Smartphone Gamification

Augmented Reality For Lower Extremity Rehabilitation

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climb up for summer research
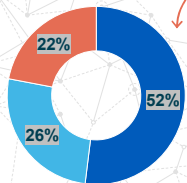
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Significance

The Technical Novelty

- **Unique:** Augmenting reality through smart device cameras for the patient to perform rehab exercises anywhere.
- **Fun:** Turning exercise into video games.
- **Data Analysis:** Recording meaningful information about the exercise to help the medical team adapt to patient needs.

Background Data

- **Knee and Hip Rating:** Western Ontario and McMaster Universities Osteoarthritis Index is rated on pain, stiffness, and the functional ability of joints [See Figure A].
- **Household Funds:** The Average American household funds split into 3 categories [See Figure B].
- **Cost of Current Therapy Programs:** On site Physical Therapy sessions are approximately $50 to $350 depending on the injury and time needed for the patient. These sessions occur multiple times a week for at least a month. This is unaffordable for most Low and Middle Income Families.
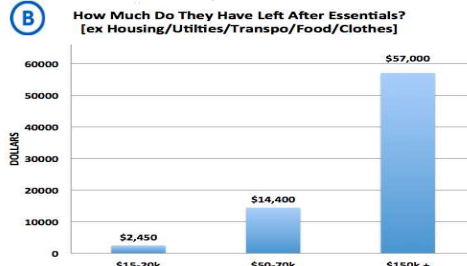
(A) **WOMAC Index**

Figure A: Inpatients have twice as much recovery compared to Outpatient and other methods.

22% / 52% / 26%

■ Inpatient ■ Outpatient ■ Other

Physical Therapy Treatment Study on Osteoarthritis of the Knee

(B) **How Much Do They Have Left After Essentials?**
[ex Housing/Utilties/Transpo/Food/Clothes]

$2,450 ($15-20k) / $14,400 ($50-70k) / $57,000 ($150k +)

"The Atlantic" news article site

Methods

- **Game Development Diagram:** [See Figure A].
- **Gameplay Diagram:** [See Figures in B].

(A)

Vuforia AR SDK

(B)

Outside View | A.R. View | A.R. View Zoomed

(B)
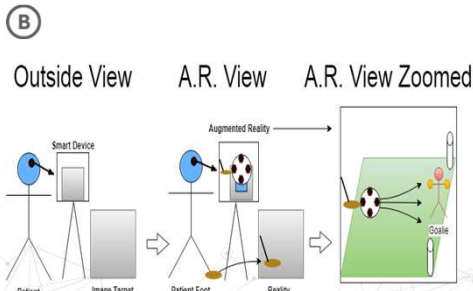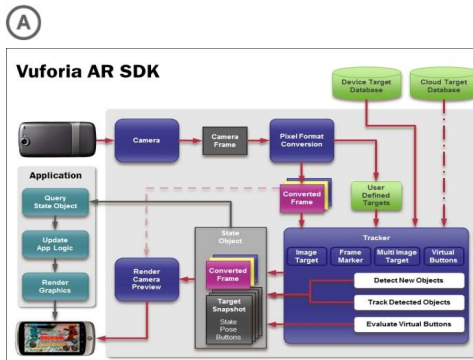
Gameplay with Multiple Camera Views within and outside game.

Evaluation

- **Virtual Buttons:** Responsive and smooth with big images and small button area (20% or less).
- **Device Gameplay:** Great, but top-down angle
  - **Using Raycast:** High shots are difficult. Programming or orientation can fix this.
- **Implementation Benefits**
  - **Increased stability:** Through Calisthenics standing on one leg and kicking with the other or holding leg in air.
  - **Improved Range of Motion:** Testing and pushing reach capabilities.
  - **Accurate data collection:** Can be analyzed by experts for therapy adaptation.
  - **Enjoyable:** May lead to higher patient adherence and improve efficiency in recovery.
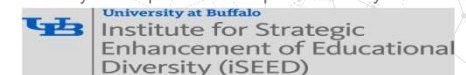
Conclusion

- **Cameras & Tracking:** Continue to improve every year which will eventually allow smaller paper targets and smoother virtual button triggering with movements.
- **Portability:** With a smart device and a paper anyone can take this game anywhere and play it whenever they desire. More control over the road to recovery.
- **Accessibility:** Most families have an android device. Several devices can be bought for $50 on amazon. Therefore, for the cost of one therapy session someone can have access to infinite sessions.
- **Efficiency:** Computer Scientists and Medical Teams can set up and collect meaningful data to adapt to the patients needs and respond quickly with modifications.

References

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Acknowledgments

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