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Hand Gesture Recognition of Robot using Neural Network

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Abstract: Now a day's most of the industries demand for robots. The challenge in human robot interaction is that they don't feel real or natural. Growing interest towards gesture recognition of robots and challenges faced, this paper present different methodologies used for hand gesture recognition of robots. Each methodology in sequence improves the recognition rate (RR).These methodologies are listed as follows-Artificial Neural Network (ANN), Bio sleeves, Multilayer Neural Network and Bicubic Interpolation, Gesture Segmentation. Gestures are classified into Static Gestures (SG) and Dynamic Gestures (DG).

Keywords: Homan Robot Interaction, Methodologies, Recognition Rate.

I. INTRODUCTION

Humans use custom methods such as text based programming or teach pendants for training industrial robots. These methods are little clumsy and lacking in performance. In today's date human robot interaction has taken a new turn. Industrial robots are used for performing task which is impossible to do by humans or may be risky to perform. In Industries they are mostly used to work on welding, parts assembling, painting, etc. which require high precision. This paper describes the surveys and inventions done on hand gestures of a robot to make it more reliable and efficient for working. Gestures are processed on the classification of static or dynamic gestures. User command robot to go and stop at particular position, the process of moving from one place to another is a dynamic gesture and stopping at one position is static gesture. In short we can say that static gestures consist of pre-processed templates which are matched with captured image whereas motion or real time gestures are dynamic gestures.

II. BACKGROUND

Artificial neural network is collection of neurons connected to each other. Using this network according to studied paper it was found that RR up to 99% was achieved for 10 types of gestures. Neural network basically deals with human brain but when connected with machine learning it is called as artificial neural network. These are mathematically represented as follows:

$$f: x \rightarrow y$$

Artificial neural network is used to train robots on large scale. As real time learning is supported, many mistakes are about to occur i.e. overlearning by particular machine is possible for e.g. If a machine is presented with frames of picking and placing things on a particular surface, It should not always learn to put anything on that particular surface only.

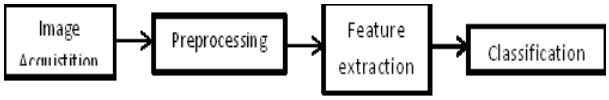

Fig.1 Gesture recognition process

III.LITERATURE REVIEW

After studying the journal paper, I came across different methodologies used for hand gesture recognition of a robot. Each methodology has its own benefits. Major techniques are briefed in following section.

A. Gesture Segmentation

In this main challenge is to recognize the data segment which contains understandable interaction frames. Segmenting of real time gestures uses forward spotting scheme, where it follows top down approach i.e. start to end before classification of static and dynamic gestures some pre-processing is done . Sliding window threshold decision method is used in which threshold value is calculated. The threshold value needs to be adjusted according to input parameters, sliding window size, and device wearer. These parameters sometimes give false positives hence the author's proposed 2 data sets keeping length (ts) equal:

1. Static sample Cs with dimensions $n_{t \times t_s}$ was recorded where user was at rest position.
2. Motion sample Cm with dimension $n_{t \times t_s}$ was recorded with user performing slow movements.

This matrix of Cs*Cm gives the ground truth based on which the threshold is adjusted to get required samples. If motion is detected above the threshold then it is taken as

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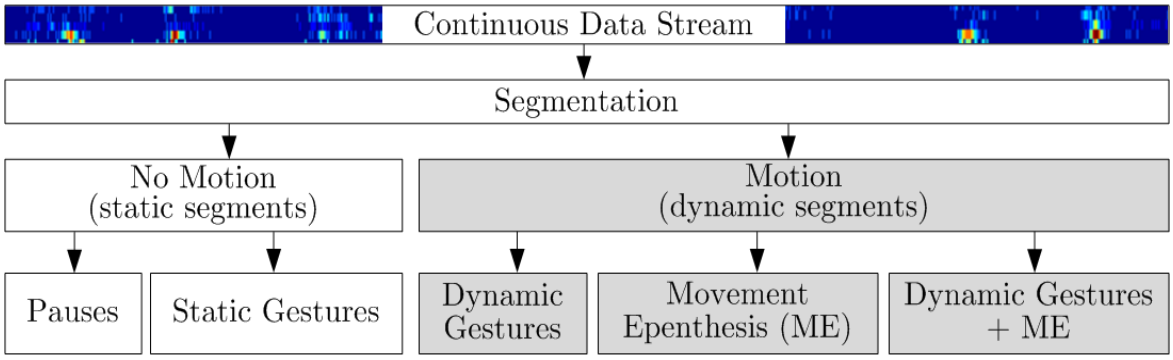

Fig 2. Segmentation of motions

sample. After this process the samples are classified into static or dynamic gesture.

