SKILLS Conference 2011
Montpellier
15th December 2011

Emanuele Ruffaldi & ROW Team

PERCRO Perceptual Robotics Laboratory
Rowing Training Challenge

Design and development of a multi-modal Rowing demonstrator with the main purpose of skills transfer for training intermediate-experts rowers
Research Objectives

• **Basic Challenges in VE training**
  – Use of multimodal feedback for complex motor task
  – Use of Virtual Humans for training

• **Design and Validate a Rowing training system**
  – Methodology for Design and Evaluation
  – Architectural
  – Support data management

• **Training of Specific Rowing Aspects**
  – Technique
  – Energy Management
  – Coordination

• **Model the Rowing Skill**
  – Real-Time Scoring
  – Integrated with Training
SPRINT
Skills Professional Rowing IN-door Trainer

Conceptual Idea

Immersive Configuration

Platform Design

Training Configuration
Phases of the Work

- Task Analysis
- Design
- Platform
- Experiment
- Prototype
- Evaluation

2007 - 2008 - 2009 - 2010 - 2011
Methodology

GOALS
• Three Scenarios have been identified:
  • Technique
  • Energy management
  • Team Rowing

PLATFORMS
• Three platforms designed
  • SPRINT
  • Light Weight Rowing
  • Boat

CAPTURING
• Performed on platforms for supporting training and modeling

TRAINING PROTOCOLS
• Energy
  • Team
  • Techopt timing
  • Techopt path
  • Techopt Transfer

ACCELERATORS
• Specialized Training Feedback
  • Augmented Visual
  • Virtual Human
  • Vibrotactile

ANALYSIS
• Modeling of the Rowing Skill
  • Segmentation
  • Biomechanics
  • Energy
  • Coordination
  • Audio
Platforms

SPRINT

LWR

Boat
Design Requirements

• Objectives
  – Focus on Training, not Simulation
  – Training based Design Decisions
  – *Provide feedback on postures and movements*
  – *Provide feedback on specific sub-goals*

• Kinematics
  – same movement of outdoor rowing

• Dynamics
  – water *resistance* and *entrance*

• Training Features
  – Scull or Sweep with same Device
Design Method

• Design Information
  – From Manuals
  – From Coaches
  – From Expert Captured data

• Validations and Refinements
  – Experts (Questionnaire)
  – Training with Novices
  – Training with Intermediate
Information Processing Model

- Digital Trainer
  - Proximal Distal
  - Bimanual coordination
  - Experts Knowledge
  - Rules
  - Training protocols

- Environment
  - Boat
  - Oars
  - Landscape
  - Fan regulator
  - Visual display

- Agent
  - BioSignals

Training Dynamics

Performance Curves
Interaction Principle
SPRINT Experience

Audio Feedback

Visual Feedback

Vibrotactile

Capturing

Force Feedback
Rowing Skill

Technique
- Timing of Phases
- Known Faults
- Efficiency of Trajectory

Energy Management
- Velocity and Energy Profile

Team
- Subject Coordination

These aspects have been modeled and integrated in real-time capture and analysis in Simulink

Technique
- Control flexibility and attention management
- Procedural skills
- Coping strategies
- Bi-manual coordination
- Balance and posture control
- Perception-by-touch

Energy
- Control flexibility and attention management
- Coping strategies
- Perception-by-touch

Team
- Control flexibility and attention management
- Procedural skills
- Coping strategies
- Balance and posture control
- Perception-by-touch
Biomechanical Modeling
Biomechanical Modeling

See related poster
Training Accelerators

Virtual Human

Localized Vibrotactile

Augmented Visual

See related posters
Evaluations

UM1
Team Training
Energy Training
LWR
Montpellier, France

PERCRO
LWR

Technion
Tech Opt
LWR
Haifa, Israel

Pisa, Italy
Full Platform
Tech Opt
<table>
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Transfer

• **Research Question**: how it is possible to correct specific subject errors in intermediate rowers in a short timeframe?

• **Proposed Approach**: leverage previous results on multimodal technique training. Extend them with real-time error recognition
Methodology

The approach pursued is based on a combination of Expert Data acquisition and Knowledge from Coach and Manuals

1) Manuals provide well known errors
2) Ask experts to perform correct behavior and known errors
3) Process everything using Machine Learning

For the purpose of
- Obtaining a way to identify error
- Score Athletes for training
Sculling Phases

Catch (Blades enter into the water)

Drive (Leg Drive, Back Swing Arm Draw)

Release (No Propulsion, Blades out of Water)

Recovery
Skying Error

| Blades Skying | Blades too high off the water at catch. | 1. Handles are lowered before being raised. | 2. Outside shoulder too low. | 1. Row with oars on top of water. |
Transfer Design

- Record subject on the real boat
- Integrate VE training in real training
Performance and Feedback

- **Performance:** score based on the real-time recognition of errors
- **Feedback:**
  - Visual feedback in the environment
- **Protocol:** 40 days, twice per week
- **Population:** rowers with 5-8 years
Results on SPRINT
Contributions

• Methodology for training aspects different aspects of rowing in VE
• The SPRINT research platform for investigating complex motor tasks
• Data acquired in the timeframe (40GB)
• Data management
Future Directions

• SPRINT
  – Moving toward active Force feedback
  – Integrate Boat performance in training
  – Generative models of Virtual Rower (DMP like)
  – Moving toward Team boat simulation
  – Better usability for Rowing Clubs

• Sports in VE
  – Role of Robotics
  – Embedded Sensing
You are welcome to see and try the system in our Booth
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