

Chapter 3.8

Neural Networks in Medicine: Improving Difficult Automated Detection of Cancer in the Bile Ducts

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ABSTRACT

Automatic detection of tumors in the bile ducts of the liver is very difficult as often, in the defacto non-invasive diagnostic images using magnetic resonance cholangiopancreatography (MRCP), tumors are not clearly visible. Specialists use their experience in anatomy to diagnose a tumor by absence of expected structures in the images. Naturally, undertaking such diagnosis is very difficult for an automated system. This chapter

proposes an algorithm that is based on a combination of the manual diagnosis principles along with nature-inspired image processing techniques and artificial neural networks (ANN) to assist in the preliminary diagnosis of tumors affecting the bile ducts in the liver. The results obtained show over 88% success rate of the system developed using an ANN with the multi-layer perceptron (MLP) architecture, in performing the difficult automated preliminary detection of the tumors, even in the robust clinical test images with other biliary diseases present.

DOI: 10.4018/978-1-60960-561-2.ch308

INTRODUCTION

There are a large number of algorithms and applications that have been and are actively being developed to assist in medical diagnosis. As medical problems are biological in nature, it is expected that nature-inspired systems would be appropriate solutions to such problems. Among the most popular of such nature-inspired tools is the artificial neural network (ANN), which has lent itself to applications in a variety of fields ranging from telecommunications to agricultural analysis. There is a large amount of literature on the use of ANN in medical applications. Some examples of medical systems developed employing neural networks include those for screening of heart attacks (Furlong et al., 1991) and coronary artery disease (Fujita et al., 1992), facial pain syndromes (Limonadi et al., 2006), diabetes mellitus (Venkatesan & Anitha, 2006), psychiatric diagnosis (NeuroXL, 2003), seizure diagnosis (Johnson et al., 1995), brain injuries (Raja et al., 1995), and many more.

There is an increasing number of cancer cases in most countries, with an increasing variety of cancers. Over the years, ANN has been actively employed in cancer diagnosis as well. ANN systems have been developed for cancer of the breast (Degenhard et al., 2002), skin (Ercal et al., 1994), prostate (Brooks, 1994), ovaries (Tan et al., 2005), bladder (Moallemi, 1991), liver (Meyer et al., 2003), brain (Cobzas et al., 2007), colon (Ahmed, 2005), lung (Marchevsky et al., 2004), eyes (Maeda et al., 1995), cervix (Mango & Valente, 1998) and even thyroid (Ippolito et al., 2004). ANN has also been used for cancer prognosis and patient management (Naguib & Sherbet, 2001).

Although there has been extensive development of ANN systems for medical application, there are still many more diagnostic systems for diseases and organs that would be able to gain from this nature-inspired technology. This chapter proposes a multi-stage nature-inspired detection

scheme that mimics the radiologist's diagnosis strategy, where most of the algorithms employed are themselves nature-inspired. The scheme is augmented with the nature-inspired neural networks to improve the system performance in tackling automatic preliminary detection of a difficult and much less researched set of tumors affecting the bile ducts, using the defacto diagnostic imaging technology for the liver and pancreato-biliary system.

BACKGROUND

Bile is used in the digestion and absorption of fat-soluble minerals and vitamins in the small intestines. In addition, it also has the function of removing soluble waste products from the body, including cholesterol. Diseases affecting the biliary tract cause distension (swelling) in the bile ducts, blockages, swelling of the liver and build up of toxic waste in the body, which can be fatal. Tumor of the bile ducts, medically known as cholangiocarcinoma, is the second most common primary malignant tumor of the liver after hepatocellular carcinoma and comprises approximately 10% to 15% of all primary hepatobiliary malignancies (Yoon & Gores, 2003). The incidence of this disease has been on the rise in recent decades (Patel, 2002). It is highly lethal as most tumors are locally advanced at presentation (Chari et al., 2008). These tumors produce symptoms by blocking the bile duct, often seen in clinical diagnosis as clay colored stools, jaundice (yellowing of the skin and eyes), itching, abdominal pain that may extend to the back, loss of appetite, unexplained weight loss, fever, chills (UCSF, 2008) and dark urine (Chari et al., 2008).

The clinical diagnosis of the biliary tumor depends on appropriate clinical, imaging, and laboratory information (Yoon & Gores, 2003). Generally, after taking the medical history and performing a physical examination, the doctor would order one or more tests to get a better view

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