B. **JPL Bio Sleeves**

It is wearable devices which consist of 16 surface Electromyography (EMG) channels and Inertial Measurement Unit (IMU). This device provides detail information for hand movements. IMU provides detailed information about arm motion and its position. The combination of array of EMG sensors, IMU sensors and insleeves processing provide high degree of freedom for gesture tracking .EMG captures the movements of muscles activated and IMU sensors identify the limb movements. EMG sensors are located near elbow of the forearm bio sleeves. Wrist and fingers movement information is stored in EMG array. When IMU sensors are combined with EMG array the information is sufficient to classify the gestures

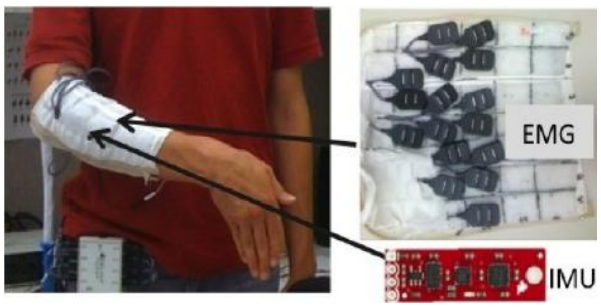

Fig 3. JPL biosleeves with EMG and IMU

C. **Artificial Neural Network(ANN)**

ANN is used for recognizing gestures pattern. This method is mostly used for training industrial robots. At real time the communicative and non-communicative gestures occur intermediately. To classify these gestures two ANN are used together. ANN provide reliability, good learning and generation capability in gesture recognition hence it is used in different areas such as recognition of continuous and posture from grey level video, Image data input as acceleration etc. Whenever the gesture is captured back propagation is done, where the evaluation of gesture from end to start is done, the two ANN are used to classify communicative and non- communicative gestures. To recognize a non-communicative gesture the input and the neurons provided are same as that for Communicative gestures. But the output of these may vary because the output neurons are equal to number of trained non gesture. If the input pattern is a communicative gesture it is given to both ANN with same input but if input pattern is a non-communicative gesture the process stops there only.

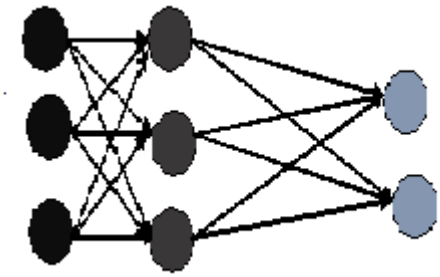

Fig 4. Three layers of ANN

D. **Multilayer Neural Network**

Multilayer neural network is nothing but the connected artificial neural network. It consist of 3 layers as input layer, hidden layer, output layer.in this each and every layer node is connected with each and every node of another layer. A static gesture does not need any transformations as they are represented as single frame. The sampled data is resampled using bicubic interpolation to classify dynamic gestures, because the sampled data obtained from magnetic device are undetermined in size. The dynamic gesture x^ihave various numbers of frames which are converted to fixed dimension samplesx'. In bicubic interpolation third degree polynomial is evaluated. For 2*2 dimensions 4 data points of which we know the value of f and can derive the value of f_x,f_y,f_{xy}.

The interpolated value can be given by

$$p(xy) = \sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij} x'y^i$$

This equation give sixteen different linear equations in this way derivatives of different neighbouring patches are maintained. The sample(s) we get is thecombination of SG and GD. To separate them we use index notation so now s^i represents the sample of i^{th} group and SG is stated as

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s: i ∈ i^s where i^s is the static gesture. Same procedure can be followed for dynamic gestures.

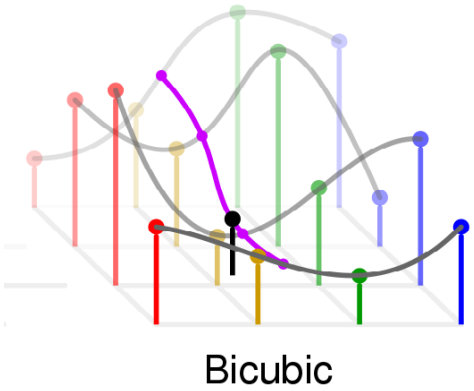

Fig 5. Bicubic interpolation

IV. CONCLUSION

The paper presented different recognition approaches with different recognition rate. The result after study was found that Multilayer Neural Network provide high recognition rate for hand gesture recognition with accuracy 98.7% for static and 99% for dynamic gestures whereas ANN provide 96% accuracy, the segmentation method provide error rate of 2.70% for motion segmentation. Higher accuracy rate means lower training and learning time, good ability to generalize from particular situation.

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