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DESIGN OF A NEURAL NETWORK BASED CERVICAL CANCER DIAGNOSIS SYSTEM: A MICROCONTROLLER APPROACH

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ABSTRACT

Cervical cancer is the second most common type of cancer that affects women, ranked after breast cancer. In Malaysia, there is a shortage of pathologists that can diagnose the disease. Therefore, automated or semiautomated diagnosis systems are needed to overcome this shortage. In this study, a neural network based cervical cancer diagnosis system using microcontrollers is proposed. The current study proposes a hybrid neural network, known as the Hybrid Multilayered Perceptron (HMLP) network, to process the input features for diagnosis. The Modified Recursive Prediction Error (MRPE) algorithm is used as a training algorithm for the HMLP network. The Intel 8051 microcontroller is used as the brain of the system. The developed system is used to test a total of 202 sets of input features obtained from patients. Prior to the testing, medical experts have classified the data, based on their diagnosis, into 2 categories: normal and abnormal. The experts' diagnosis will be used as a standard to grade the suitability of the system. The suitability of the system is determined by five criterias, namely accuracy, sensitivity, specificity, false negative and false positive. After testing, it is discovered that the system achieved 100% accuracy, sensitivity and specificity values. There are 0% of false negative and false positive cases. This shows that the diagnosis of the system matches exactly to that of the medical experts.

INTRODUCTION

Cervical cancer is the second most common type of cancer that affects women, ranked after breast cancer. Most women with cervical cancer experience a long

asymptomatic period before the disease becomes clinically evident (Canavan Doshi. 2000). It is important that the disease is detected early to prevent it f becoming lethal. In Malaysia, there is a shortage of pathologists that diagnose the disease. Therefore, there is a need for automated or semiautom diagnosis systems to be developed. This study proposes a microcontroller-ba cervical cancer diagnosis system that utilizes the Hybrid Multilayered Percept (HMLP) network, a form of neural network.

METHODS

The main component of the designed system is the 8051 8-bit microcontrolle Four parameters will be used as the input to the system, namely nucleus size cytoplasm size, nucleus greylevel and cytoplasm greylevel. These parameters ar extracted from cervical cell samples of patients. The HMLP network, utilizing the Modified Recursive Prediction Error (MRPE) training algorithm, is used to process these inputs. This network is then integrated to the system before processing the above-mentioned inputs. After processing, the output of the network is obtained. The output of the network is the classification of the cell type, that is whether the cell is normal or abnormal.

HYBRID MULTILAYERED PERCEPTRON NETWORK

A hybrid multilayered perceptron (HMLP) is an enhanced version of the multilayered perceptron (MLP) network. The proposed network allows network inputs to be connected directly to the input nodes via some weighted connections to form a linear model in parallel with the nonlinear, original MLP model (Mashor 2000).

A HMLP network with one hidden layer is shown in FIGURE 1. HMLP network with one hidden layer can be expressed by the equation (1) (Mashor 2000).

$$\hat{y}_k(t) = \sum_{j=1}^{n_h} w_{jk}^2 F\left(\sum_{i=1}^{n_i} w_{ij}^1 v_i^0(t) + b_j^1 \right) + \sum_{i=0}^{n_i} w_{ik}^2 v_i^0(t) \qquad (1)$$

for $1 \le k \le m$

where w_{ij}^1, w_{jk}^2, w_{ik}^2 denote the weights between input and hidden layer, weights between hidden and output layer, and weights between input and output layes respectively. b_j^1 and v_i^0 denote the thresholds in hidden nodes and inputs that are supplied to the input layer respectively. F(.) is an activation function. A sigmoid function is normally selected as the activation function.

