

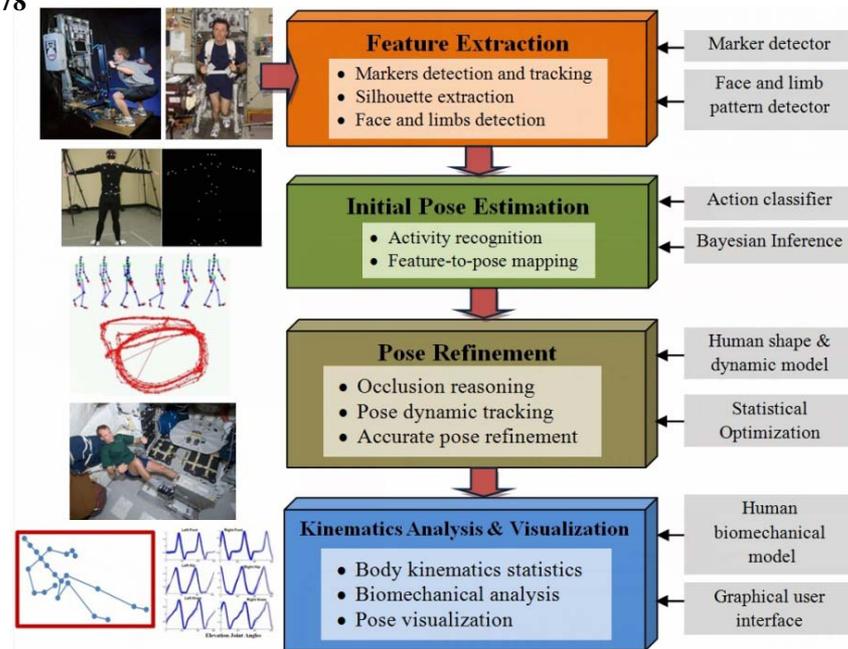
**X11.01: Crew Exercise System**  
**ESPRIT: Exercise Sensing and Pose Recovery Inference Tool**  
 Intelligent Automation Inc.– Rockville, MD  
 PI: Mun Wai Lee, Ph.D.  
 Proposal No.: X11.01-8378

## Identification and Significance of Innovation

Crew exercise is important for maintaining the health and fitness of astronauts, especially in preventing adverse health problems associated with long-duration space flight, such as losses in muscle strength and endurance, bone density, balance and aerobic capacity. These adverse effects could degrade their performance during space missions.

We developed algorithms for **ESPRIT: an Exercise Sensing and Pose Recovery Inference Tool**, in support of NASA's effort in developing crew exercise technologies for astronaut health and fitness. ESPRIT is a stereo camera system that monitors the exercise activities of the crew, detects markers placed on the body and other image features, recovers 3D kinematic information of the human body pose, and compiles statistical data about the exercise activities. The main challenge is the sparsity of observed markers. Some parts of the human body could be obscured by other parts of the body (self-occlusion) or by the exercise equipment. This will cause some markers to be missed by the tracking algorithm.

To address this challenge, ESPRIT relies on strong prior knowledge and modeling of human body, pose, dynamics, and appearance. It also relies on advanced machine learning and statistical inference techniques to achieve robust and accurate pose estimation.



Expected TRL Range at the end of Contract (1-9): TRL level 4

## Technical Objectives and Work Plan

The Phase I technical objectives are.

- 1: Software and hardware requirements and design of ESPRIT.
- 2: Knowledge base and model for pose and dynamics as prior models for pose estimation.
- 3: Robust human pose estimation
- 4: Demonstration of the feasibility of ESPRIT.

The work plan includes the following tasks.

- Task 1: Define system requirements for ESPRIT.
- Task 2: Develop module for feature detection and tracking.
- Task 3: Design module for pose estimation.
- Task 4: Design framework for kinematic analysis.
- Task 5: Develop Phase II and transition plans.

## NASA and Non-NASA Applications

### Potential NASA Commercial applications

ESPRIT system will support NASA's Exercise Countermeasure Project for observing crew's exercise activities, performing 3D motion capture and kinematic analysis.

### Potential Non-NASA Commercial applications

Non-NASA applications include uses in medicine and rehabilitation, such as gait analysis, orthopedics, and other applications for monitoring skeletal movement. Other applications include simulation, immersive reality, video games, personal fitness, human-robotics and human-computer interaction.

### Firm Contacts

PI: Mun Wai Lee, Ph.D.; (301)294-4762; [mlee@i-a-i.com](mailto:mlee@i-a-i.com)  
 Business Official: Mark James; (301) 294-5221; [mjames@i-a-i.com](mailto:mjames@i-a-i.com)