**Motivation:**
- Millions of people suffer from limb impairment that limits their dexterity
- Tasks that do not seem challenging such as:
  - Unlocking doors
  - Turning lights on/off
  - Changing channels of a TV
- Become extremely difficult to do and leads to diminished quality of life
- EEG technology is becoming more advanced
- Smart devices are becoming more popular and less expensive
- Internet of Things
  - Everything can be connected

**Objective:**
Offer more independence, and improve quality of life.
- Use a headset with EEG sensors to measure and record brain signals
- Map the signals to specific cognitive commands using pattern recognition
- Use these commands to control smart devices

**Methods & Process**
- **Step one: Virtual Reality**
  - Proof of concept
  - Cost effective way to test design
  - Gives feedback on headset connectivity, latency, and bugs
- **Step two: Work with real device**
  - Control smart devices with 4 commands
  - Connect multiple devices

**Detected Cognitive Commands:**
- **Emotiv EPoC+ Headset**
  - **EEG Data**
  - 14 EEG sensors
  - 0.2-45Hz range at 128 samples per second
  - 2.4Ghz wireless connectivity
  - 16 bit ADC
  - 12 hour batter life

**Emotiv’s SDK**
- Contains powerful pattern recognition software
  - Training module included to help map cognitive thoughts
- Contains a comprehensive API written in C++
  - Allows access to generated events
- Ability to analyze EEG raw data
  - Helps detects which thoughts have less overlap
  - Can help combat false positives
- Muscle movements are easier to detect
  - Blinks, or smiles
- Amplitude of thoughts are relatively small

**Virtual Reality:**
- **Creating Models**
  - Used Autodesk modeling software developed by Autodesk
  - Focused on interactive objects, e.g. lights, doors, and TV.
  - Basic models for functionality

**Building an Interactive Environment:**
- Used Unity3D game developing engine
  - Allows user to interact with objects
  - Scripts written in C# language.

**Displaying Virtual Reality**
- Initially used Oculus Rift
- Switched to Samsung Gear

**Real Devices:**
- **Overview**
  - Needs to work with multiple devices
  - Distribute commands to devices that are not in general vicinity
  - Needs to be scalable

**Smart Home Network**
- **COGNITIVE CONTROL**
  - Push?
  - Node
  - Server
  - Smart Devices
  - Yes
  - Restart
  - No

**Accomplishments:**
- Successful at detecting thoughts and using them as input
- Created small virtual environment for testing
- Cognitive Control
  - Written in C++
  - Handles generated events
  - Combats false positive events
- Cognitive Connect
  - Written “golang”
  - Scalable
  - Connects smart devices
  - Distributes commands

**Challenges Faced:**
- False positive events occur often and can cause fatigue
- Connectivity between user and headset varies
- Cognitive Control code is not one size fits all, specific to each user
- Oculus Rift induces motion sickness
- Time consuming to build models for VR

**Future Work:**
- A method for selecting a specific device among multiple devices, some ideas
  - Motion detector
  - Camera
  - RSSI signal
- Security precautions must be taken to ensure user safety
- Virtual Reality models and actions
- Test with virtual smart home with real patients to get feedback on the headset

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