Presented to New Mexico Legislative Science and Technology Committee, October 17, 2013.

Reduced-Gravity and Biomechanics (RGB) Laboratory and Robotics and UAV Laboratory

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RGB videos demos available at: http://www.youtube.com/channel/UCZ1EFux2g75RPy6a9kR-2zw
Reduced-Gravity and Biomechanics (RGB) Laboratory

Lab manager: Kenneth Ruble  (Tel: 575-646-5532)
Robotics, Mechatronics and UAV Laboratory

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Education and Outreach Efforts

Students trained in the last 5 years:
- 11 Ph.D. students
- 11 M.S. students
- 32 Undergraduates (excluding capstone teams)
- 12 Community college students (AMP)
- 13 High school students (EXCEL)

Outreach activities in the past 3 years:
- 1655 Students toured the RGB lab
- 106 Professionals toured the RGB lab
- Students made many presentations and workshops in other schools and public events

Undergraduate students Alexandra Mauer and Ember Krech assembling AFRL satellite test stand

Undergraduate students Gabriela Anguiano-Molina and Brandon Mee testing the RGB system

Undergraduate students Jeremy Bruggmann and Jacob Gilbert testing a robotics-based satellite inertia identification algorithm in microgravity flight onboard NASA’s C-9 aircraft

Undergraduates students Jason Wright, Tom Nicklaus, Steven Stroup and Rachel Tessier assembling the simulator.

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Research Activities

- Study of human performance and factors in zero- or reduced-gravity environments (e.g., Moon, Mars, an asteroid or orbit)
- Development of technology for predicting fall risk of older adults
- Development of technology for mathematical modeling and simulation of human body dynamics
- Bio-inspired UAV design, modeling, guidance and control
- Space robotics control and ground-based simulation and experiment
- Impact-contact dynamics modeling and experimental study

Output: In last 5 years, Dr. Ma and his students have published 17 peer-reviewed journal papers and 41 conference papers, and received 2 US patents.

Outlines of these projects are in the next few slides.
Study of Human Performance and Factors in Zero- or Reduced-Gravity Environment

Study human-human or human-robot interactions for EVA tasks in future space missions.

Key collaborating researchers:
Dr. Ou Ma, Mechanical and Aerospace Engineering Department
Dr. Robert Paz, Electrical and Computer Engineering Department
Dr. Edward Pines, Industrial Engineering Department
Ken Ruble, Mechanical and Aerospace Engineering Department

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Technology to Assist Mobility Rehabilitation

Current body weight support & offloading methods

Our new body weight support & offloading method

Key collaborating researchers:
Dr. Ou Ma, Mechanical and Aerospace Engineering Department
Dr. Jennifer Fabre, Human Performance, Dance and Recreation Department

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Prediction and Prevention of Fall Risk of Old Adults

We are studying a new measurement index called \textit{mobility index} to measure the risk of falls and to assess the progress of falls prevention measures. The index was derived based on the understanding of human walking dynamics.

\begin{center}
\textbf{Result of a pilot study}
\end{center}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Subject & Fallers & Non-fallers \\
\hline
1 & 15.2 & 19.1 \\
2 & 13.5 & 24.3 \\
3 & 13.3 & 24.7 \\
4 & 17.1 & 16.5 \\
5 & 15.6 & 13.2 \\
6 & 11.3 & 35.0 \\
7 & 12.2 & 23.6 \\
8 & 9.3 & 16.7 \\
9 & 16.9 & 29.2 \\
10 & 20.8 & 19.2 \\
11 & 15.9 & 16.9 \\
\hline
\multicolumn{2}{|c|}{Average} & 14.6±3.2 & 21.7±6.4 \\
\multicolumn{2}{|c|}{p-value} & 0.0073 \\
\hline
\end{tabular}
\end{table}

Key researchers in the team:
Dr. Robert Wood, Human Performance, Dance and Recreation Department
Dr. Ou Ma, Mechanical and Aerospace Engineering Department
Dr. Jennifer Fabre, Human Performance, Dance and Recreation Department

Video
Mathematical Modeling and Simulation of Human Bodies

Model a human body as a multi-body system for dynamically simulating and analyzing human physical behavior

Walking on the Moon

Simulate walking on the moon using our RGB system

Key collaborating researchers:
Dr. Ou Ma, Mechanical and Aerospace Engineering Department
Dr. Tonghui Wang, Mathematics Department

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Bio-Inspired UAV Design, Guidance and Control

Nature has been optimized over millions of years and thus, we want to learn from the nature for design innovation.

Inspiring

Key collaborating researchers: Dr. Ou Ma and Ken Ruble, Mechanical and Aerospace Engineering Department.
We turned a low-cost RC toy helicopter into an autonomous UAV

Key collaborating researchers:
Dr. Ou Ma and Ken Ruble, Mechanical and Aerospace Engineering Department
Space Robotics Control for On-Orbit Servicing

- Tracking and capturing a satellite in orbit for service by a robot is a difficult task
- Capturing a tumbling object in orbit is even more challenging and risky job
- More advanced robotic technology needs to be developed

Key researcher:
Dr. Ou Ma, Mechanical and Aerospace Engineering Department

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Impact-Contact Dynamics Modeling and Simulation

Goals:
- Enhances technology for simulating complex systems.
- Improves the efficiency and quality of impact-contact dynamics simulations.

Methods:
- Model order reduction
- Systematic identification of the key model parameters (i.e., stiffness, friction, damping parameters)

2D stick-slip test/simulation comparison

Key researcher:
Dr. Ou Ma, Mechanical and Aerospace Engineering Department

Video1  Video2