Intelligent Embedded Health Care Seat Cushion of Vision Robot Design by Fuzzy Neural Network

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ABSTRACT: *In this paper, two sensors which are pressure sensor and infrared sensor are used. These sensors are mounted on the seat cushion of vision robot, respectively such as to get data of pressure and distance with back of cushion. At first, the signal is sent to the microprocessor (MCU) to do fuzzy inference then to decide whether the human should leave the chair or not. It can let patient to avoid sitting for a long time or bad posture and other issues. By using pressure sensor, if the sitting time is longer than the threshold time then the system will generate a warning signal. By using the Infrared sensor, if the distance is measured too far then it means the patient has bad posture, the system will also produce a signal to remind patient to change his sitting position. This is a two input one output intelligent health management for health care of vision robot which is designed by fuzzy logic method such as to avoid some unnecessary false decision. The implementation results show that it possesses good commercial applications, low cost, easy to installation, high availability and huge market. This cushion of vision robot is ideal and effective and it can improve the health management for patients.*

Categories and Subject Descriptors:
I.5.1 **[Pattern Recognition Models]**: Fuzzy Set; F [**Theory of Computation**]: Neural Networks

General Terms:
Neural Networks, Fuzzy

Keywords: Seat cushion, vision robot, intelligent robots, Nueral networks

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1. Introduction

The fuzzy logic applications for health care have been developed to assess the health of the patient. The developments were developed by using fuzzy approaches since the boundaries of statuses are not sharply defined. In terms of hospital health care, the waiting list management was also another topic to which fuzzy mathematical programming has been applied. Another expert system was designed to help physicians and hospital staff in administrative, diagnostic, therapeutic, statistical, and scientific works. In this system, there are separate data-storing, health insurance supporting, and simple advisory programs [1-6]. For vision robot, it has been focused by many researchers recently, because it can be controlled by camera via Wi-Fi communication and it possessed good performances [7-9].

The design concept of this paper is to divide this concept into two parts which are the lower part and the back part of cushion of vision robot. The first part of pressure sensor is mounted on the lower part of seat cushion of vision robot, the second part is back issues. By applying of

pressure sensor to start the timer and distance measurement of infrared through fuzzy logic programming operation, it is easy to implement and production. This is the reason for this design of seat cushion management. The design method is with two inputs and one output fuzzy logic inference which can avoid some unnecessary false alarms.

1. Preliminary of ANFIS

In this paper, the fuzzy neural network is utilize the adaptive network fuzzy inference system (ANFIS). The ANFIS uses a hybrid learning algorithm to identify the membership function parameters to generate Sugeno type fuzzy inference systems (FIS). It uses the method of combination of least-squares and backpropagation gradient descent methods to train FIS membership function parameters to model a given set of input/output data. The principle of ANFIS is briefly described as follows: [10].

$$\begin{aligned} &R_i : If\ x_1\ is\ A_{i1}\ \ ...and\ x_n\ is\ A_{in} \\ &then\ u_i = p_{i1}x_1 + .. + p_{in}x_n + r_i \end{aligned} \tag{1}$$

where R_i denotes the ith fuzzy rules, $i = 1, 2,..,r$; A_{ik} is the fuzzy set in the antecedent associated with the kth input variable at the ith fuzzy rule; and $p_{i1},..., p_{in}$, r_i are the fuzzy consequent parameters.

Based on the *weighted averaged method* of defuzzification. The output u can be calculated as

$$\begin{aligned} u &= \frac{w_1}{w_1 + .. + w_n} u_1 + .. + \frac{w_n}{w_1 + .. + w_n} u_n \\ &= \overline{w}_1 u_1 + .. + \overline{w}_2 u_n \end{aligned} \tag{2}$$

where w_i is the ith node output firing strength of the ith rule; and

$$\overline{W}_1 = \frac{W_1}{W_1 + .. + W_n} \quad \overline{W}_n = \frac{W_n}{W_1 + .. + W_n}$$

Because the fuzzy inference system is a Takagi-Sugeno type, i.e. $u_i = p_{i1}x_1 + .. + p_{in}x_n + r_i$, Equation (2) can be rewritten as

$$\begin{aligned} u &= w_1 u_1 + .. + w_n u_n \\ &= (\overline{w}_1 x_1)\, p_{i1} + .. + (\overline{w}_1 x_n)\, p_{in} + (\overline{w}_1)\, r_1 \\ &\quad + \\ &\quad \vdots \\ &\quad + (\overline{w}_n x_1)\, p_{i1} + .. + (\overline{w}_n x_n)\, p_{in} + (\overline{w}_n)\, r_n . \end{aligned} \tag{3}$$

