USF Corporate Forum on Aging & Technology
Virtual Reality for Health
Center for Assistive, Rehabilitation, & Robotics Technologies (CARRT)

Stephanie Carey
University of South Florida
Department of Mechanical Engineering
Research Coordinator, CARRT
http://carrt.usf.edu
Mechanical Engineering
At USF

- 1000 undergraduate; 200 graduate students & 22 faculty members. Our students come from over 50 countries.
- Areas of research include robotics, biomedical and tissue engineering, nanomaterials and nanomanufacturing, biosensors and biofluids, animal biomechanics, oil spills, clean energy technologies, compliant mechanisms, rehabilitation engineering, autonomous vehicles and networked multiagent system.
- Our faculty and students have received close to 60 patents through innovative research as well as design courses at both undergraduate and graduate levels.
- The program has active student sections of ASME and SAE centered on national and international design competitions.
- The department has ten professional society fellows; and several prestigious national teaching and research award winners including the 2012 US Professor of the Year awarded by the Carnegie Foundation for the Advancement of Teaching, five NSF CAREER awardees, and one NSF PECASE awardee.
USF’s CARRT MISSION STATEMENT

Improve the quality of life, and increase independence and community reintegration of individuals with reduced functional capabilities due to aging, disability or traumatic injury, as in the case of our wounded warriors, through integrated research, education and service in assistive and rehabilitation technologies in collaboration with consumers, clinicians, government and industry partners.
Statewide program providing:

- Rehabilitation technology consultation
- Modifying vehicles, work sites, homes
- 1000 persons/year served
- 6 Engineering Teams (Engineer and Technician)
Education

Omni-Directional Wheelchair

Piano Pedal Pusher

Paintball Gun Support

Fishing Assist

Mobility Cart for 6 mo-2 year olds

Amphibious Kayak
Community Outreach

- Engineering Expo
- Girl Scouts Minds for Design camp
- STEM summer camps
- MOSI exhibitions
Rehabilitation Robotics and Prosthetics Testbed

- An infrared Vicon motion analysis system including:
  - 8 MX-T20S cameras each with 2.0 mega pixel resolution, up to 690 frames/second
  - Software: Vicon Nexus, Tracker, Bodybuilder, Polygon, Analysis toolkit
  - Two Bonita 720c video cameras
- Two AMTI OR6-7-1000 biomechanics force platforms with amplifiers
- ATI 6 axis force transducer with amplifier
- A testing apparatus that includes a door, shelving system, and steering wheel will be located here to test prosthetic motion during activities of daily living
- Various ramps, a gait platform, and a gravel pit will be located in the motion analysis lab to allow for testing of lower limbs prostheses in different environments
REED lab

Using low cost Wii Balance board for assessment

Modified crutch tips to propel the user forward.

Gait Enhancing Mobile Shoe (GEMS) for over-ground stroke gait rehabilitation
Assistive and Rehabilitation Robotics Lab

- Baxter Robot
- 562 PUMA 6DOF robotic arm
- Phantom Omni – haptic device
- BarrettHand gripper
- Spaceball
- Basic Stamp Works Kits
- Mechatronics Kits
- Digital Servo Workshop
- Automotive Transducer Kit,
- LabVIEW Virtual Instruments with multi-channel digital data acquisition and systems control
- BumbleBee Stereovision Camera
- SICK Laser Range Finder
- Microsoft Kinect System
- Wheelchair Mounted Robotic Arm
School of Physical Therapy and Rehabilitation Sciences
Muscular Strength and Endurance
• BIODEX computerized dynamometer: skeletal muscle performance in isokinetic, isometric and isotonic modes.
• MedX cervical and lumbar exercise testing and training dynamometers: spinal muscle strength, endurance, and range of motion

Posture and Joint Assessment
• BIODEX Balance System SD force platform: posturography.
• Medmetric KT-2000 ligament laxity arthrometer. Test: validated assessment of ability to perform common activities of daily living.
• EPIC Lift Capacity workstation

Applied Cardiopulmonary Testing
• Cardiopulmonary stress testing system
• COSMED K4b2 portable metabolic system
• 12-lead electrocardiographic stress system (Quinton Q Stress) with treadmill and cycle ergometer
• Pulse oximeter for % arterial oxygen saturation measurements.
Funded by the National Science Foundation: “MRI: Acquisition of a CAREN Virtual Reality System for Collaborative Research in Assistive and Rehabilitation Technologies”
CAREN Extended

