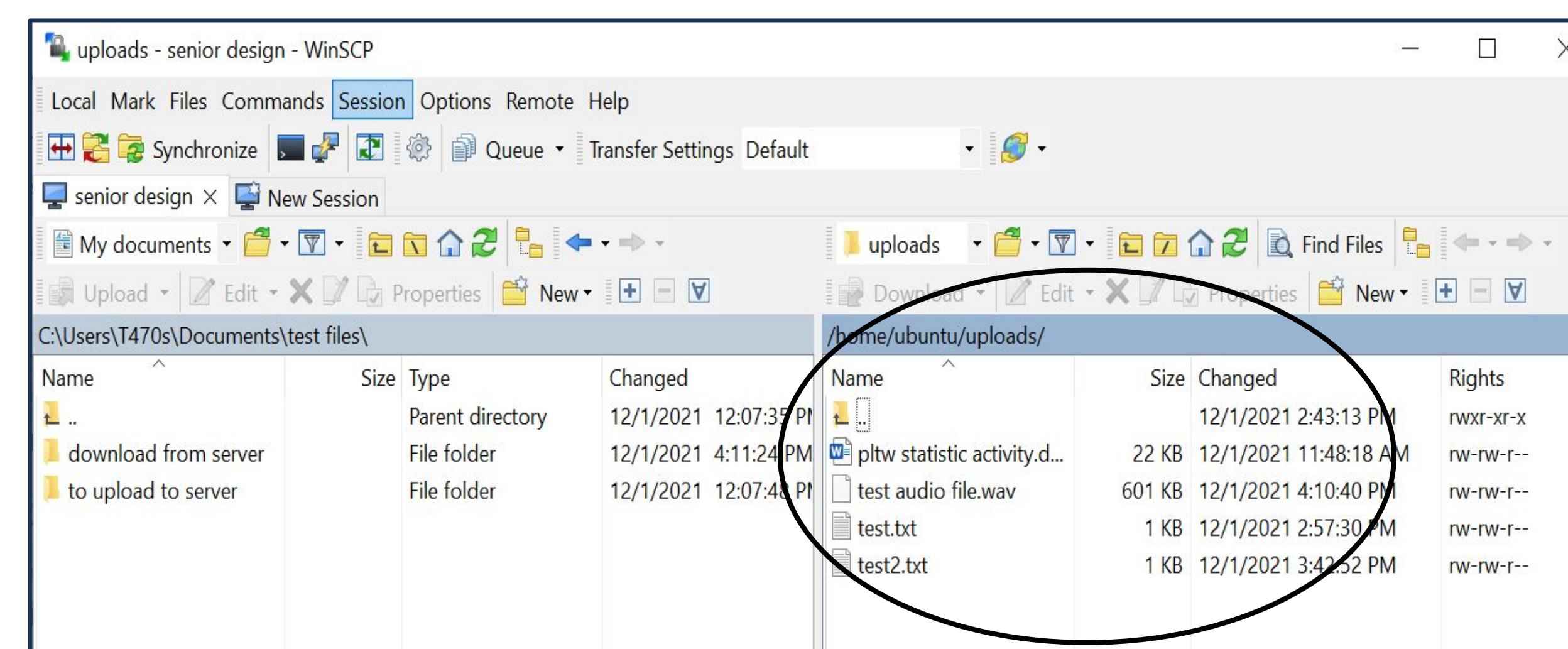


Figure 5. View of WinSCP where the files in the server can be accessed and downloaded on a device.

