On the Development of a Tool for Tongue Images Analysis

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***Abstract*—Artificial intelligence is currently being used for medical image analysis in various fields, and particularly for organ and injury segmentation, disease detection and classification, and to assess response to treatment. In this paper we refer about the development of a software module that is in charge of analyzing tongue images in order to support the identification of specific disease. The module extends the system SIMPATICO 3D.**

***Index Terms*—Health Data Management, Images Analysis**

I. Introduction

AI is undoubtedly a major frontier in the general healthcare domain. Techniques for data analysis [20], [21], as well as methods for image analysis (generally based on Machine Learning (ML) and Artificial Intelligence (AI)), have been provided in the literature [24], [25] and are extensively used in medical information tools for data prediction and diagnostic procedures [2], [4], [7], [9], [29], as well as in computer vision and in machine learning techniques for melanoma lesions characterization and features detection [10], [11], [13], [15], [23], [29]. Artificial intelligence is currently being used for medical image analysis in various fields, and particularly for organ and injury segmentation, disease detection and classification, and to assess response to treatment.

Automated segmentation, which determines the boundaries of an organ or lesion, is a fundamental application of artificial intelligence that allows physicians to reduce or totally eliminate the burden of manual execution [25]. Efficient and comprehensive models based on artificial intelligence that allow automatic segmentation of tongue images and the extraction of relevant features will therefore find great clinical utility. Manual labeling of images is a time-consuming activity, and may not be strictly necessary in clinical practice, therefore, approaches such as semi-supervised learning, multi-instance learning and transfer learning have become popular. Multiple Instance Learning (MIL) scenario is particularly useful when disposing of local annotated labels is expensive, while global labels for whole images, such as the outcome of a diagnosis, are more readily available. The MIL paradigm is particularly well suited to image classification, given that to classify an image containing an object of interest, it is necessary to examine only some sub-regions of the same image. With a MIL approach it is therefore possible to obtain global information from local one [17]. In [18], a detailed review is given concerning Multiple Instance Learning applied for medical images and video analysis, while in [19] various techniques of image classification task are reported.

In the millennial Traditional Chinese Medicine (TCM) tongue analysis is greatly taken into account and is used as an extraordinary diagnostic method for which it has been proved that correlations exist between the aspect of the tongue and the patient's health status [3], [8], [22], [30]. Tongue analysis has the advantage of deriving from a non-invasive observation, while allowing to understand the pathological changes of the body. According to the fundamental principles of reflexology, in fact, "a part reflects the whole" and "abnormal external manifestations are the reflection of diseases of the internal organs" [16]. Therefore, any observable anomalies on the tongue could be indicative of pathologies both of internal organs and related to psycho-somatic disorders [1], [5], [6], [32]–[37]. The MIL approach, as far as we know, has not been used for Tongue Image Analysis.

In this work we refer about a software module (we are currently working on), implementing the MIL approach, that is in charge of analyzing tongue images in order to support the identification of specific diseases. The module extends the system SIMPATICO 3D (Sistema Informativo Medico PATologIe COmplesse) [2], [4], [7], [9]. SIMPATICO 3D, funded under the FESR 2014/2020, is a system supporting scientists and physicians by providing facilities for case studies analysis and diagnostic imaging in a shared virtual environment. In mode details, we are applying the MIL approach to a set of tongue images in order to correlate the features of the tongue to the patient's condition also in the case of COVID-19. As regards the COVID-19 specific disease the idea stems from the work in [14], [26]–[28] in which a database of COVID-19 patients (established by the Center for Evidence-Based Medicine of the Tianjin University of TCM) accompanied by images of the tongue is examined. Tongue images are inspected by TCM experts to extract features related to tongue color, lining color, tongue body shape, and lining texture. The study correlates the features of the tongue and the COVID-19 patient's condition. Patients with mild and moderate COVID-

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19 diagnoses commonly had light red tongue and white coating, while more severe patients had purple tongue and yellow coating. The authors highlighted that the fatty coating is a significant feature of patients with COVID-19. As the disease worsens, a proportional increase in the fatty coating can be appreciated and is evaluated in 53.3%, 73.3%, 83.6% and 87.5% in correspondence with stages of the mild, moderate, serious and critical.

Concluding, tongue features are correlated with many different diseases and, recently, research evidences a correlation to the stage of progress of COVID-19. The Tongue Module is under development with the final aim of examining relevant features to support clinicians in evaluating patient's condition and prognosis.

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