

Chapter 32

Development of an Automated Decision Support System for Diagnosis of Digestive Disorders Using Electrogastrograms: An Approach Based on Empirical Mode Decomposition and K-Means Algorithm

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ABSTRACT

The disorders of the digestive tract lead to various problems such as bleeding, bloating, nausea, etc. In order to diagnose various digestive abnormalities, the electrogastrograms (EGG) can serve as an efficient tool. In an EGG, several electrodes are placed onto the abdomen over the stomach and the electrical signals originating from the stomach muscles are recorded. By analyzing these electrical patterns, the abnormalities in digestive system can be analyzed. This chapter describes the developed system for measuring EGG signals along with the decision support system developed for automated classification of digestive disorders. The normal and abnormal EGG signals were acquired at Balaji Medical Hospital, Chennai. Further, the features were extracted using descriptive statistics and empirical mode decomposition (EMD) algorithm. Finally, an automated classification system was developed using k-means algorithm. This chapter explains the recording of electrogastrograms and a method for classification of normal and abnormal EGG signals.

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INTRODUCTION

The digestive system consists of the digestive tract, a tube extending from the mouth to the anus, and its associated accessory organs, primarily glands, which secrete fluids into digestive tract (Tortora & Derrickson, 2008). The function of digestive system includes: Ingestion, mastication, propulsion, mixing, secretion, digestion, absorption and elimination. Digestion is a multistage process in which food is broken down and nutrients are absorbed (Paramasivam, Rajagopal, & Krishnamurthy, 2016). Digestive system is highly interconnected since disorder in digestive system affects other systems.

Digestive diseases are disorders of the digestive tract and problems in the digestive tract include several symptoms like heartburn, nausea, vomiting, bleeding, bloating, diarrhea, constipation etc (Alagumariappan, Krishnamurthy, Kandiah, & Ponnuswamy, 2017). The clinical pattern of digestive diseases differ in different parts of the world and even vary from area to area in the same country. Racial, hereditary factors, climatic conditions, dietetic habits etc. are some of the important factors involved in the genesis of these variations (Vakil, 1960; Inoue, Iwamura, & Yoshida, 2001). Digestive diseases significantly affect millions of humans worldwide resulting in decreased quality of life. Several diagnostic techniques such as biopsy, endoscopy, ultrasound scanning, Electrogastrography etc. are used to investigate the digestive system disorders. Nowadays Endoscopy procedure is followed to investigate the problems in the digestive system disorders, which is a tedious, expensive and invasive method (Gopu, Neelaveni, & Porkumaran, 2008).

One of the primary disadvantages of ultrasound is that it is operator dependent and the accuracy of the examination is limited by the comfort level of patient and skill of the examiner. Although ultrasound can provide exquisitely detailed pictures, it is not intended to evaluate diffuse pain. Limitations of abdominal ultrasound generally are related to factors which limit transmission of the ultrasound beam. These limitations include obesity, excessive bowel gas, and barium in the intestines from recent fluoroscopic procedure. Obese patients are more difficult to image by ultrasound because greater amounts of tissue attenuate (weaken) the sound waves as they pass deeper into the body.

Electrogastrography is an efficient and noninvasive alternative for diagnosis of digestive disorders. EGG signals are electrical activity generated by the stomach (Alagumariappan, Krishnamurthy, Kandiah, & Ponnuswamy, 2017; Yin & Chen, 2013; Ding, Qin, Miao, Xi, Li, & Wang, 2010). The EGG signals are measured by placing cutaneous electrodes onto the abdomen over the stomach (Alagumariappan, Krishnamurthy, Kandiah, & Ponnuswamy, 2017). The features of the EGG signals of normal individuals differ when compared to the features of the signals obtained from human subjects with digestive abnormalities (Gopu, Neelaveni, & Porkumaran, 2008; Paramasivam, Rajagopal, & Krishnamurthy, 2016). By analyzing such features, various digestive diseases such as Gastroesophageal Reflux Disease (GERD), Diabetic Neuropathy, Anorexia Nervosa, Idiopathic Gastroparesis, Motion Sickness, Pan Gastro Neoplastic Syndrome, Bradygastria, Tachygastria, Functional Dyspepsia, Epigastric Pain Syndrome etc can be diagnosed. Electrogastrogram is a low cost, painless method and is an initial mode of investigation for gastric disorders before encouraging the Endoscope procedure for uncomplicated gastric disease and benign tumors.

Several electrodes such as wet electrodes, gelled electrodes, dry electrodes etc. are commonly used for acquisition of biological signals (Neuman, 1998). The silver/silver chloride (Ag/AgCl) electrodes are most commonly used cutaneous electrodes since it provides stable recordings for various physiological measurements even at low voltage and low frequency signals (Alagumariappan, Krishnamurthy, Kandiah, & Ponnuswamy, 2017). The Ag/AgCl electrodes are disposable and the recordings are highly optimal.

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