Human Touch Behaviour Recognition Based On Neural Networks

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ABSTRACT

The present study describes, the method of recognising human touch behaviours for developing a robot that can naturally interact with humans through touch. In this the recognising process is divided into pre -process phase and recognition phase process. In the former one, the recognisable characteristics are calculated from the data generated by the touch detector which is fabricated using fine touch-z rather than force sensing registers which is already been used. In fine touch-z, a multi touch input device which detects pressure using a resistive touch technology which is simple and widely available. The recognition phase classifies human touching behaviours using a multilayer perceptron which is a neural network model. In this work we measure three different human touching behaviours such as for hitting, stroking and tickling. The technology which is being used is completely touch dependent. In fine touch-z technology when the user touches the display, electric current flows in accordance with the touch applied pressure in the direction of z-axis in the transparent pressure sensitive ink layer and by detecting that current, the sensor feels the coordinates and the strength of the pressure of the touch. The test conducted recognises generated for each user, the average recognition rate was 93.8% while the test conducted with the single recognizer showed a 79.8% average recognition rate. These results show the feasibility of the proposed human touching behaviour recognition method.

KEYWORDS: *Neural network, multilayer perceptron, fine touch-z, resistive touch, touch recognition.*

I. INTRODUCTION

Reviewing the development of robotics, the trend is moving towards robots which provides humans with emotional relief. The Interactive technologies between humans and robots have also been extended from sound and image recognition to natural interaction. The touch sensors being currently developed for the purposes are the axis and three axis touch sensors which are in the film shape. Recently the touch sensors have been developed to enable interaction between humans and robots through touching behaviours. Human touching behaviours are recognised using the

MLP(multilayer perceptron) which is a neural network. They are defined into nine behaviours namely tickling, poking, scratching, slapping, petting, patting, rubbing, squeezing and contact. These behaviours were recognised via the six characteristics including the strength of touching, the direction of movement, and the change of direction of the movement at the contact surface. As for the characteristics by which the neural network model can classify touching behaviours, nine variables maximum force, time elapsed to reach maximum force, contact time, contact frequency, average distribution of force, average force, maximum contact area, maximum distance between the two points in the contact area, and the direction of the contact area movement are calculated. This paper suggest a human touching behaviour recognition method that will enable robots to form emotions in accordance with the touching behaviours of humans.

II. MULTILAYER PERCEPTION

It is a feed forward artificial neural network model that is responsible for sensing touch behaviours of humans. An MLP consists of multiple layers of nodes in a directed graph , with each layer fully connected to the next. MLP uses a supervised learning technique called “Back propagation for training the network. MLP is a modification of the standard linear perceptron and distinguishes data that is not linearly separable. It consists of three or more layers of nonlinearly-activating nodes and is thus considered as a deep neural network . Since MLP is a Fully connected network, each node in one layer connects with a certain weight φij to every node in the following layer . Some people doesnot consider the input layer while counting the number of layers and there is a disagreement in the weights that aare considered normally from i to j or other way.

Applications of MLPs are diverse in various fields such as Speech recognition , image recognition , touch recognition and machine translation software.

III. BACKPROPAGATION ALGORITHM

Learning occurs in the perceptron by changing connection weights after each piece of data is processed , based on the amount of error in the output compared to the expected result. It is an example of a supervised learning , and is carried through backpropagation , a generalization of the least mean squares algorithm in the linear perceptron.

IV. FINE TOUCH Z TECHNOLOGY

In this technique we can touch as well as write on a single sensor. It has a passive stylus , that is it does not require any additional electronics, no additional conducive parts are needed and no rubber tip. This is a multi-touch technology, which allows the many touch inputs. It is the first pressure based touch sensing solution that can compete with the projected capacitive touch screens .It uses smart detection technique.

V. EXISTING METHOD

The touch detectors in this method uses force sensors which have a pillars and contact area made up of thin plastic plate with dimensions 13.5cm*8.5cm*1mm as shown in the figure.

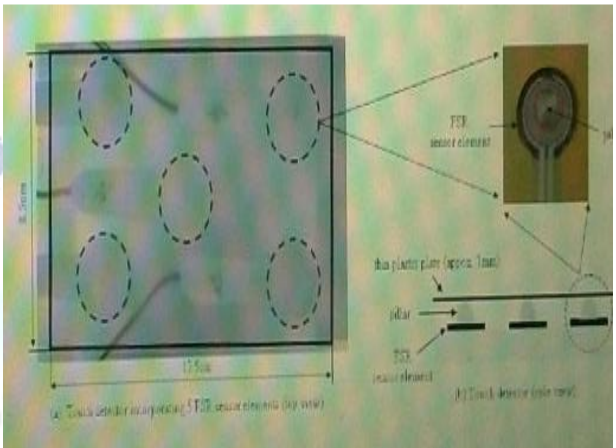

Fig. 1. Touch detector using FSR sensor elements

Underneath the contact area 5FSR. Sensing element on which 4mm pillars support the plastic plate. Pillars and plastic plates enables the detection of the contact force exerted on the sensor. If the force is exerted outside the pillar, the plastic plate transforms the force to the pillar and the sensor. Therefore, contacts on a wider area can be detected with fewer sensors. The FSR sensor is a polymer film in which electric resistance decreases accordingly to increase in the force exerted on the surface.

