2025 START Program
CFP Brief

THEME: **05. Robotics**

SUB-THEME: **5.2. Physical interaction between Robots and Humans**

Context/ Overview

Samsung Research America invites proposals for innovative solutions to enhance the interaction between robots and humans through physical contact. This initiative seeks to address critical challenges such as safety, precision, ergonomics, and reliability. Proposals should emphasize the development and validation of robotic systems using advanced simulations, accurate human tissue models, and plant-based testing, but explicitly exclude testing on actual human beings or animals.

Problem Statement

Robots are increasingly being deployed in environments inhabited by humans. Various studies are being conducted on how a robot should behave in the presence of humans. However, we do not yet have a good understanding of how a robot can safely perform physical interaction with humans. One such example is during caregiving—how does a robot accurately assess how much torque to apply to a person's elbow and in what direction in order to help humans with changing their clothing? How does the robot estimate the force/torque based on different people's stature and other physical and medical conditions? While the above questions are just one example of a physical interaction between robots and humans, this CFP aims to address several such physical interactions.

Objective

The longer-term goal is to develop robotic systems that can safely and effectively assist humans across all ages (from infants to seniors) with daily activities, personal care, and mobility, ensuring physical comfort and psychological wellbeing. Creating adaptable, reliable, and cost-effective robots that prioritize human safety and psychological comfort is critical to deploying robots in environments where they can cohabitate with people.

To that end, the focus of this call is to develop robust movement and interaction systems (hardware and/or software) wherein robots are physically interacting with humans, and hence, are simultaneously adaptable, reliable and safe, while providing the required functionality.

As an example, a comprehensive system will be able to successfully comprehend, assess, differentiate between, and deliver a touch, lift, or a push during a physical interaction with a human. The model should be able to determine the required force vectors depending on the age, stature, build, position and health of the human, and the situational context of the request (e.g., in distress). Translatability of models trained using data from one set of conditions to other conditions is highly desired, so use of appropriate transfer learning and domain adaptation techniques is strongly encouraged.

※ The topics are not limited to the above examples and the participants are encouraged to propose other original ideas.

Scope

Proposals should address the following key areas:

1. Safety and Precision: Innovative sensor and control systems, as well as interface materials to ensure safe physical interactions with humans.
2. Human-Robot Physical Compatibility: Designs that accommodate diverse physical conditions and body types.
3. Model Adaptation and Transfer Learning: Techniques for adapting robotic models trained in one interaction context to another.
4. Ergonomics and Comfort: Ergonomic design principles to ensure human user comfort.
5. Reliability and Consistency: Ensuring long-term performance and durability.
6. Emotional and Psychological Impact: Design considerations to make physical interactions comfortable, safe, and reassuring.
7. Cost and Accessibility: Strategies to make robotic solutions affordable and accessible.

Focus areas for the proposal

Proposals should include a comprehensive approach to solving the above problems, with a detailed plan for validation. The following elements must be included:

1. **Detailed Description of the Proposed Solution:**
   a) Innovative features and technologies.
   b) Approach to ensuring safety and precision in physical interactions.
   c) Use of materials and ergonomic design.
   d) Techniques for transfer learning and domain adaptation to apply robotic models across different user groups.

2. **Technical Feasibility:**
   a) Description of the technical approach and methodologies.
   b) Plans for developing and integrating sensor and control systems.
   c) Methods for adapting and fine-tuning robotic models for new user groups.

3. **Validation Plan:**

Due to extensive protocols required for testing on vertebrate animals and humans, we encourage proposals to take low overhead approach to validation. Successful proposals will use a combination of the approaches below.

   a) Use of simulations to model human-robot interactions and predict outcomes.
   b) Testing on accurate models of human bone, muscle, and tissue to validate safety and efficacy.
   c) Acceptable testing methods on plants as preliminary validation steps.

4. **Implementation Plan:**
   a) Timeline for development and testing phases.
   b) Milestones and deliverables.
   c) Risk assessment and mitigation strategies.

Additional evaluation criteria

In addition to the four **(4) START Program evaluation criteria** mentioned on the **Proposal Guidelines** document, proposals for this Sub-Theme will also be judged based on:

1. **Model Adaptation and Transfer Learning**: Effectiveness of techniques for adapting robotic models to new user groups.
2. **Validation Methodology:** Robustness of the validation plan, including the use of simulations and accurate models.
3. **Impact Potential**: Potential benefits for humans in performing daily activities, personal care, and mobility.
4. **Implementation Plan:** Clarity, feasibility, and comprehensiveness of the implementation plan.

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