Ph.D. project, Cotutelle 2020

Diagnosis of heart disease using artificial intelligence

Diagnostic de maladies cardiaques par l'intelligence artificielle

Supervisor: Farah CHEHADE

farah.chehade@utt.fr

Université de Technologie de Troyes, Institut Charles Delaunay, M2S

1 – Context

Nowadays, heart disease is the leading cause of death in the world. It touches all ethnicities, sexes and ages, but it increases with age. Heart disease refers to complications that affect heart functions, including cardiovascular diseases, such as heart attack, arrhythmias, heart failure, or pulmonary diseases, such as acute respiratory distress syndrome. Some of these pathologies are given in Figure 1- Some types of heart disease. Heart disease has different symptoms, such as shortness of breath, chest pain, sweating and nausea. It also has several risk factors, like smoking, hypertension, diabetes and obesity. Occurrence of heart disease may lead to mortality, disabilities or functional declines. Besides the degradation of life quality, it imposes a huge burden in terms of healthcare costs. An essential strategy to overcome these heavy consequences is to anticipate the occurrence of heart disease by predicting it and diagnose it as soon as possible to provide the surveilled subject the required treatment.

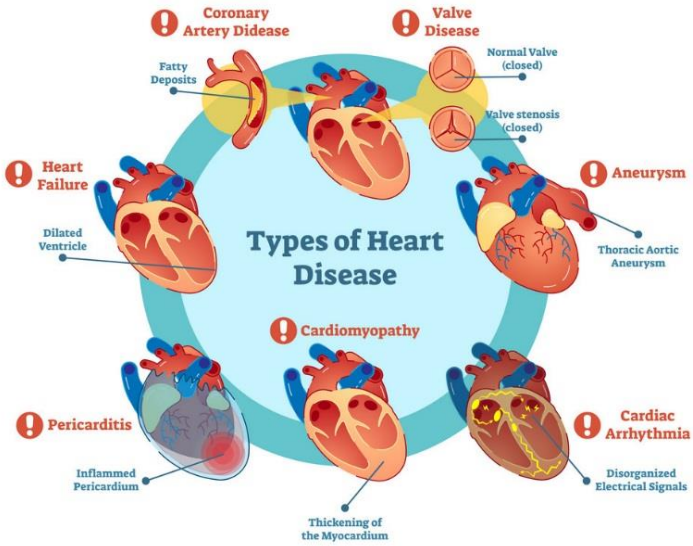

Figure 1- Some types of heart disease

2 – Objective

The objective of this Ph.D. project is to develop methods for predicting and diagnosing a set of heart diseases that are heart failure and arrhythmia. This will be done by analyzing vital signals of subjects, extracting significant information from these signals, diagnosis the current state and forecasting eventual degradation to generate an alert.

2.1 – Extracting signals and parameters

The Ph.D. student will first handle the public database MIMIC III that includes a large amount of vital records of patients having different pathologies [1]. Signals, like heart rate, respiratory rate, airway blood pressure and oxygenation saturation, will be needed from this database, to be used afterwards in surveillance [2]. An illustration of heart rate signals of a healthy subject and an ill subject is given in Figure 2- Heart rate signals of a healthy subject (at left) and an ill patient (at right).

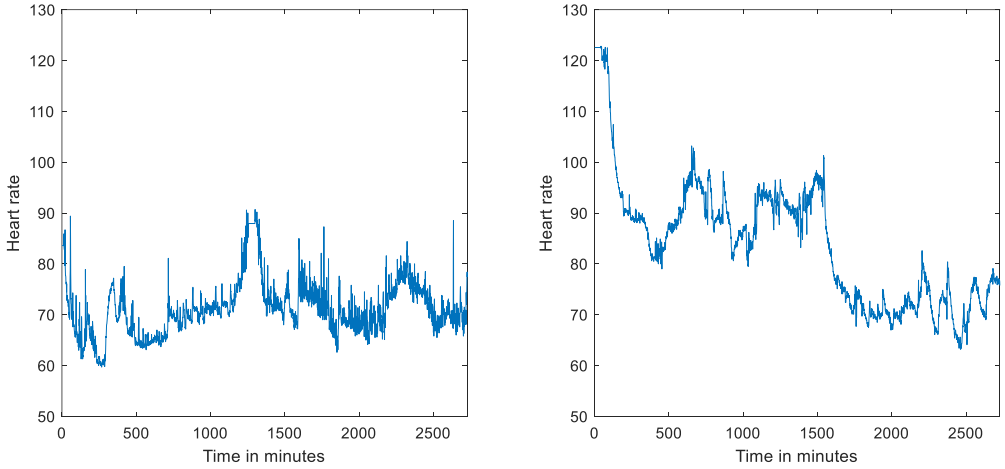

Figure 2- Heart rate signals of a healthy subject (at left) and an ill patient (at right)

The extraction of signals will be followed by an extraction of significant parameters from these signals. Parameters could be statistical, such as the mean, the standard deviation, the kurtosis, the skewness, frequency parameters, or without physical definitions, based on nonparametric methods [3], [4].

2.2 – Diagnosis and prediction of several pathologies

Having several considered heart diseases, the objective of this work is to give a diagnosis of the state of a surveilled subject and to follow its state in time in a way to predict the occurrence of future illnesses. Indeed, a patient could be at a normal state, as it might have one or more pathologies at a time. First, the objective of the Ph.D. work is to characterize the considered pathologies using the real-time extracted parameters and to develop an algorithm

for diagnosing the state of the subject, where multiple pathologies might be obtained [5], [6], [7]. It consists of developing classification methods, using machine learning, that take the parameters as input and yield the illnesses as output. Afterwards, the deep learning will be considered to model the system including the complexity of the human body. Finally, the Ph.D. student will work on developing a prediction approach by studying the evolution of the state of the surveilled subject, based on dynamic processing. This part of the study allows the prediction of future illnesses and the remaining time for the patient state to reach them. An alert, for the doctor, is then generated to take care of the patient.

Bibliography

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