

Pregnancy Detection with Machine Learning using Traditional Chinese Medicine Pulse Palpation Diagnosis

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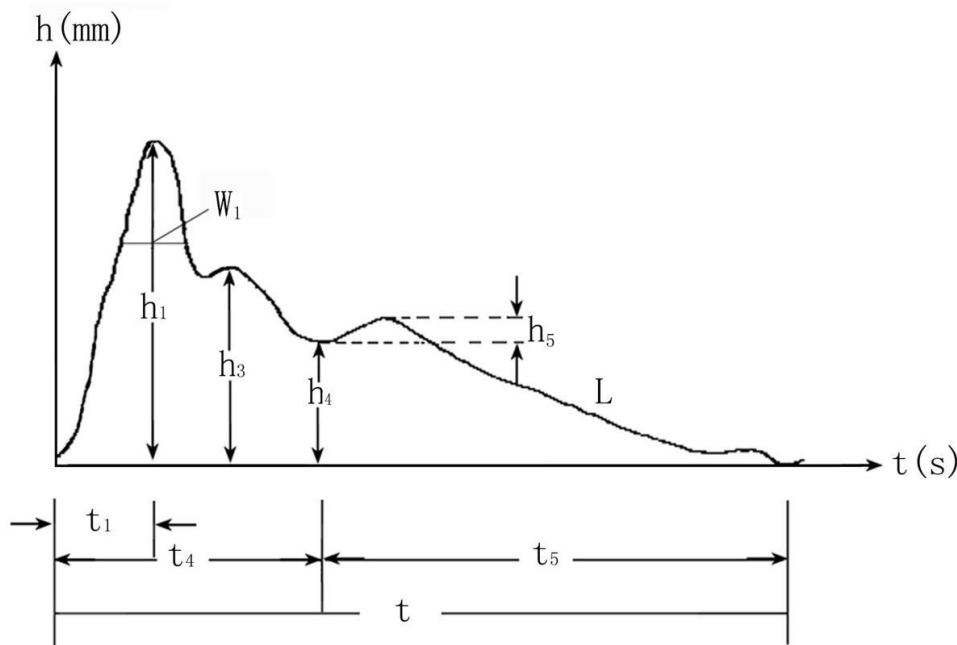
Introduction

Traditional Chinese Medicine (TCM) is based on the cumulation of over two thousand years' worth of traditional medicinal practices, including various forms of herbal medicine, acupuncture, dietary therapy, pulse palpation, and more. Because TCM is not based on scientific knowledge, practitioners often have differing opinions on diagnoses and treatments. Thus, it is fundamentally important to determine whether TCM practices have scientific explanations or evidence.

There are five diagnostic methods in TCM: inspection, auscultation, olfaction, inquiry, and palpation. Among them, palpation is the only method which involves direct contact with the body, and serves a critical role in TCM. Pulse palpation involves examining the pulse on the radial artery of a patient's wrist. The pulse is observed for several characteristics, including rhythm, strength and volume. There is no equipment for such measurements; they are taken instinctively by TCM doctors. In TCM, no quantitative ways exist to record and characterize pulse waves and their features, so pulses are described with only phrases expressing the feeling of the pulse, such as "slippery pulse", "floating pulse", "bolstering-like pulse", "feeble pulse", and "thready and quick pulse," where each of these feelings indicate certain disease patterns. Problematically, doctors often disagree on the diagnosis of the same pulse. Due to the inability to reach a consensus in many cases, it is very difficult to record and characterize pulses repeatedly. Learning proper TCM pulse diagnosis can take several years.

The pulse itself contains very rich features, and it is not impossible for those features to reflect information about the human body. In recent years, many Chinese research organizations have developed pulse measurement instruments, the first in TCM history, enabling a quantitative observation of pulse waves. A standardized method of characterizing pulse waves involves recording the heights of the peaks in the wave as well as the lengths of time between each peaks.

[Figure 1] *Patterns and characteristics of a TCM pulse wave.*



An issue that naturally follows is question of whether these quantitatively recorded pulse waves and extracted parameters are related to the diagnostic expressions such as “slippery pulse” or “floating pulse,” and further, whether they are related to the medical conditions of the patients as claimed in TCM. Unfortunately, simply extracting these parameters is not sufficient evidence for TCM claims.

Similar to pulse waves, in Western medicine, ECG measurement has been used to diagnose medical conditions extensively. Detecting irregular heart rhythms, so called arrhythmias, from ECG records has traditionally been challenging for computer systems, with accuracy rates ranging from 50% to just 1 in 7 correct diagnoses. Thus, arrhythmia detection is usually performed by expert technicians and cardiologists. Recently, however, computer scientists at Stanford have developed a [model](#) which can diagnose irregular heart rhythms from ECG wave signals while outperforming human cardiologists. To automatically detect heart arrhythmias in an ECG, an algorithm must discern the complex relationships between them over time. This is difficult due to the variability in wave morphology between patients as well as the presence of noise. The newly developed model can identify 12 different heart arrhythmias, sinus rhythm, and noise, for a total of 14 output classes.

Following the example of the arrhythmia detection model, it is possible that machine learning may be capable of classifying and distinguishing subtle differences in pulse waves and correlate these differences with a patient’s medical condition. In this paper, we use a machine learning approach to identify pregnancy based on pulse waveforms. Pregnancy is one of the popular

conditions that TCM claims can be determined through pulse palpation, but it is yet to be proved scientifically. The raw pulse data was recorded from a women and children's hospital, using pulse recording instruments from SMF Science and Technology Ltd, where the measuring device, a pressure detector, was wrapped around the patient's wrist.

[Figure 2] *Commercial equipment used to measure pulse waves.*