TESTING RESULTS

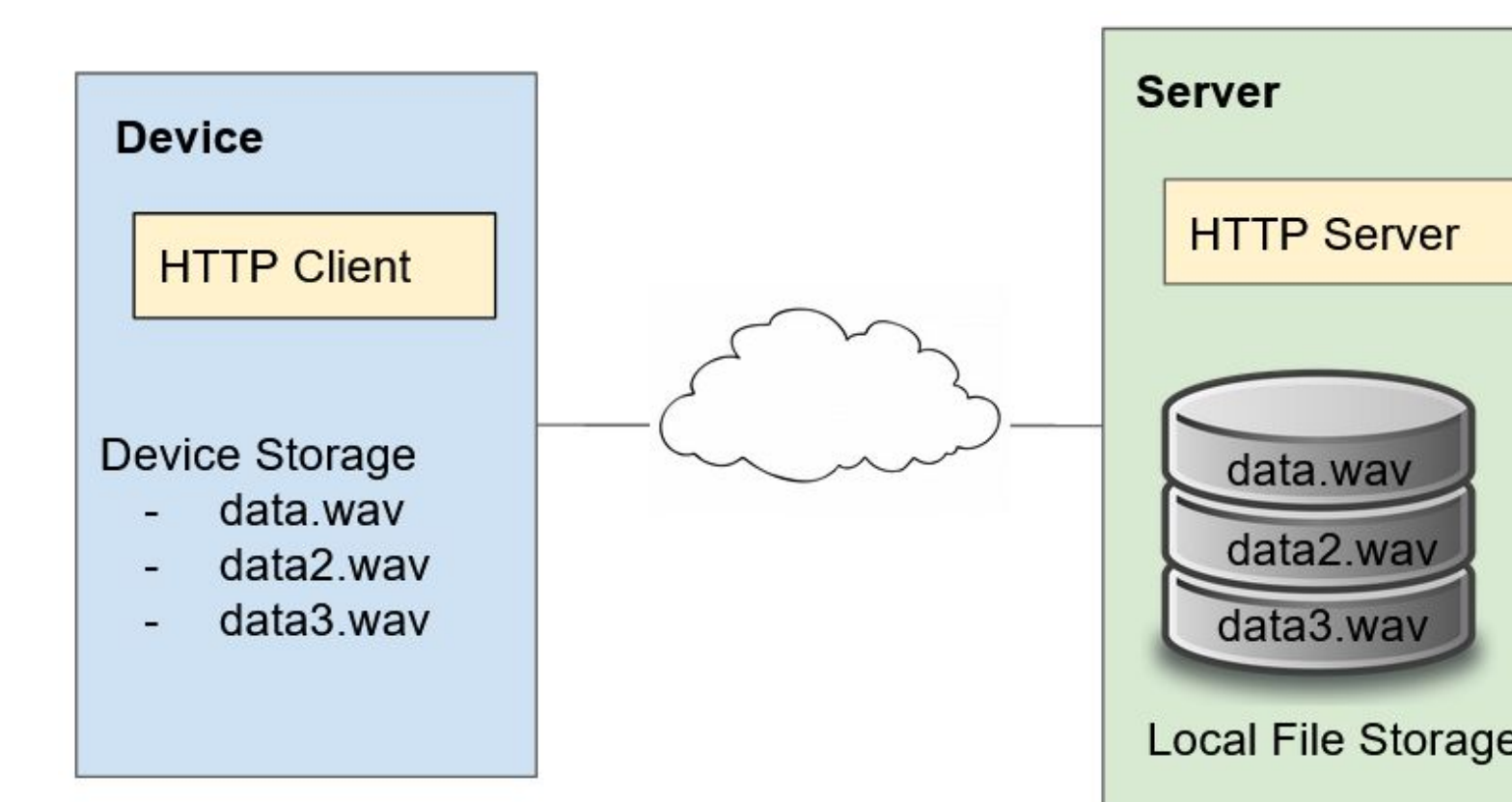


Figure 6. Schematic of the device and server communication.

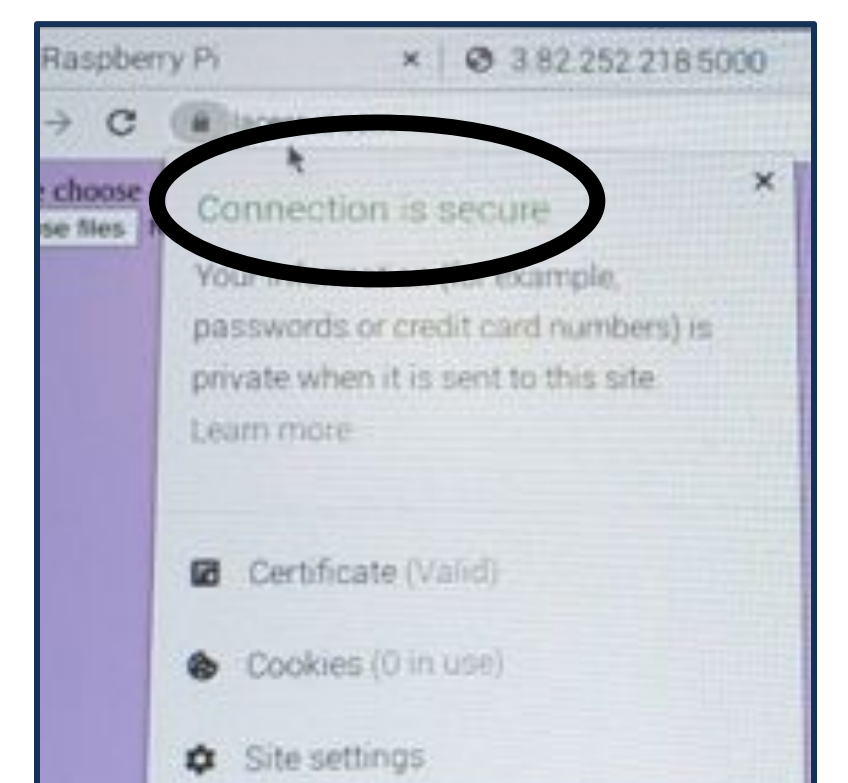


Figure 7. HTTPS is set up on this domain, so there is a secure connection established on this web page.

