# Tailored Automated Coaching and Assessment with an Interactive Exercise Intervention for Older Adults in the Home

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## Motivation

**Exercise enhances mobility, flexibility, and balance in seniors.** Exercise that improves strength, flexibility and posture, will in turn will help with balance, coordination, and reducing the risk of falls. Strength training also helps alleviate the symptoms of chronic conditions such as arthritis.

**Exercise reduces the impact of illness and chronic disease.** Among the many benefits of exercise for seniors include improved immune function, better heart health and blood pressure, better bone density, and better digestive functioning. Seniors who exercise also have a lowered risk of several chronic conditions including Alzheimer's disease, diabetes, obesity, heart disease, osteoporosis, and colon cancer.

**Exercise improves sleep.** Poor sleep is *not* an inevitable consequence of aging and quality sleep is important for overall health and functioning. Exercise often improves sleep, especially for seniors.

**Exercise boosts mood and self-confidence.** Endorphins produced by exercise can reduce feelings of sadness or depression. In addition, being active and feeling strong naturally helps seniors feel more self-confident.

**Exercise improves cognitive functioning.** Exercise benefits cognitive function in several ways, including increasing blood flow to the brain and in increasing brain plasticity. Research has shown that several types of exercise improve seniors' cognitive scores.

**Exercise helps seniors maintain or lose weight.** As metabolism naturally slows with age, maintaining a healthy weight is a challenge. Exercise helps increase metabolism and builds muscle mass, helping to burn more calories.

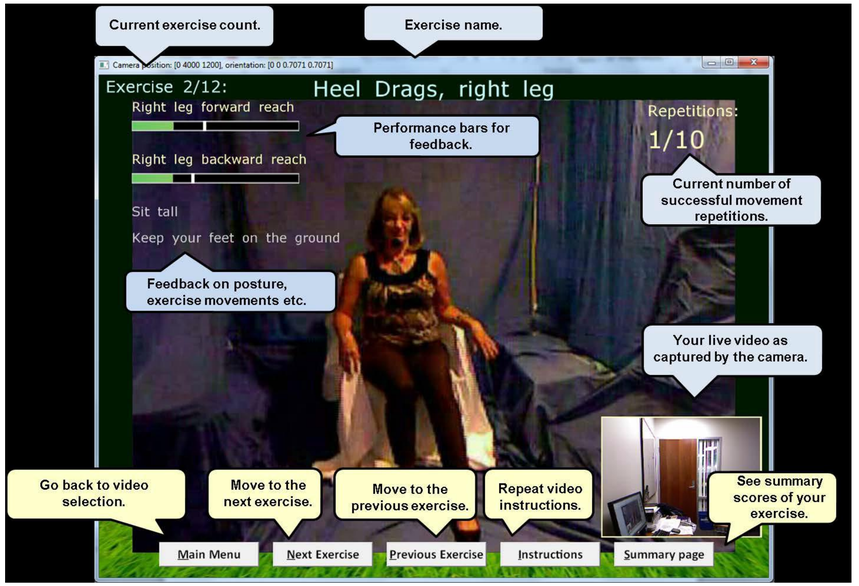
## Approach

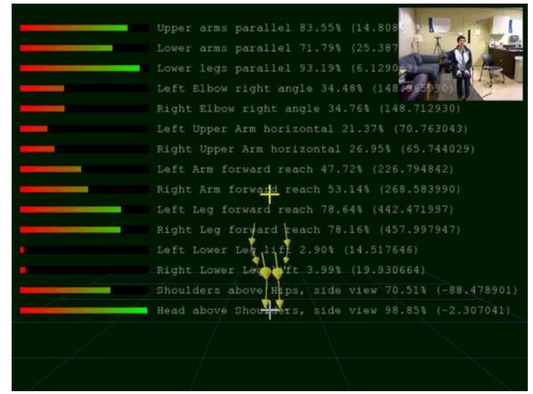
**Software platform for delivering health behavior coaching interventions to the home:** Tailored interventions for physical exercise, sleep, socialization and cognitive exercise for seniors. Adherence and outcomes based on sensor data (activity, computer interactions, etc.). Designed to facilitate a health coach in managing a large population.

