Heart Condition Diagnosing via Machine Learning

Champagne, Matthew
matthew.champagne@stonybrook.edu

Khadka, Abiral
abiral.khadka@stonybrook.edu

Flores, Yasmin
yasmin.flores@stonybrook.edu

December 12, 2024

1 Abstract

Remote diagnosing and evaluation of heart disease problems via telemedicine are vital in monitoring and managing diseases such as coronary artery, arrhythmias, and heart failure. Traditional forms of diagnosing and managing heart related problems are proven to be dependable and useful but lack the ability to provide for a telemedicine option. The capability of providing a remote method to track and diagnose this disease can open new possibilities in making heart condition diagnosing more accessible and require less visits to the doctor' s office. In this paper we provide a new perspective on this issue that is broken down into two phases, where phase one entails of creating and evaluating a machine learning model where we can load and preprocess data into convenient data structure. While phase two involves finding capable hardware of running the model and creating an application that uses the model. Consequently, once combining these two phases with the dataset acquired from Jordan University of Science and Technology on sound data using a 3M Littman electronic stethoscope model containing 336 audio files that were annotated with the sound type and diagnosis and location on chest; our model accuracy was 85 percent and its precision was 86 percent.

2 Key Words

KEYWORDS: Machine Learning, Heart Disease, Electronic Stethoscope, Proactive Monitoring, Cardiovascular Disease Management, Telehealth

3 Introduction

yasmin to work on

4 Background and Motivation

In this section, we first provide background knowledge on the importance of monitoring heart related problems and one of the most common standard methods used in heart disease evaluation via the usage of a stethoscope. We then introduce our new approach on a stethoscope design and its limitations of directly capturing a range of datasets.

5 Importance of Monitoring Heart Related Problems

Monitoring heart disease problems is essential for early detection, effective management and prevention of serious complications. According to the American Heart Association, regular monitoring assists in identifying risk factors such as: 'diet quality, physical activity, smoking, body mass index, blood pressure, total cholesterol, blood glucose and sleep quality' [X]. In other words, regular monitoring not only allows the doctors to treat the patients' health but also make the necessary adjustments to optimize the treatment plan by considering several risk factors and improve long-term results. Ultimately, monitoring of heart health can be viewed as a proactive method in lowering heart problems while also serving as an essential method to continuously better prognose patients who already have existing heart related problems.

6 Traditional Stethoscopes

One of the main instruments in diagnosing and monitoring heart related problems is a stethoscope as seen in figure 2. This medical tool is composed of three parts: a chestpiece, tubing and a set of earpieces. It then functions by amplifying internal sounds from the body through two important elements: vibrations and sound waves [2]. It works when the chestpiece/diaphragm is placed on the patient's chest, where the heartbeat creates soundwaves that makes the chestpiece to vibrate. Where afterwards these vibrations make its way through the tubing and into the earpieces. At this point the doctor can begin to interpret the heartbeat and sounds. As shown in figure 3, there are four common breathing sounds when using a stethoscope which all can be interpreted when diagnosing heart related problems.

7 DATA COLLECTED

The sound data was collected using a 3M Littmann Electronic Stethoscope model 3200, positioned on specific chest zones divided into upper, middle, and lower sections on both the left and right sides, including anterior and posterior locations. The stethoscope transmitted sound data to a computer via Bluetooth, and the 3M Littmann StethAssist Visualization software was used to extract recordings in .wav format. The recordings were filtered through three modes (Bell, Diaphragm, and Extended) to emphasize different frequency ranges and highlight specific sound profiles.

The dataset contained 112 participants aged 12 to 90 years including 43 females and 69 males. Among these, 35 were healthy, while 77 had respiratory conditions such as asthma (32), pneumonia (5), COPD (9), bronchitis (3), heart failure (21), lung fibrosis (5), and pleural effusion (2). Each participant contributed a single recording lasting 5 –30 seconds from specific chest zones. The data files included annotations detailing health conditions, sound types, chest zones, and demographic information, making this dataset a valuable resource for developing algorithms for detecting and diagnosing pulmonary diseases.

[2]

References

[1] Emelia J. Benjamin, Paul Muntner, Alvaro Alonso, Marcio S. Bittencourt, Clifton W. Callaway, April P. Carson, Alanna M. Cham-

Figure 1: Levelized cost of energy production by method of generation. [1]

berlain, Alexander R. Chang, Susan Cheng, Sandeep R. Das, Francesca N. Delling, Luc Djousse, Mitchell S.V. Elkind, Jane F. Ferguson, Myriam Fornage, Lori Chaffin Jordan, Sadiya S. Khan, Brett M. Kissela, Kristen L. Knutson, Tak W. Kwan, Daniel T. Lackland, Tené T. Lewis, Judith H. Lichtman, Chris T. Longenecker, Matthew Shane Loop, Pamela L. Lutsey, Seth S. Martin, Kunihiro Matsushita, Andrew E. Moran, Michael E. Mussolino, Martin O'Flaherty, Ambarish Pandey, Amanda M. Perak, Wayne D. Rosamond, Gregory A. Roth, Uchechukwu K.A. Sampson, Gary M. Satou, Emily B. Schroeder, Svati H. Shah, Nicole L. Spartano, Andrew Stokes, David L. Tirschwell, Connie W. Tsao, Mintu P. Turakhia, Lisa B. Van-Wagner, John T. Wilkins, Sally S. Wong, Salim S. Virani, On behalf of the American Heart Association Council on Epidemiology, Prevention Statistics Committee, and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2019 update: A report from the american heart association. *Circulation*, 139(10):e56–e528, 2019.

[2] Edwin A. Takahashi, Lee H. Schwamm, Opeolu M. Adeoye, Olamide Alabi, Eiman Jahangir, Sanjay Misra, Carolyn H. Still, on behalf of the American Heart Association Council on Cardiovascular Radiology, Council on the Kidney in Cardiovascular Disease Intervention, Council on Hypertension, and Stroke Council. An overview of telehealth in the management of cardiovascular disease: A scientific statement from the american heart association. *Circulation*, 146(25):e558–e568, 2022.