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Affordance Gesture Input Motion Interpolation

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Abstract. An affordance gesture motion interpolation is proposed, using an intuitive wireless 6DOF gesture input device, which includes Magnetic, Angular Rate, and Gravity (MARG) sensors, and a user interactive 3D gesture control interface, for creating motion by pose interpolation, from Dynamic Time Warping (DTW) gesture recognizer algorithm. In this paper we demonstrate that user can create and control the motion of avatar in real-time using the proposed gesture interaction method. User can introduce new poses and gestures to this interface, to create and control the motion of avatar to meet specific constraints by interpolation of poses. Our gesture interaction system can generate rich set of avatar behavior motions from the pose and gesture data stored in our system.

Keywords: Affordance, Gesture, Motion Interpolation, Avatar Control, Wireless Sensor, DTW.

1 Introduction

As the communication environments improved, the use of virtual avatars replaced to communicate and express ourselves over the years. Creating and controlling variety of 3D avatar behavior motion is important in computer games and virtual environments. Motions of avatars created using the motion capture do not allow to control the avatar behavior. The 3D authoring and motion capture systems are too expensive for personal use in mobile communication.

We are developing a novel interface system to create and control the motions of virtual avatar using intuitive gesture interactions. In this paper we show that a rich set of 3D avatar motions can be created using combination of predefined poses by interpolation. The generated motions can be effectively conveyed and expressed using affordance gestures for each of the generated avatar motions in mobile communication system.

The related work is presented in next section, which describes some of the motion interpolation and gesture control techniques. System interface, Motion interpolation and implementation details with results are explained in section third and fourth respectively. The last section concludes our work.

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2 Related Works

In keyframe methods of character animation, animator defines keyframe poses using a 3D modeling tools, and the in-between frames are generated by interpolation. Data driven motion interpolation methods have been widely used in interactive avatar control and animation. Motion graph technique is widely used in computer animation which generates new motions by cropping motions into small clips and reordering them [1]. Data-driven keyframing, the user specifies a sequence of key poses, which are interpolated by natural in-between motions generated from input motion data is demonstrated in [2].

Motivated by above data-driven motion interpolation methods, we adapted the interpolation synthesis to create new motions form the mixture of predefined poses, using gesture control techniques. In order to control the interpolations of 3D mobile avatar in real-time using MARG sensors, intuitive affordance gesture inputs are provided. There are many frameworks for 3D spatial gesture recognition systems like HMM, SVM, KNN, and DTW. Very general, powerful and cycle-hungry systems such as HMM, SVM are not suitable for real-time and mobile applications [3]. Instead a real-time gesture recognition algorithm using dynamic time warping (DTW) is best suitable for our application, as it is simple and effective for mobile applications.

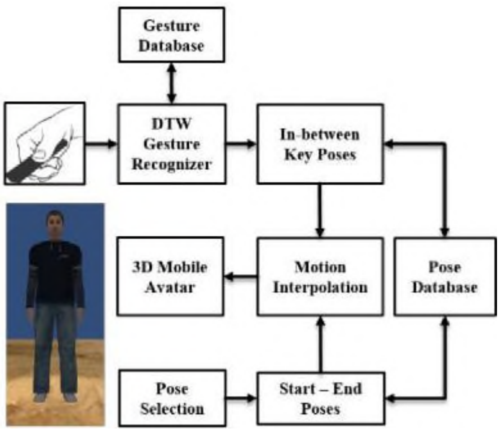

Fig. 1 System Interface.

3 Motion Interpolation and DTW

The data-driven keyframe motion interpolation provides real-time character motion for interactive entertainment or avatars in virtual worlds. The pose database in our system consists of pre-defined key poses. Fig 1 shows the overview of system interface. We have selected 18 important joints from the skeleton of avatar for motion interpolation. All key poses have rotation data for each joints of the skeleton for the 3D mobile avatar, only hip (*root*) joint has position data. User selects start and end poses for which he wants to do motion interpolation from the pose database. We use linear interpolation for position data and spherical linear quaternion interpolation (*Slerp*) for rotation data [4] using equations (1)-(4).

