ARMove: A Smartphone Augmented Reality Exergaming System for Upper and Lower Extremities Stroke Rehabilitation

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About Stroke

Background:
- Stroke affects 800,000 Americans per year.
- Stroke damages cells in multiple regions of the brain.
- Brain damage affects activities of daily living (ADLs) such as meal preparation, bathing, household, and general mobility.

Significance:
- Providing continuous rehabilitation for stroke patients in both upper and lower extremities will give the most benefits to regain independence, relearn skills, and improve quality of life.

Design Goals

1) Rehabilitate various motions in both upper & lower extremities
2) Train practical movements for real-world ADLs
3) Create a scalable, portable, user-friendly rehabilitation system
4) Promote adherence to at-home rehabilitation

Hardware Design
- Smartphone
- Gooseneck Phone Holder
- Printable Pattern Board

Software Design
- Augmented Reality

Feedback Mechanisms
- In-game real-time positive encouragements (visual and auditory)
- Post-game historical progress chart

Exergames
- Simulates real-world ADLs - cutting pizza, pouring water, kicking soccer balls
- Trains upper extremities - elbow flexion, forearm extension, fine motor dexterity
- Trains lower extremities - hip flexion, plantar flexion, hamstring contraction

Methodology

Current Practices

- Augmented reality (AR) and virtual reality (VR)-based exergaming promote adherence and engagement in at-home rehabilitation.
- Existing works focus on one aspect of recovery (e.g., only unilateral upper extremity motions), addressing one affected brain region.
- Much specialized hardware is required.
- Lack meaningful user feedback.

Results & Conclusions

Evaluation: Preliminary evaluations of our system were conducted on 12 young adults, 10 older individuals, and 2 stroke individuals, with IRB approval. Users generally agreed with the statements, “I would like to use this frequently”, “this would improve my performance”, “I like the smartphone system idea”, and “these activities give me pleasure”.

Conclusion: our system has potential to promote adherence and engage stroke patients in their long-term at-home rehabilitation process from their chronic disease through effective, entertaining exergaming for upper and lower extremities.