

Phase 2 Project Summary

Firm: Intelligent Automation Inc.

Contract Number: NNX12CA27C

Project Title: ESPRIT: Exercise Sensing and Pose Recovery Inference Tool

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

Intelligent Automation, Inc. (IAI) has developed algorithms for ESPRIT: Exercise Sensing and Pose Recovery Inference Tool, in support of NASA's effort in developing crew exercise technologies. ESPRIT is a stereo camera system that capture motion data of exercise activities of the crew. It does this by detecting and tracking reflective markers placed on the body or clothing and recovering 3D kinematic information of the body pose.

Crew exercise is important for maintaining the health and fitness of astronauts, to prevent adverse health problems associated with long-duration space flight, such as losses in bone density. These adverse effects could degrade their performance during space missions. Monitoring of crew health and fitness is therefore important. Commercial motion capture systems are bulky and require multiple cameras distributed around a large activity workspace and therefore not practical for spacecraft environment. A single-sensor motion capture system is therefore highly desirable.

ESPRIT relies on strong prior knowledge and modeling of human body, pose, dynamics, and appearance, and statistical inference techniques to achieve robust and accurate pose estimation. It is designed to meet the constraints in size, weight and power consumption imposed by the spacecraft environment

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The Phase II technical objectives are.

Objective 1: Develop an ESPRIT prototype system to perform 3D motion capture from stereo.

Objective 2: Conduct detailed performance evaluation with comparison of joint location estimation from commercial multi-camera motion capture system.

Objective 3: Conduct technical demonstration of the prototype in a representative environment.

The work plan includes the following tasks.

- **Task 1: Perform requirement capturing and prototype system design.**
- **Task 2: Perform algorithm enhancement for 3D motion capture.**
- **Task 3: ESPRIT Software Development.**
- **Task 4: Conduct performance evaluation and enhancement.**
- **Task 5: ESPRIT Prototype integration and testing in a representative environment.**

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

We have developed an exercise monitoring system called ESPRIT: Exercise Sensing and Pose Recovery Inference Tool. This is a stereo camera system that monitors exercise activities, detects

markers placed on the body, extracts image features, and recovers 3D kinematic body pose. A commercial motion capture system was used to provide reference data to evaluate the performance of ESPRIT during several types of exercises, including treadmill walking, curling and dead lifting. For measuring relative locations of markers, an average accuracy of about 5mm was achieved.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

Crew exercise is important for maintaining 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. The ESPRIT system will support NASA's Exercise Countermeasure project for observing crew's exercise activities, performing motion capture and kinematic analysis, and will contribute towards the understanding the effect of microgravity in physical activities. ESPRIT is designed to satisfy the constraints in size, weight and power consumption

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Non-NASA applications include uses in medicine and rehabilitation, such as gait analysis, orthopedics, and other applications for monitoring skeletal movement. Other applications include personal fitness and support of the aging, human-robotics and human-computer interaction, simulation, immersive reality, and video games. Potential customers include government research agencies such as Air Force Research Laboratory for human performance analysis and human factor engineering; National Institute of Health for rehabilitation research; physiotherapy clinics and nursing homes for patient monitoring, and sports equipment manufacturers for biomechanics studies. The development of a low cost motion capture system would open a wide range of opportunities in markets where conventional motion capture systems are too expensive.

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