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MOTION RECOGNITION: A REVIEW

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ABSTRACT

Motion recognition is widely used in the area of robotics and it has application in game playing also. Motion Recognition helps the robots to find out what others are doing and it can also change the behavior using the others behavior. At some time the robot can support the humans by recognizing the behavior. In this paper we are discussing about different methods for motion recognition and we are comparing these methods with a method called "Motion Symbol Tree". The review happens based on the method motion symbol tree**.**

KEYWORDS: Motion Recognition, Imitation

INTRODUCTION

Motion Recognition is used in robotics for understanding the human motions and recognizes the motions. It helps the humanoid robots to understand the human motions and support them. It can be also used in game technology like some games uses the hand and the whole body. Motion Recognition is used to recognize the motions of hands or whole body using mathematical algorithms. The motions can be changed after a certain number of motions these numbers of motions can be recognized as a series of motion like from walking to running. So we have to recognize the motion of walking and running separately.

Mainly two mathematical models are used in recognition, Hidden Markov Model (HMM) and Neural Networks. In this paper we comparing the methods with a method called "Motion Symbol Tree" [1]. Motion symbol tree hierarchically represents clustering relationship between motion symbols based on dissimilarity among them. Imitation learning is the method widely used for recognition of motions. Imitation helps the robots to memorize the various motion patterns as symbols and recognize the observation. MOSAIC model [2] creates a forward module and inverse module for each motion pattern. The forward module calculates the similarity between the module itself and the observation, and outputs the motion data based on similarity to imitate the behavior. Mimesis model [3] based on mimesis theory it recognizes the motions as proto symbols by using HMM. Mimesis theory states that symbol manipulation and communicative ability are founded upon behavior imitation. Discriminative and adaptive imitation [4] uses the robotic arm experiments to do the imitation. This model tells the robots that what to imitate and how to imitate the given tasks. In this paper we are making a review with different recognition models.

RELATED WORKS

Haruno, Wolpert, and Kawato et al, proposes MOSAIC Model for Sensori motor Learning and Control [2]. MOSAIC means modular selection and identification of control, MOSAIC model is an extension of MOSAIC architecture. The model uses the Hidden Markov Models for learning and control. Here motor learning is similar to motion recognition.

It contains the multiple modules of forward and inverse models. A set of forward models can be used to predict the consequences of a given motor command. The forward model is treated as predictor and inverse model is treated as controller. If the forward model predicts the errors then the inverse model learns from the prediction that there is an error in the given command. Inverse model learns the appropriate control for the motor from its paired forward models accurate predictions. The selection of the inverse models is derived from the combination of the forward model's prediction errors and the sensory contextual cues, which enable the MOSAIC, model to select controllers prior to movement. This model can learn to manipulate multiple objects and switch between them.

Inamura, Toshima, Tanie, and Nakamura et al, propose an embodied symbol emergence based on mimesis theory[2]. Mimesis theory of Donald says that symbol manipulation and communicative ability are founded upon behavior imitation, which is integration of behavior recognition and generation. Mimesis model abstracts the whole body motions as symbols, generates motion patterns from symbols and distinguishes motion patterns based on symbols. For abstracting the whole body motions as symbols we are using the Hidden Markov Models. The observed motions are transferred into sequence of motions which have dynamics existing in the sequence. This motion in the sequence is represented as proto-symbols. The motion recognition is happening when the observed motions are transformed into a sequence and calculates a parameter. The parameter calculation is done by using the probability that the observed motion is generated by the proto-symbol that parameter is called likelihood. Using this likelihood value the motion recognition is happening. When implementing this architecture the recognition of complex behavior is difficult.

Billard, Calinon, and Guenter et al, [4] adapts imitation learning these type of learning mainly asks four questions what to imitate, how to imitate, when to imitate and who to imitate. This method finds the solution to the problem what to imitate and how to imitate. The method extract the important features of a given task, to determine a generic cost function to evaluate the robot's performance, and finally to optimize the robot's reproduction of the task in a new context based upon this cost function. In what to imitate it determines the features of the task to be imitated and in how to imitate it adapts its own motor program to produce an optimal imitation. So the motion recognition is happening in what to imitate it determines the kinematics of the task. For reproducing the task the method uses the probability model hidden markov model.

Takano and Imagawa et al, propose the method Motion Symbol Tree [1], the segmented motion pattern data is encoded into Motion Symbols using Hidden Markov Models. Motion Symbol Tree hierarchically represents the clustering relationship between motion symbols based on the dissimilarity among them. Continuous motion data is given as the input to the architecture. This continuous motion data is segmented into motion patterns [5]. The motion patterns are encoded into motion symbols using Hidden Markov Models. Each motion symbol represents a motion corresponding to the observation. For creating the tree we use the ward clustering method, it finds the dissimilarity between the motion symbols and which pair has the smallest dissimilarity pair them into a parent node. In the tree the leaf node represents the motion symbols, these motion symbols are grouped into abstracted motion symbols based on the dissimilarity between them. If the two motion symbols have small dissimilarity then they are grouped into an abstracted motion symbol.

The upper level contains the abstracted motion symbol and the abstracted motion symbol represents the motion. If we have to recognize a motion we use a recognition algorithm. When we have to recognize a motion, capture the motion and give this motion to the root. Select the root's child which have greatest probability with the captured motion and then make that child as the parent. Repeat this until we get a leaf node from that leaf node we can recognize the motion. Fast motion recognition can be done using this method because we are using a tree like structure. It can also be used to find the motion prediction and generation. If we have the first sequence of motion then it will predict the next motion.

For prediction and generation we are using a method called “Motion Symbol Graph”. It creates a graph structure using this motion symbols by using an N-gram model. The whole body motion patterns are used to evaluate the motions. So we can easily find out which motion is happening during the experiment.

REVIEW

The different methods used for motion recognition is discussed here. Each method have its own advantage and disadvantages, each method uses different motion patterns and experiments this is shown in Table 1. The MOSAIC model can only be used to imitate a certain task or experiment with different objects and the experiments are done with only the hand. The model can only do the tasks with object it doesn’t know how to represent it in whole body motion. In the case of mimesis model it takes the motions as symbols and it recognizes and generates the motions. But the model is complex when it comes to recognize the multiple behaviors. In descriptive and adaptive imitation it recognizes the given task only and it is only using the hand movements. Generation and recognition of motions is defined in terms of kinematics. Motion symbol tree is a tree like structure so we can recognize the motions fast. It makes use of a recognition algorithm too. The motion symbol tree considers the whole body motion patterns to find out the motions. So we can get which motion is accurately happening and division of motion is already done at the time of segmentation.

Table 1: Comparison with the Methods Used in the Motion Recognition

Methods	Motions	Mathematical Model	Experiments Done Using this Method
MOSAIC	Hand movements only	Hidden Markov Model	Identified the objects given in the hands
MIMESIS	Full body motion patterns	Hidden Markov Model	Walking, dancing, kicking , and crawling
Discriminative and Adaptive imitation	Hand movements only	Hidden Markov Model	Stirring the fondue, hammering a nail, and grabbing a ball with 2 hands
Motion Symbol Tree	Full body Motion Patterns	Hidden Markov Model	A radio physical exercise

CONCLUSIONS

This paper discuss about the motion recognition. We discussed the different methods used for motion recognition. It is compared with a method called Motion Symbol Tree. The disadvantages of other methods is listed out and the advantage of motion symbol tree. it also discusses why the method “Motion Symbol Tree” is better.

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