$R\alpha 1/F$.

The signal processor unit comprises of an A/D converter which converts Analog data into a digital data. Force below or exceeding the limits generates zero or maximum signals. The scan frequency in the signal processor is 47HZ generating the output for 47 times a second.

Drawbacks of Existing Method

- The touch behaviours such as stroking tickling cases exhibit less pattern detections.
- When the touching time is long the existing method does not recognise touching behaviour until there is no stimulation at the touch detector.
- Single touch input device which detects touch based on force.

VI. PROPOSED METHOD

To overcome the drawbacks of the existing method, the following technology is used for better improvement. Fine touch-Z is the digital-resistive touch panel technology which is an updated version of STANTUM'S INTERPOLATED VOLTAGE SENSING MATRIX. The primary change is the addition of the transparent pressure sensing material. A typical fine touch-z sensor consists of a PET substrate, patterned with the ITO columns a layer of peratech's material only a few microns thick, and a PET cover sheet printed with cover-glass decoration and patterned with the ITO rows. Cover sheet has a hard coat, which may be for the first time for this level of durability has been available in any resistive touch- panel. The Ivsm digital matrix produce excellent high resolution handwriting. The rows and columns spacing of the Ivsm digital matrix is around 1.5mm,which produces high resolution handwriting.

When the user touches the display electric current flows in accordance with the touch applied pressure in the direction of the z-axis in the transparent pressure sensitive material, by detecting that current, the sensor feels the coordinates and the strength of the touch. Touch sensors sensitivity can be controlled by the electronics. In most cases the designer will require a physical ouch to activate a coordinate. Sensitivity can be increased by adding z-axis or z-coordinates so that simple placement of a hand near the touch screen can be detected. The additional improvement is significant reduction in the minimum activation force. The primary advantage of stantum'sivsm core technology is the ability to use simultaneous fingers and styles with on a single sensor. This allows the styles to produce very fine art work with varying line widths to capture the full dynamics of the signature. The sensors are available in 5inch to 12inch range. By adding the peratech pressure sensing material adds z-axis sensitivity with 256 levels.

Fine touch-z incorporates different operating systems such as Android OS and windows with instruction set architecture such as ARM,X86at low level power consumption and superfast scanning engine.

Method of Recognising Touch Tehaviour:

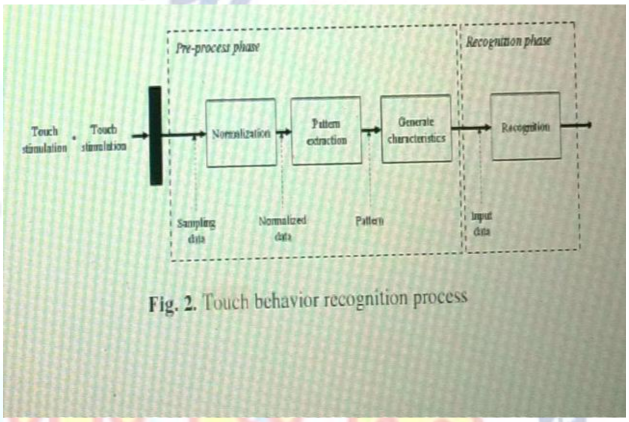

Fig. 2. Touch behavior recognition process

The touch behaviour recognition process can be divided into pre-process phase and recognition-phase process. The pre-process phase converts the sampling data generated in the touch detector into the input of the recogniser. The recognition phase classifies the input data into behaviours using the recogniser.

VII. RESULTS

The tables below show various results of many users. Each row shows the average results conducted by changing the initial values five times by user. For six users the average recognition rate was 93.8%.

Table 3. Results of the toucher dependent

	RMSE	Recognition Rate (%)	Stroking (%)	Tickling (%)	Hitting (%)
User-1	0.229	91.2	97.5	97.8	81.8
User-2	0.122	94.0	100.0	94.6	100.0
User-3	0.187	94.3	100.0	94.6	92.2
User-4	0.177	94.4	89.6	97.6	92.3
User-5	0.004	100.0	100.0	100.0	100.0
User-6	0.244	88.7	96.8	92.6	70.9
Total	-	93.8	95.7	96.2	89.5

RMSE: root mean square error

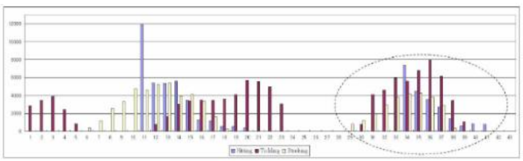

Fig. 6. Touching behavior histogram of user-6

Applications:

- Development of the emotional robot which can interact with the human beings naturally.
- Recognising human beings based on their touch behaviours.

VIII. CONCLUSION

Optical clarity and ability to function both with conductive objects and nonconductive objects makes this pressure based solution on par with the projected capacitive based touch screens.

Future work:

In future we are thinking to apply this touch sensing technique based on neural networks that will be used in the industrial security systems. That will recognise humans based on their touching pressure. And the way they touch during the recording of the inputs.

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