Hybrid Artificial Muscle Robot(HAMR): Exosuit Building Block

Research Plan

Biomedical Engineering

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Rationale

Background:

- There are many diseases that lead to movement disability. However, there are no cures for every cause.
    - This problem lead to use of movement aiding device.
- However, movement aiding devices have limitations (devices such as wheelchairs, prosthetics, robotic arm and exoskeleton devices).
    - These devices requires maintenance from expert
        - It is physically hard for individuals to reach maintenance experts
        - Cost of maintenance is high
    - These devices does not fit everyone
        - Requires support in different body part
        - Body size is different
        - Economic situation might not allow high cost devices
        - Environment might not allow to reach this devices
            - Active war
            - Natural disasters
    - Having them does not mean it provides movement that is equal to normal people.
        - Examples:
            - Wheelchair cannot operate at uneven road.
            - Exoskeleton devices have limited degree of movement.
    - Inefficient energy use
        - Devices such as robotic prosthetic arm, exoskeleton, and wheelchairs require power source
        - These devices must be charged frequently
            - This is inefficient

Importance/Social Impact:

- HAMR system will provide flexible movement support
- Individual can customize the device for their specific needs like building legos
- Maintenance can be done by replacing HAMR block
- Maintenance can be done by individuals, no requirement for meeting experts

- HAMR can be wear by individuals like normal cloth
- Cost of HAMR will be significantly low (plan less then $10 for pack of 100)
- HAMR can be drop from airplanes to active war zone and built by anyone without any expertise

Research Question/Hypothesis/Engineering Goal/Expected Outcomes

- Research Question:
  - Will building block system cover the problems(mentioned on rationale section) shown in traditional methods for movement support?
- Engineering Goal:
  - Energy Efficient
  - Building block system
  - Can operate independently as one unit
  - Can be assemble to work together as a unit
  - Low production Cost
  - High power output
- Hypothesis:
  - Implementing structures of hydrostatic skeleton of worms will provide basis for the building block structure
  - Implementing fuel cell structure will provide energy-efficient/self-sustainable device
- Expected Outcomes
  - HAMR will be a stepping stone to building block that can be assembled into exosuit that provide freedom of movement to people, fulfilling problem stated on rationale section.

Procedures/Risk and Safety

1. Research
   1.1. Read previous research on various topic to learn knowledge required for prototyping
2. Design
   2.1. Create 2D drawing of prototypes
   2.2. Create paper model to test the structure
   2.3. Create 3D drawing for the final design
3. Gathering materials
   3.1. Research on online to find needed materials
   3.2. Visit local hardware stores for the tools
   3.3. If material cannot be found
      3.3.1. Produce material based on scientific paper
4. Fabrication
   4.1. 3D printing

    - 4.2. HAMR Chip Assembly
    - 4.3. Silicone Body
    - 4.4. Sanding/drilling
    - 4.5. Assembly of HAMR
5. Method for data collection
    - 5.1. Energy
        - 5.1.1. Use electrometer to collect voltage and amps
    - 5.2. Various Situations
        - 5.2.1. Adapt HAMR to different situation
            - 5.2.1.1. Vertical/Horizontal positions
    - 5.3. Method collecting procedure
        - 5.3.1. Take a video of whole experimentation
        - 5.3.2. Connect to electrometer
        - 5.3.3. Prepare safety equipment and procedures

- General Safety Guidelines during prototype testing
    - Wear protection gear
        - Safety glasses
        - Masks
        - Gloves
    - Fire extinguisher
    - Under supervision at all times
    - First Aid

- Subject-specific guidelines:
- Vacuum Pump (according to the University of Texas at Austin Environmental Health & Safety)
  - Physical
    - Electric wires are free from defects
    - Do not place pumps in unventilated area
    - Do not operate pumps near flammable materials
    - Use correct or approved wire for vacuum pumps
  - Chemical
    - Always check valve for oil leakage
    - Put pots to collect potential oil leakage
    - Change oil frequently and dispose it based on local guidelines
    - Vent the pump properly
  - Personnel/supervision
    - Conduct operations behind a table shield and always wear protection gears(safety goggles, lab coat, and gloves)
    - Keep check the condition of pump
  - Sulfuric acid(0.02N)
    - Potential Hazards
      - May cause irritation to the respiratory tract.

        - Contact with skin causes burns and irritation.
        - Ingestion may cause permanent damage to the digestive tract.
    - Safety precautions/minimize risk
        - Respiratory protection
        - Hand protection
        - Eye protection
        - Skin and Body protection
        - Keep it away from combustible materials
    - Disposable method
        - Store it in a closed system.
        - Hand it to the proper waste facility.
- Hydrogen Peroxide(3%)
    - Potential Hazards
        - Potential to cause fire or explosion
        - May cause burns to digestive and respiratory tract
        - May cause nausea, vomiting diarrhea, damage to the red blood cell
        - May cause skin and eye burns.
        - May cause central nervous system effects
    - Safety precaution/minimize risk
        - Respirator protection
        - Hand protection
        - Eye protection
        - Skin and Body Protection
        - Store at the tightly closed in a dry and well-ventilated area.
        - Store away from the combustible materials
    - Disposable method
        - Store it in closed container
        - Then send to the proper waste facility.

Data Analysis

- Visual Analysis of the HAMR performance
    - Measure expansion length
    - Measure different characteristics
- Analyze energy usage based on the data collected from electrometer

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