- **Projection screen**
  - 180° cylindrical shaped
  - 5 m diameter
  - 3 m high
  - 3 × high end projectors
  - various virtual environments
- **6 Degree of Freedom motion base**
  - pitch, roll and yaw
  - dynamic simulator
- **10 camera Vicon optical motion capture:**
  - user to visual his movement in real time
  - analysis of joint angles, forces and moments
  - clinical reports and comparisons
- **Spilt belt treadmill**
  - allows independent control of each leg
  - asymmetric training post stroke or amputation
- **CAREN community**
  - client portal
  - knowledge base
  - user forum
  - file sharing
CAREN System Applications

- **Applied Rehabilitation Research:** real-time feedback to the user; physical and/or cognitive therapy

- **Early Diagnosis:** quantify behavioral indicators for early detection of disorders or fatigue

- **Efficacy studies:** comparison of prosthetic components in various environments

- **Adaptive Equipment Design and Testing:** dynamic adaptive driving simulator; robotic arms, crutch tip

- **Injury Prevention and Human Factors:** mechanism for fall recovery; biomechanical analysis of war fighters with equipment
Human Body Model and Gait Reports

- Both subject and operator can visualize human avatar in real-time
- Provides real-time gait parameters and feedback to patient and clinician allowing for immediate adjustment to gait and balance during the session
- After testing or training can output a clinical gait report
The Use of a Virtual Reality System to Enhance Upper Extremity Prosthetic Training and Rehabilitation

The CAREN system is used to immerse patients into real life situations while providing real time visual feedback of their motion with the integration of an optimal goal model.
Avatars used on CAREN

Real-time avatar (mocap) provides feedback to user

Character avatar to display optimal motion from RHBM
VR training module
Adaptive Driving Simulator Using CAREN

- Advanced Electronic Vehicle Interface Technology (AEVIT) DBW controls from Electronic Mobility Controls (EMC)
- Lever device controls gas and brake & Small wheel device controls steering
- Signals from the controllers sent to a Phidgets, Inc. microcontroller board which interfaces with the CAREN system
Adaptive Driving Simulator
Using CAREN

Controls:
• Reduced effort steering wheel
• Gas/Brake lever
• Regular driving controls

Scenarios:
• City
• Highway

Data Collection:
• 10 Subjects
• Subjects completed a survey after each trial
Kinect Crutch Tip
Sold as the Moterum MTip

Crutch with Standard Crutch Tip

Crutch with Kinetic Crutch Tip

\( F_{\text{Applied}} \)

\( \theta \)

\( F_{\text{Push}} \)

\( F_{\text{Push}} \)

\( R_{KS}(\theta) \)

Forcing Movement

Kinetic Shape Definition

Kinetic Crutch Tip

U.S. Patent 9,763,848
Modified Crutch Tip

- Crutch tip based on Kinetic Shape that systematically converts a downward force into a rolling motion.
- Changes the “equilibrium point” of the crutch and provides an assistive motion propelling the user forward.
- Can also resist forward motion to make it easier to descend down a slope.

Commercially available as the Moterum Mtip
https://moterummtip.com
VR for VR

• Virtual Reality Simulation for Vocational Rehabilitation (VR4VR).

• Head mounted display, optical motion tracking system, 180° curved screen, job coach’s remote control panel are used for VR system.

• Use VR to assess and train people with severe disabilities on transferrable job skills.
Cognitive Disability Modules

- Environmental Awareness
- Money Management
- Cleaning
- Social Skills
- Shelving
- Truck Loading
VR for VR

Physical Disability Modules

• Job Training for people with physical disabilities.
• Practice Tasks in Virtual Environment with Physical Assistance Robotic System.
• Virtual Physical Assistance Robotic System modeled after Real World Robotic System.
• Skills practiced in Virtual Environment carry over to real world.
VR for VR

Job Coach’s Control Panel

This is a tablet app to remotely control the simulation, environment, and record data.

Features:

• Trainee info
• Reports
• Simulation control
• Real time intervention
• Note taking