The hybrid learning algorithm developed in [10] can be applied to Equation (3) directly. A neural network structure of ANFIS is shown in Figure 1. In the *forward pass* of the hybrid algorithm, functional signals go forward till layer 4 of Figure 1 and the consequent parameters p_{i1}, p_{i2}, r_i are identified by the *least squares estimate* (LSE) approach. In the *backward pass*, the error rates propagate backward and the premise parameters x_1, x_2 are updated by the gradient descent approach. As the values of these parameters change, the membership functions vary accordingly; thus exhibits various forms of membership functions on linguistic labels A_{i1} and A_{i2}.

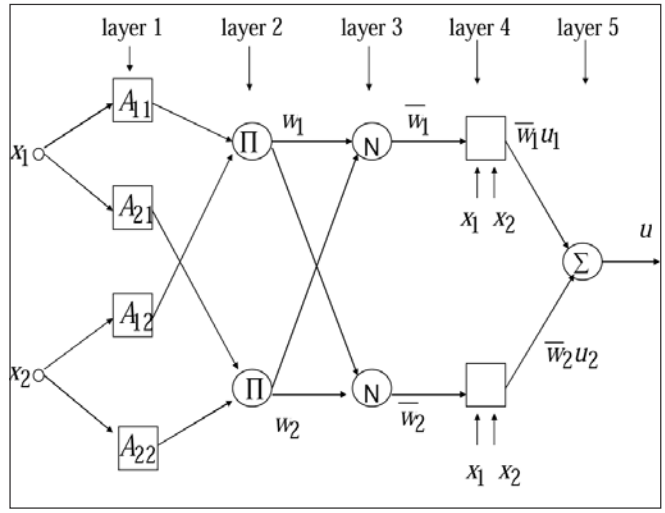

Figure 1. A two-inputs one-output ANFIS architecture

2. Implementation Results

By using MCU fetched sensor values, the fuzzy logic inference of 'if ... then ....' will construction a look-up table to grab the best value of C language program to generate output. This is the two inputs and one output control monitoring system. When an abnormal condition is sensed, it will induce program to enter the interrupt subroutine to execute lights or audible output to remind people to move a bit to avoid some diseases arising sedentary. The preliminary production diagram is shown in Fig 2. Schematic design concept of this work is shown as in Figure 3. It divided into the lower part of the back cushion of vision robot. A pressure sensor mounted on the lower cushion of vision robot, the back mount infrared sensor, the signal sent to the microprocessor (MCU) operation, generates a judgment signal is output. Just one sit down, it will start the timer, and start the infrared sensor and MCU. By MCU algorithm uses fuzzy logic to determine the coefficient of health management of Fuzzy logic, beyond a warning when the coefficient value (Threshold) will chirp or lights to alert the patient to get some activity, or seat back rest. So it can improve the patient to sit for too long not up activities, or bad posture and other issues. Application of pressure sensors start the timer, infrared distance measurement back through fuzzy logic programming operation, easy to implement and production. This is the reason for sitting cushions management, design methods with two inputs and one output fuzzy logic inference is to avoid some unnecessary false positives. MCU as the center, the front by two sensors, fuzzy algorithm produces an output when the output is higher than the critical value, and it will immediately generate a warning signal. Hardware is simple, easy to implement. Software is the C program language; it can be work after compiled programming is completed. Before writing C language; it need be simulated in order to generate fuzzy association matrix (FAM).

Fuzzy logic simulation of the work is shown in Figure 4 which is using established 'if ... .then' fuzzy rules. After the implementing of the infrared part, by using of infrared emission diode and receiver diode sensor, when the distance is within the sensing range, the red LED will be light. After combining the whole experiment, it is shown in Figure 5, in order to model the cushion of vision robot when experimental tool with MCU experiment minimum ystem board. When patient is sitting wrong, development board on the left of the green light will be light. When sitting for too long time, development board on the left of the yellow will be light. When not sitting correct, and sit for a long time, development board on the left of the green and yellow will be all light. This experimental result is completed and meets the design requirements. The prototype diagram of intelligent embedded seat cushion system is shown in Figure 6.