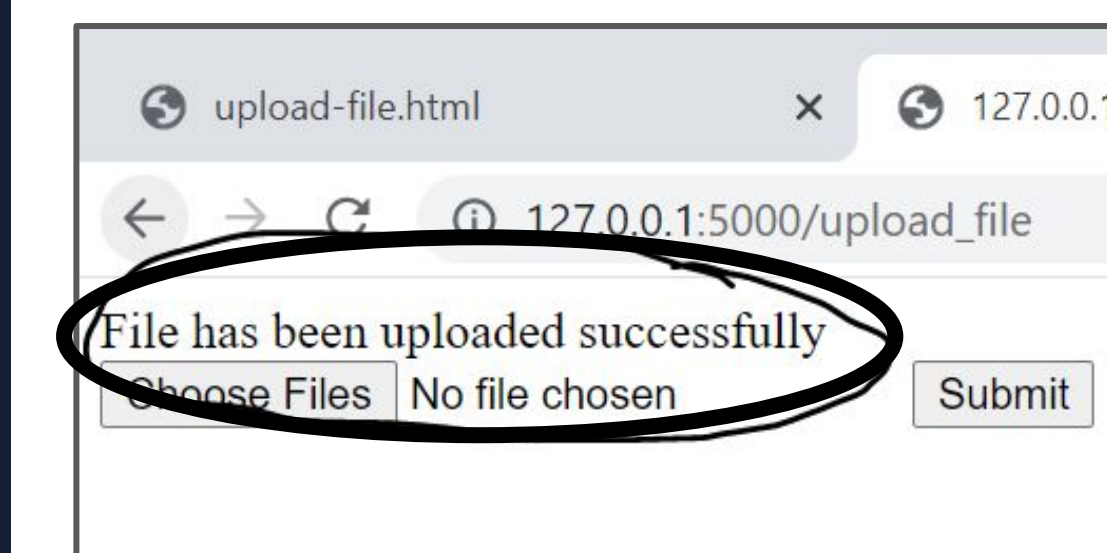


Figure 8. Upload status message after local communication (use local IP) test.

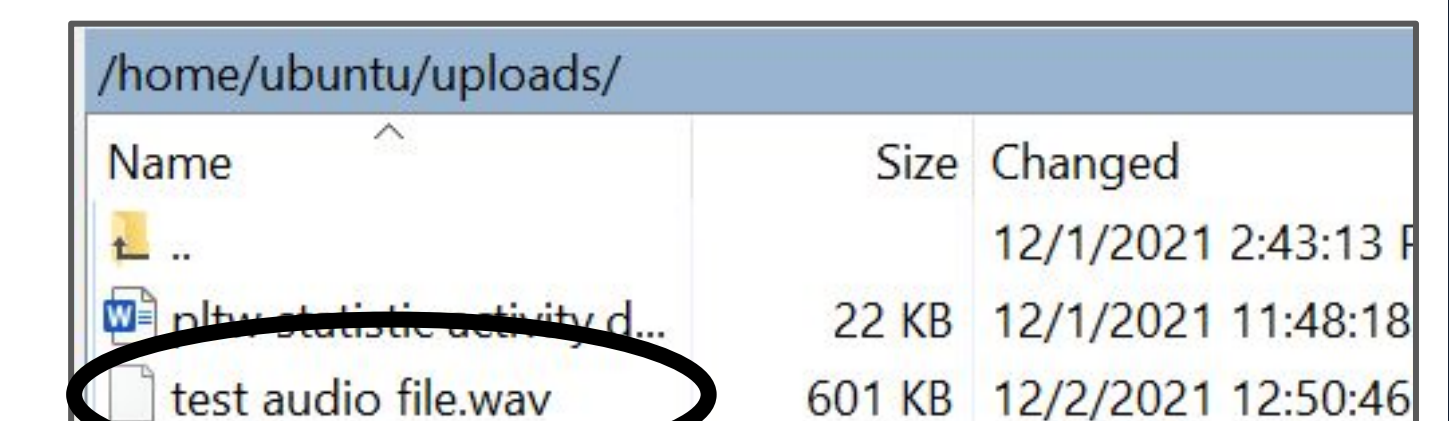


Figure 9. Successful upload of file to server.

FUTURE DIRECTIONS

Hardware:

- Finding and eliminating causes of HDMI drops and mic overheating
- Eliminate mic recording dead time
- Enhance current machine-learning model to improve acoustic analysis

Software:

- Code to automate file upload
- Schedule script to run on a specified time interval
- Test for continuous updates and mitigate data overload on edge device

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