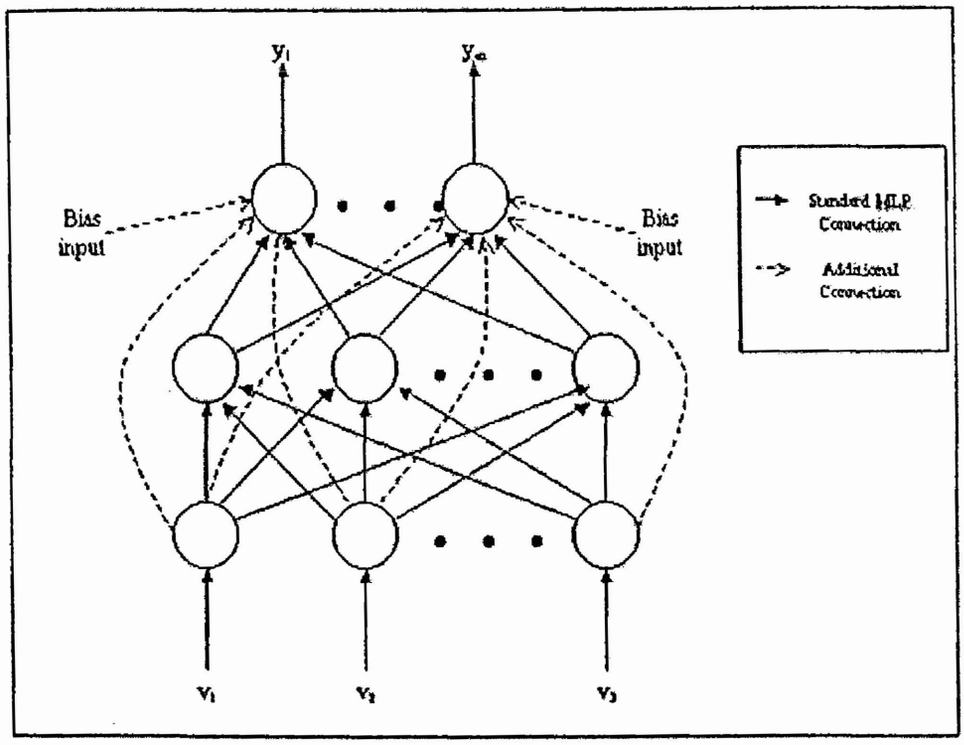

FIGURE 1: Hybrid Multilayered Perceptron Network

MODIFIED RECURSIVE PREDICTION ERROR ALGORITHM

The Modified Recursive Prediction Error Algorithm is used as the training algorithm of the HMLP network. It is based on structured learning error correction and is a modified version of the Recursive Prediction Error Algorithm (RPE). It converges at a smaller MSE value and has a faster convergence rate compared to its predecessor (Mashor 1999). More information on this algorithm can be obtained in studies conducted by Mashor (1999 and 2000).

SYSTEM DESIGN

For this study, the 8051 microcontroller is used as the main component for mathematical computations and interface purposes. The 8051 is chosen because of its availability and affordability. A 16x2 matrix LCD is interfaced to the microcontroller to display the result of the diagnosis to users. A 4x3 keypad is used as an input of the features into the system. Other peripherals that are interfaced with the microcontroller include memory, latches, multiplexers and

other electronic components. The main components of the system are shown in FIGURE 2.

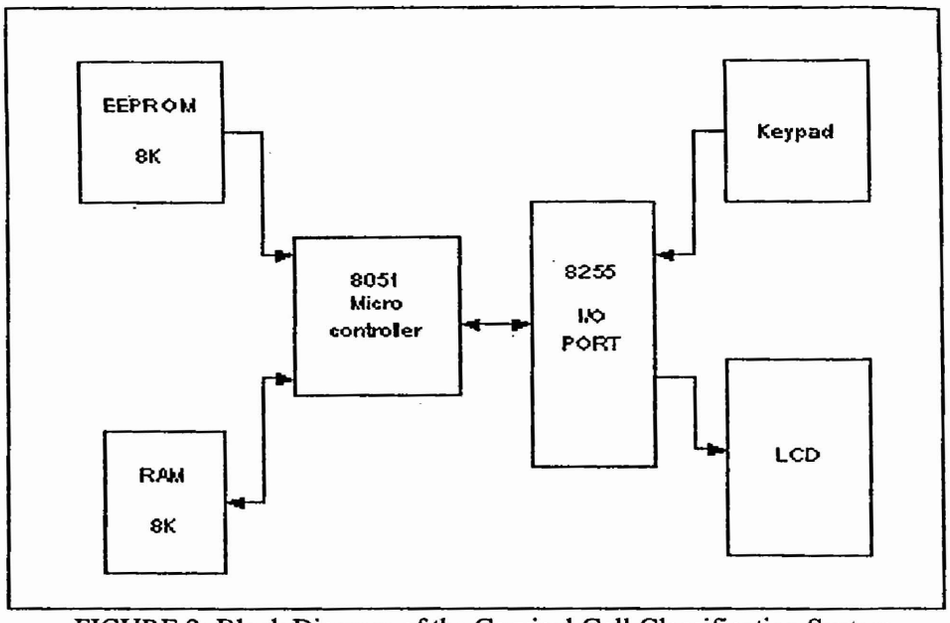

FIGURE 2: Block Diagram of the Cervical Cell Classification System

The system is also designed to be portable, therefore it has a dimension of around 17 x 10 x 5 centimeters.

RESULTS

In an experiment to determine the suitability of the device, a total of 202 sets of input parameters are obtained from patients. Prior to the testing, medical experts have classified the data, based on their own diagnosis, into normal and abnormal categories. The experts' diagnosis will be used as the standard to grade the suitability of the system. The suitability itself is determined by five criteria, namely accuracy, sensitivity, specificity, false negative and false positive. After inputting the parameters into the system and observing its outputs, it is discovered that the system managed to achieve 100% accuracy, sensitivity and specificity values in differentiating cells between normal and abnormal categories. There is no false negative or false positive case.

CONCLUSION

As a conclusion, the cervical cancer diagnosis system performed admirably in classifying the 202 sets of data obtained from patients. In the future, testing will be done for more sets of data to further confirm the suitability of the system in the medical field.

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