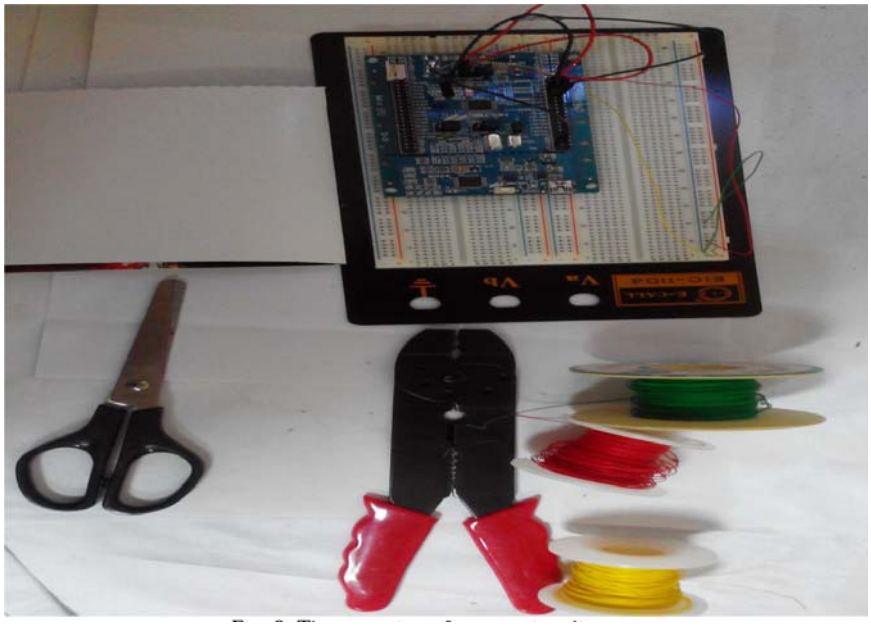

Figure 2. The operation of preparation diagram

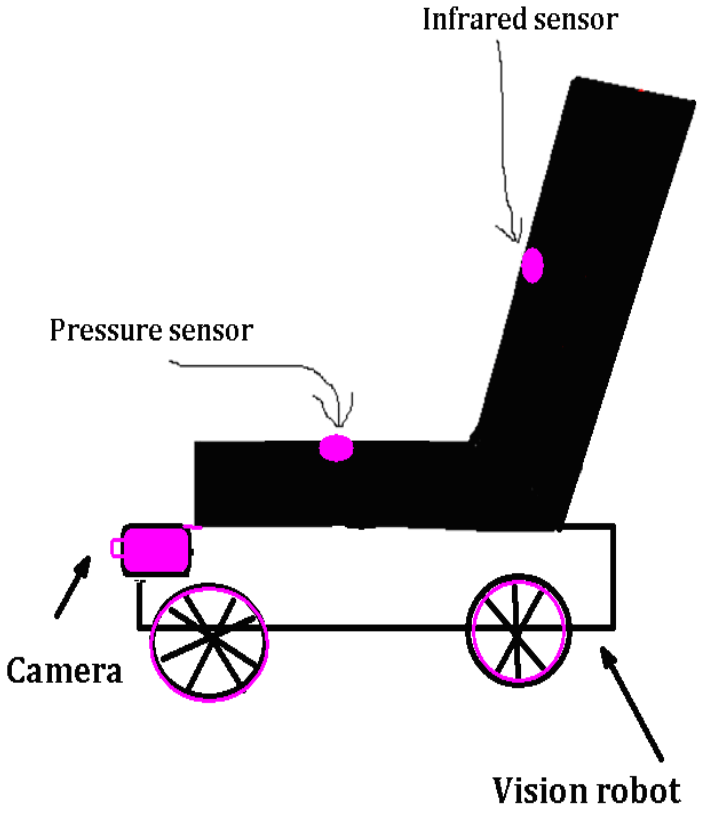

Figure 3. Intelligent healthy seat cushion of vision robot design diagram

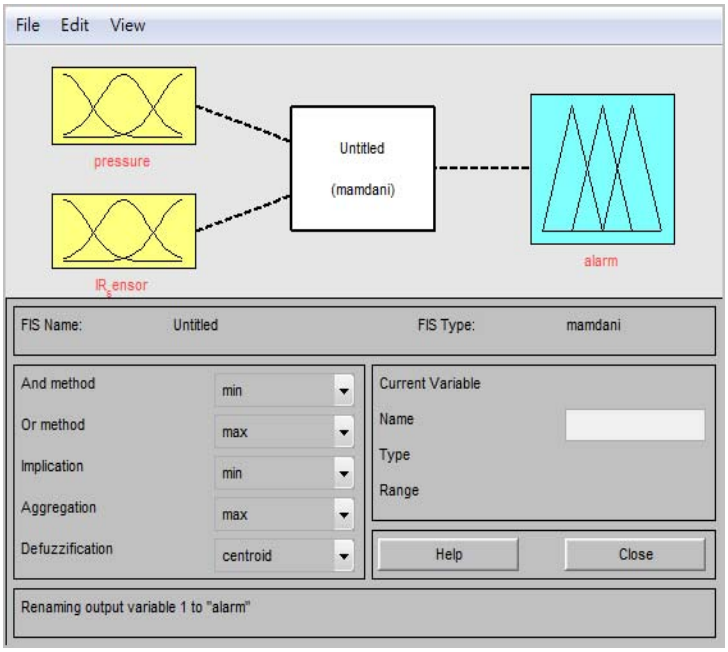

Figure 4a. Fuzzy design diagram

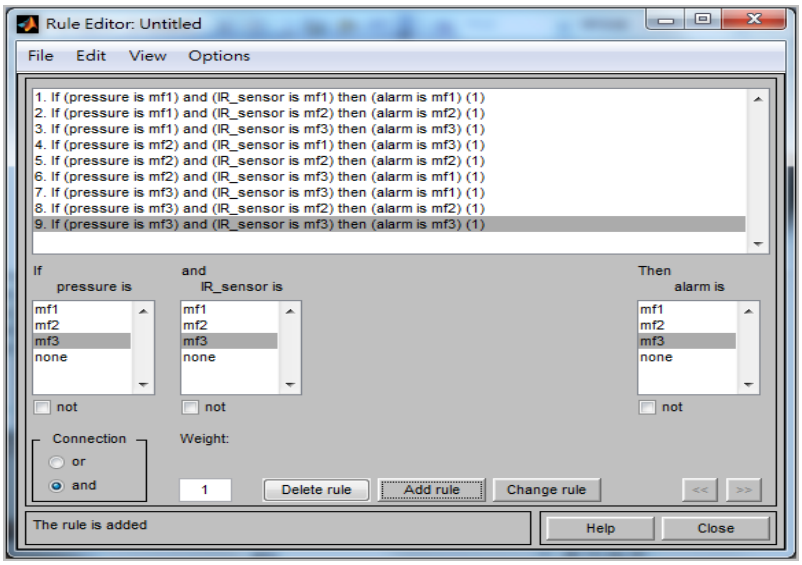

Figure 4b. Diagram of fuzzy rule

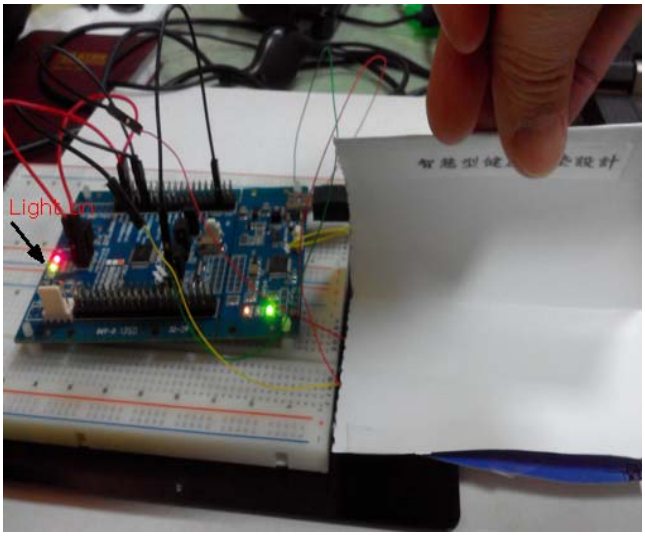

Figure 5a. Sitting wrong then the left green LED on

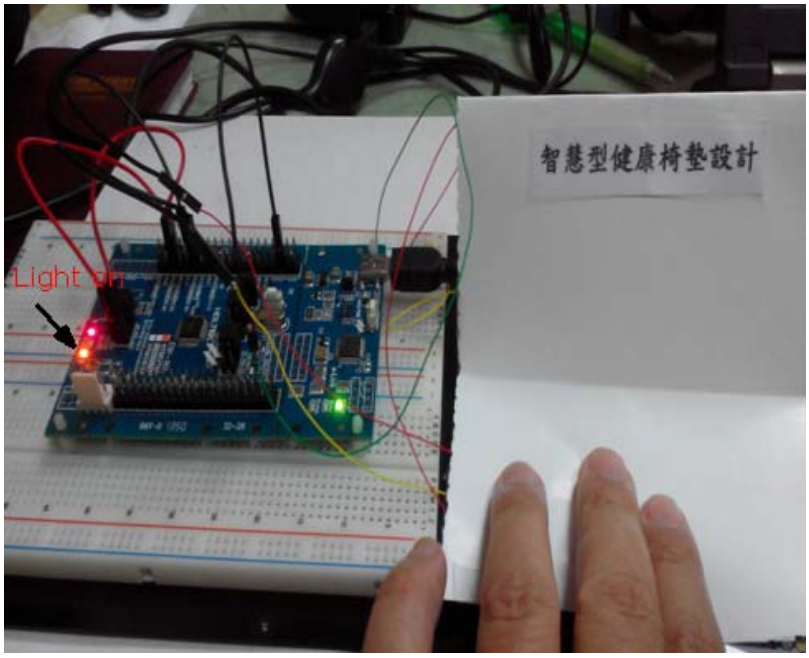

Figure 5b. long time of sitting then the left yellow LED on

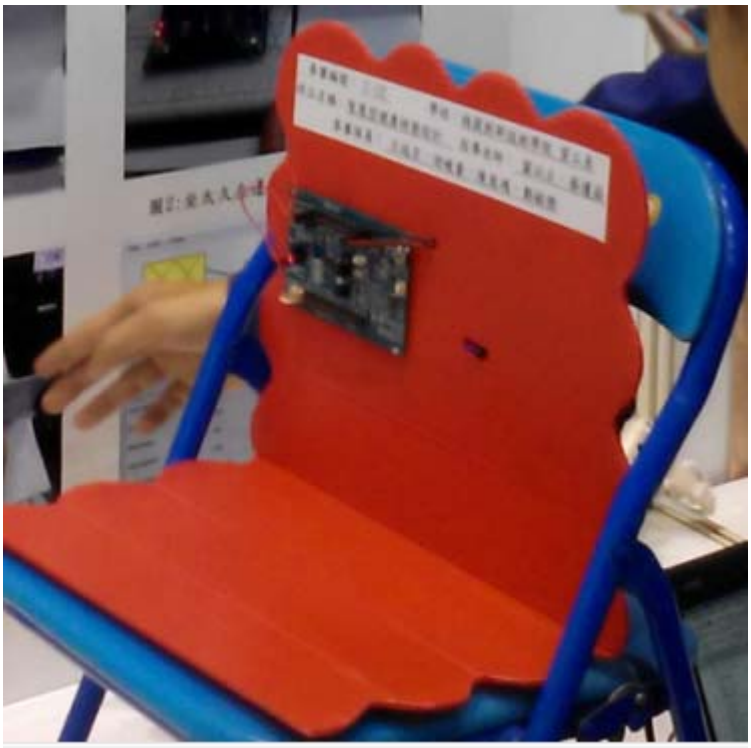

Figure 6. Prototype diagram of intelligent embedded seat cushion system

3. Conclusion

In this paper, two parts of the lower part and back part of the seat cushion of vision robot are discussed. Pressure sensor is mounted on the lower seat cushion of vision robot and back part is mounted as infrared sensor. The signal will be sent to the microprocessor (MCU) to generate a judgment signal. Just at the time of human sit down, it will start the timer of MCU and start the infrared sensor and MCU's operations. The MCU algorithm will judge the alarm signal by using health management coefficients of fuzzy logic. When it is beyond a warning coefficient value of threshold it will chirp or light to alert the patient to get some activities. So it can let the patient to avoid sit for a long time or bad posture and other issues. The applications of pressure sensors start the timer, infrared distance measurement back through fuzzy logic programming operation, it is easy to implement and has easy production. This is the reason of this paper design for sitting cushion of vision robots management. This design method is with two inputs and one output of fuzzy logic inference to avoid some unnecessary false alarm signals. By implementing in development board of MCU, it presents the experimental results are satisfied and

possess good performances.

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