On the Riding Aids Recognition System for Horse Riding Simulators

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***Abstract*—Riding aids are instruction signals from a rider to a horse in the horse riding. In this paper, we present a study on the riding aids recognition system for horse riding simulators using multimodal sensing data. The riding aids recognition system provides an effective interactive function based on the riding intentions. The system has three types of sensors including vision, voice, and touch sensors. It has adopted certain schemes for multimodal data acquisition, feature extraction, data fusion, template matching, and intention classification. The system can provide recognition means for a riding aid so as to provide sense of reality such as actual horse riding to the user.**

Keywords-riding aids; riding intention; horse riding; sports simulator.

I. INTRODUCTION

The horse riding simulator is a machine that simulates the riding motion through an imitation of the basic movements of a real horse [1][2]. A current simulator is developed to move like an actual horse so that similar exercise effects to actual riding are provided to a user. The effects of exercise and recreational elements are also taken into account. However, it is not easy to provide continuous interest to users when operating a simulator. To solve this problem, it is necessary to develop hardware and software platform. Our approach infers the intention recognition using multimodal sensing data in a horse riding simulation environment.

In this paper, we propose a riding aids recognition system with multimodal sensing in horse riding simulator environments. The proposed system consists of sensor data acquisition modules, a feature extraction and fusion module, and a class generation and template matching module for intention classification. It is possible to increase the sense of the real for the user by enabling the horse riding simulator user to perform similar interaction to actual horse riding, and to increase effects of horse riding training using the horse riding simulator. Particularly, it is possible to provide an effective method for recognition of the intention of the rider in the horse riding simulation environment.

II. HORESE RIDING SIMULATOR

We developed a horse riding simulation system for replicating the mechanistic movements of realistic riding motions [3]. The interaction control module performs a controlling function for the interaction between the rider and several different functional components. The simulation hardware control module drives the movements of the hardware apparatus including horse body and the peripheral devices, and detects the movement of the rider using mounted multi-modal sensor devices. The riding content display module presents the relative contents on a large interactive screen that enables the user to actually ride the device, and returns feedback notifications generated within the content environment. The logging and coaching database manages the user's historical and specialized coaching information for personalized exercise mode and systematic training.

This paper is organized as follows. Section 2 presents our developed system related to the horse riding simulator. Section 3 describes the structure of the proposed riding aids recognition in the simulation environment and functional components of that. Conclusions are given in Section 4.

III. RIDING AIDS RECOGNITION

A riding aid which is an instruction signal from a rider to a horse in the horse riding means enabling the horse to

TABLE I. NATURAL RIDING AIDS

	Applying methods	Reactions
Seat	collection, balance, steering, forward movement	stop, go forward, turn
Leg	applying equal pressure against the horse's sides	increase in speed, upward transition
	one leg in a neutral position when applied	turn on the haunches or turn on the forehand, pirouette
	one leg farther back, with the other leg in a neutral position	actively encouraging the horse forward
Hand	direct rein (one rein pulls straight back)	turn in the direction of pressure
	indirect rein or bearing rein (pulls back inward)	correct straightness, lateral movements
	opening rein (does not pull back, moves his hands away)	turn in the air when jumping a fence
	neck rein (laying the rein)	turn a horse without bit contact
Voice	calming tone	slow down
	upbeat voice	move forward

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TABLE II. ARTIFICIAL RIDING AIDS

	Applying methods	Reactions
Whip	training tool, using light taps	collect gaits or perform movements
Spur	brief, light touch, sharp jab	encourage more impulsion, go forward

recognize user intention [4][5]. Riding aids are the cues a rider gives to a horse to communicate what they want the animal to do [6][7]. Riding aids are broken into the natural aids and the artificial aids. The natural aids that the rider uses are the hand, leg, seat and voice aids, as shown in Table I. The artificial aids are used to backup natural aids using equipment such as a whip or spur, as shown in Table II.

Our horse riding simulation system has three types of sensors. The touch sensors detect movements of the rider. The touch sensors are mounted on the artificial body of the simulator. They include six photo interrupter sensors for bridle rein and two film-type pressure sensors for detection of a spur. The voice sensor detects voice intentions of the rider. It is possible to provide a speech-based control function for the simulator. The voice sensor is mounted on a riding helmet using a condenser microphone. The vision sensors detect postural intentions of the rider using two depth sensing devices. The vision sensors are installed in positions such as the left and the reverse side.

The data acquisition module uses multiple combinations of touch, voice, vision and other sensors to sense rider's commands or movements. The key data of user's movements are balanced sitting, drawing or pulling reins, spur, whip, and the like. The verbal commands are results of speech detection with minimum pulse length and endpoint detection. For the postural intentions, the module collects image and depth data for riding postures of the rider. Feature extraction and fusion module extracts each feature data from the relevant collected sensing information. It generates a feature data set through data fusion of the extracted feature information. The class generation module combines the extracted feature information from the feature data set, and generates a combination class depending on a predefined template type. The intention recognition module performed the recognition function based on the above generated class as the riding aids.

The riding action of the user is predefined and converted into an object model. The action is stored in the database as the riding aids class. The class includes the following:

- start - spurring (if stop state)
- acceleration - continuously spurring
- left turn - pulling a left portion of the bridle
- right turn - pulling a right portion of the bridle
- deceleration/stop - simultaneously pulling the bridle
- stop - pulling back an upper portion (while pulling the bridle)
- balancing - bending the upper portion forward (if walking)
- propulsive force increase - leg pressure
- exercise maintenance - leg release or bridle release

The classes include strength information expressed through the action of the user as a parameter. The parameter includes gait level, driving velocity, pulling degree of the bridle, spurring strength, acoustic score, and rider's joint degree. The template class matching function compares the generated combination class with the intention class stored in the intention database. Based on a result of the comparison, the system recognizes the intention of the action of the user. Using information on the recognized user action intention, the system sends the feedback, including changes for the gait level and driving velocity, and the simulation hardware control module controls the artificial body. We performed an experiment on the six classes such as start, acceleration, left turn, right turn, deceleration, and stop. In the initial experiment, the average recognition rate of ten subjects was around 90.5 percent overall.

IV. CONCLUSION

A substantial interactive process between human and horse riding simulator system must be provided for natural interaction. The process usually requires continuous riding aids recognition. In this paper, we present a riding aids recognition system using multimodal sensing data in horse riding simulator environments. The system can provide an effective interactive function based on the riding intention recognition.

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