$$p = (1 - t) * p_1 + t * p_2, \text{ where } t \text{ in } [0,1] \tag{1}$$

$$q = (q_1 *(\sin((1 - t)\Omega)/\sin(\Omega))) + (q_2 *(\sin(t\Omega)/\sin(\Omega))), \quad \text{where } t \text{ in } [0,1],\ \Omega = \arccos(q_1 . q_2) \tag{2}$$

Dynamic time warping algorithm measures similarity and computes distance between two signals which may vary in time or speed [5]. DTW algorithm for gesture recognition from gesture database is applied. In our system DTW algorithm computes the distance between two gesture signals given by acceleration or angle signals changing in time. If $X = \{x_1, x_2, ..., x_n\}$, $Y = \{y_1, y_2, ..., y_m\}$ are two gesture signals, to align these two signals using DTW we need to define distance matrix *D* containing Euclidian distances between pairs of points (x_i, y_j).

$$D\ (i, j) = d\ (x_i, y_j). \text{ where } d\ (x_i, y_j) = |x_i - y_j| \tag{3}$$

Then we define cumulative matrix *P* recursively,

$$P(1,1) = 0,\ P(i,1) = D(i,1) + P(i - 1,1),\ P(1,j) = D(1,j) + P(1,j - 1), \quad \text{For } i,j>1\ P(i,j) = D(i,j) + \min\{P(i - 1,j), P(i,j - 1), P(i - 1,j - 1)\} \tag{4}$$

The optimal total distance $q_{DTW} = P\ (n, m)$ between X and Y is obtained after alignment.

Once the user gesture is recognized and classified from the predefined gestures of the sensor from gesture database using DTW gesture recognizer, the classified gesture is mapped to get the corresponding in-between poses from the pose database. The in-between poses are then combined with the start and end poses which are selected by the user in the beginning. All keyframe poses are then passed to the motion interpolation synthesis which applies user defined motions to the 3D mobile avatar for the corresponding class of affordance hand gesture input from the sensor.

The gesture database in our system consists of predefined affordance hand gestures from the MARG sensors given by acceleration and angle signals from the 3-axis accelerometers and gyroscopes changing in time. Our system supports user to introduce new poses to this interface for creating new motion of avatar to meet specific constraints and gestures to classify the new set of avatar motion.

4 Experimental Results

The predefined hand gestures using sensor data are collected in XML file format for template database creation, which are used for gesture recognition using MARG sensors. In addition to the selected start and end poses by the user, in-between poses are inserted automatically from the pose database by mapping the corresponding class of gesture to the predefined poses. Once motion interpolation stage gets all the key poses data, the script inside motion interpolation applies the interpolation synthesis to generate real-time motions to the 3D mobile avatar. The below fig 2 shows some of the gesture patterns and the corresponding motion interpolations of our system.

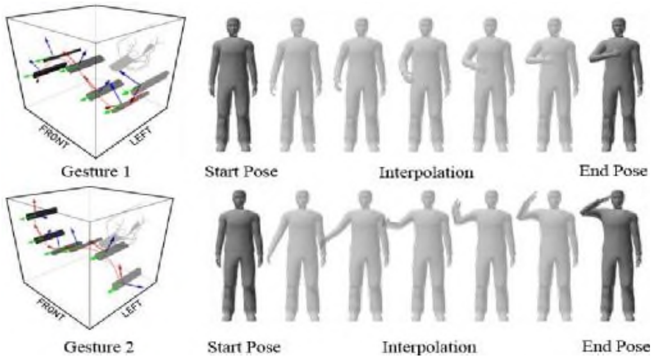

Fig. 2. Gesture Patterns and corresponding Motion Interpolations.

5 Conclusion

We presented an interactive affordance gesture input motion interpolation for 3D avatar using MARG sensors. We used the concept of data-driven motion interpolation synthesis to create new motions from a mixture of predefined pose data. This method can be useful for interactive real time applications and predefined animations.

Our gesture interaction system can generate rich set of avatar motions from the pose and gesture data, with variety of different styles and behaviors of motions, the user can express his intentions effectively in a mobile communication environment.

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