MemSpark: Artificially Intelligent Virtual Reality System for Non-Intrusive Therapy and Evaluation of Dementia

**Background**

Dementia is a neurodegenerative disease caused by an abnormal accumulation of proteins in the brain. This results in ruptured connections among neurons which in turn causes significant brain changes. These changes manifest through psychological and physical symptoms, impacting daily life of a person with dementia (PaD).

**Current Therapy Options**

While there is no cure for dementia, current mainstream pharmacological and therapeutic options also fail to reduce the progression. They falsify the improvements, or cause significant physical and mental side effects, leading to poor quality of life (QoL) and shorter lifespan. Addressing such shortcomings need a better solution.

**Engineering Solution**

Virtual Reality (VR) mimics brain’s ability to create a mental map of an environment using senses. Utilizing VR for a therapeutic intervention has proven to enhance neural connections leading to heightened neuropsychology and cognition among children and seniors. To address the shortcomings of current therapies an immersive set of serious games could be developed using VR. Engaging a PaD through a gaming experience helps avoid intrusion and the side effects of a typical task-based therapy such as anxiety, frustration, self-guilt and feeling of getting lost.

**Artificial Intelligence**

A biologically inspired artificial computational network such as multilayer perception (MLP) can help automate the profiling and evaluation procedure. In current profiling process, a dementia expert collects cognition data through various tasks and analyzes over days to determine PaD’s dementia level and progression. Using an MLP with backpropagation learning algorithms, can reduce time for such supervised procedure to seconds after training. An MLP’s flexibility to customize structure, algorithm, data preprocessing, and measure effectiveness through overfitting, and sensitivity analysis make it most suitable for this problem.

**Goals**

1. Profiles a patient’s cognitive abilities with 90% accuracy.
2. Produces cognition profile within 1 minute.
3. Does not involve profiling specialist.
4. Trains on at least 1700 data points: 1350 training, 250 testing, 200 validation.

**System Design**

**Virtual Reality Therapy**

- Eight serious games to exercise recall, reasoning, executive function and overall cognition.
- Produce performance metrics for profile.

**Profile**

- Feature extraction and dimensionality reduction.
- Use transfer learning.
- Generate scores for recall, reasoning, executive function and cognition.

**Progression Tracker**

- Captures fine-grained progression of a PaD.
- Compares current scores with past.
- Enables caregivers to see progression.

**Results**

- Recall
- Reasoning
- Executive Function
- Cognition (ADAS-Cog)

**Conclusion and Impact**

- Creates an adaptable game experience.
- Select tasks within the level with weighted probability (additional dimension of difficulty).
- Eye-tracking to directly measure features such as coordination.
- Add games for improving physical functions.
- Use on-the-edge computing to reduce the cost of computing in cloud.

**Key References**


* All tables, graphs, and figures were created by the Finalist unless otherwise cited.