**Design an automated interactive exercise system:**

- **Video with a selection of prescribed chair exercises featuring our physical therapist**
- **Kinect camera used to obtain skeleton representations of the user's movements during the exercise in the home**
- **Compare goal movements to actual movements to generate automated feedback**

**Develop automated assessment methods to measure and monitor balance, flexibility, and strength**



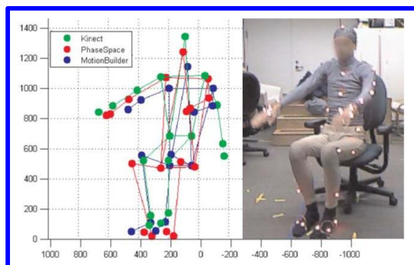

Examples of pose measurement primitives.

These are internal, not shown to the user.

### Example: Inference of Balance

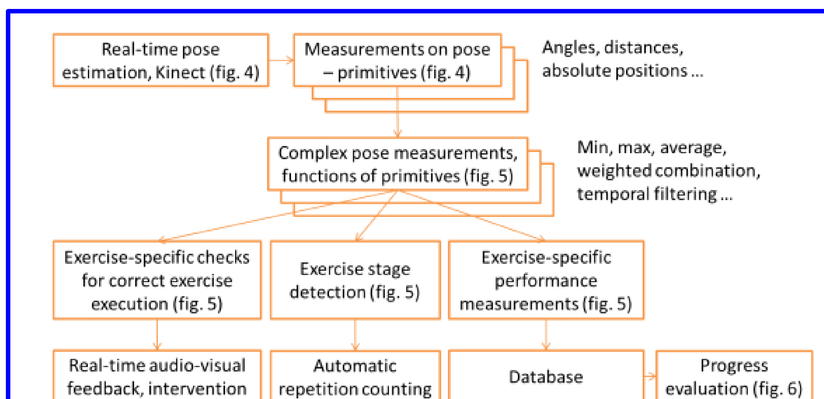
For the shallow squat exercise, the features used for defining balance are based on (1) the position of the left hip relative to the left foot, (2) the position of the right hip relative to the right foot, (3) the position of the left shoulder relative to the left foot, and (4) the position of the right shoulder relative to the right foot. Balance is then defined as the stability of the center of mass and the minimum jerk trajectory.


Achieved exercise-specific performance measures are stored in a database, temporal progress charts are shown after each exercise




| Joint | mean dist $\mu_j$ | std. dev $\sigma_j$ | weight $\rho_j$ | outliers $\frac{\lvert O^P \rvert}{T}$ | indicated $I$ $\frac{\lvert I^P \cap I^K \rvert}{\lvert I^P \rvert}$ | indicated $O$ $\frac{\lvert O^P \cap O^K \rvert}{\lvert O^P \rvert}$ |
|---|---|---|---|---|---|---|
| Left Hip | 213 mm | 27 mm | 1.00 | 0% | 100% | — |
| Right Hip | 234 mm | 23 mm | 1.00 | 0% | 100% | — |
| Left Knee | 79 mm | 16 mm | 0.78 | 22% | 100% | 0% |
| Right Knee | 77 mm | 12 mm | 0.74 | 26% | 100% | 1% |
| Left Ankle | 146 mm | 39 mm | 0.87 | 13% | 97% | 8% |
| Right Ankle | 193 mm | 38 mm | 0.86 | 14% | 99% | 6% |
| Left Shoulder | 49 mm | 18 mm | 0.85 | 15% | 100% | 0% |
| Right Shoulder | 44 mm | 17 mm | 0.85 | 15% | 100% | 0% |
| Left Elbow | 57 mm | 25 mm | 0.82 | 18% | 95% | 8% |
| Right Elbow | 76 mm | 31 mm | 0.83 | 17% | 96% | 0% |
| Left Wrist | 67 mm | 30 mm | 0.81 | 19% | 97% | 86% |
| Right Wrist | 76 mm | 42 mm | 0.81 | 19% | 93% | 61% |

Comparison of Kinect skeleton with motion capture based skeletons (left). Parameters of distribution of L2 distances between the joints determined by the motion capture and the Kinect skeletons (right).




Automated evaluation of performed exercises: Data flow overview

## References:

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