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Independent Exercise Assistive Device for Individuals with Visual Impairments

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BIOMEDICAL

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Introduction

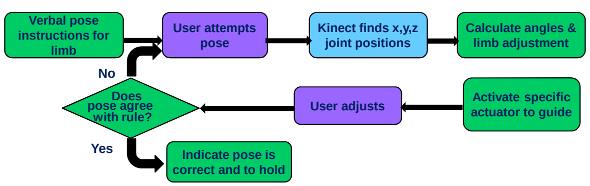
It is difficult for individuals who are blind to perform exercises. There is rarely any tactile or audio feedback cues built into equipment that can provide instructions, corrections, or information regarding performance. Exercising at home independently is especially difficult, because they cannot watch an exercise video or read instructions and look at body positions. With no way of knowing if they are doing the exercise correctly or if they need to make adjustments to their body positioning, there is also a risk of injury during exercising.

Design Requirements

- Usable with no vision or low vision
- Affordable – people with disabilities often have low income
- Can be used independently
- Low maintenance
- Safety including tripping and electrical issues
- Simple exercises performed by people of varying fitness levels

Solution

Our design uses a body motion sensing camera in conjunction with a program that can teach exercises without the use of visual guides or feedback. It includes verbal and tactile feedback to inform users how to adjust their movements, and when they are doing the exercise correctly. This creates a feedback loop between the user's current position seen by the camera and the activation of the appropriate vibration motor to guide movement until the user is in the correct position for the specified exercise.



Design

Skeletal Tracking

The kinect 3D depth sensing camera can track 20 points on the human body during motion in real time. This allows the program to use data points to determine body position in the x, y, and z directions.

Angle Calculations

The program then uses the position data to:

- calculate the angles of limbs relative to one another using trigonometry
- determine if the angle is correct for the exercise or if the position needs to be adjusted
- assign a value to activate the correct feedback

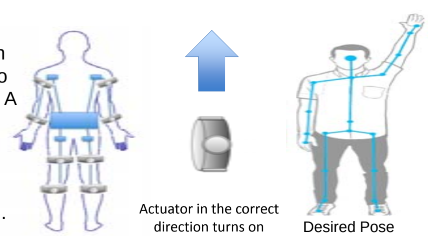
$$x = |\text{Left Knee}(x) - \text{Left Hip}(x)|$$

$$y = |\text{Left Knee}(y) - \text{Left Hip}(y)|$$

$$\text{Left Hip Abduction} = \tan(x/y)$$

Vibrational Feedback

Each limb has vibration motors on opposite sides to indicate which direction the user needs to move to be in the correct position. A microcontroller activates the vibration motor to guide the user to the correct pose based off of the output of the program.

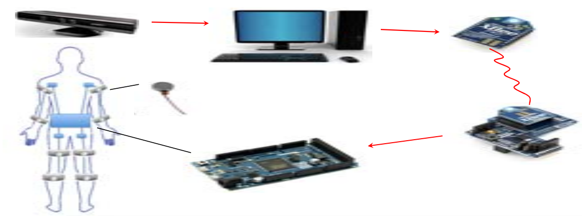


Exercise Poses

4 Poses were chosen based off of the capabilities of the Kinect- Skeletal data is most accurate when the user is standing facing the camera. The poses focus on balance, flexibility, and spatial awareness.

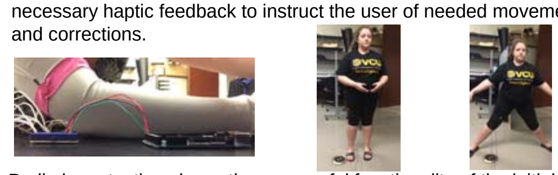
5-Point Star | Mountain | Warrior II | Tree

Block Diagram of System



Results & Conclusions

The program was able to determine the joint angles of the user and apply these values to the rules of each yoga pose. It also provided necessary haptic feedback to instruct the user of needed movements and corrections.



Preliminary testing shows the successful functionality of the initial prototype. With the integration of the wireless component and optimization of the Kinect skeletal data acquisition, our product would be ready for clinical trials