

A Novel Visualization System for ICU Clinical Activity Tracking

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However, there is a lack of methods to quantify and evaluate these bedside interactions.

An automatic system is needed to calculate the interaction between nursing activities and patient outcomes.

We compared SPRINT from 2006-2008 to STAR in the last year

	STAR Christchurch	SPRINT	P- Value
Total patients	199	357	
Age	64 [54 : 72]	65(50 : 74)	0.86
Percent male	66.3	62.2	0.33
Length of Stay	5.4 [2.6 : 14.2]	4.8(2.0 : 11.6)	0.05
% Operative	38.7	44.8	0.16
APACHE II Score	20.0 [14.0 : 25.0]	18.0 [15.0 : 24.0]	0.14

LOS was increased on average from 4.8 – 5.4 days ($p < 0.05$), but APACHE II score was similar (18.0-20.0, ($p = 0.14$)).

While patients are the same level of illness, they are staying longer.

Hypothesis: more ill patient can have the same APACHE score.

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- ➔ Better allocation of nurse resource.
- ➔ Design the optimal N/P ratio for different type of patients.

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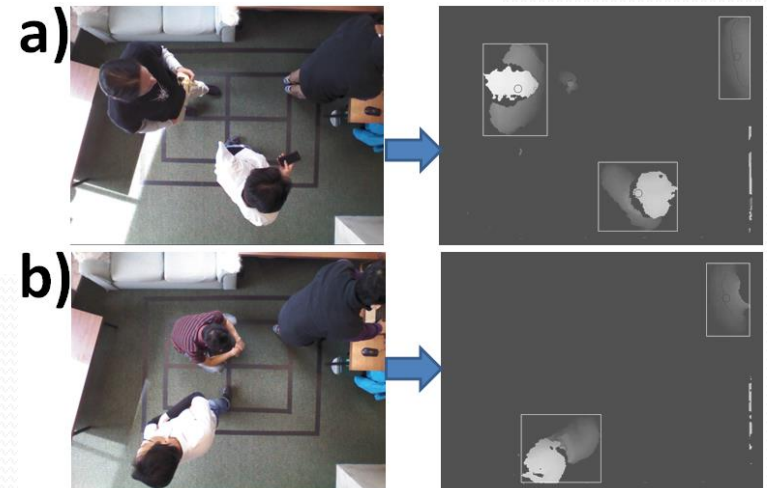
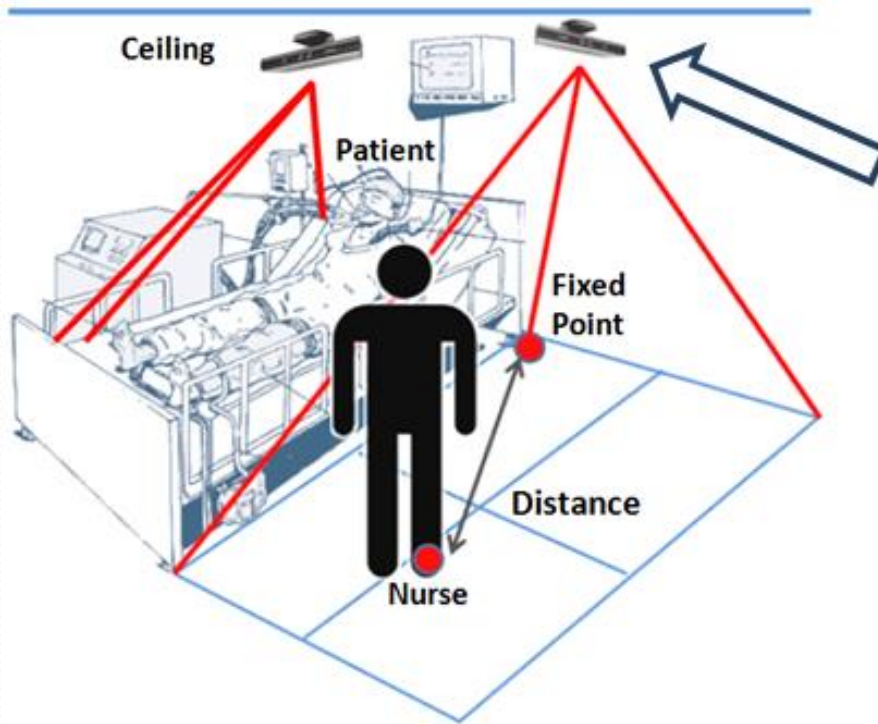
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Benefit three groups:

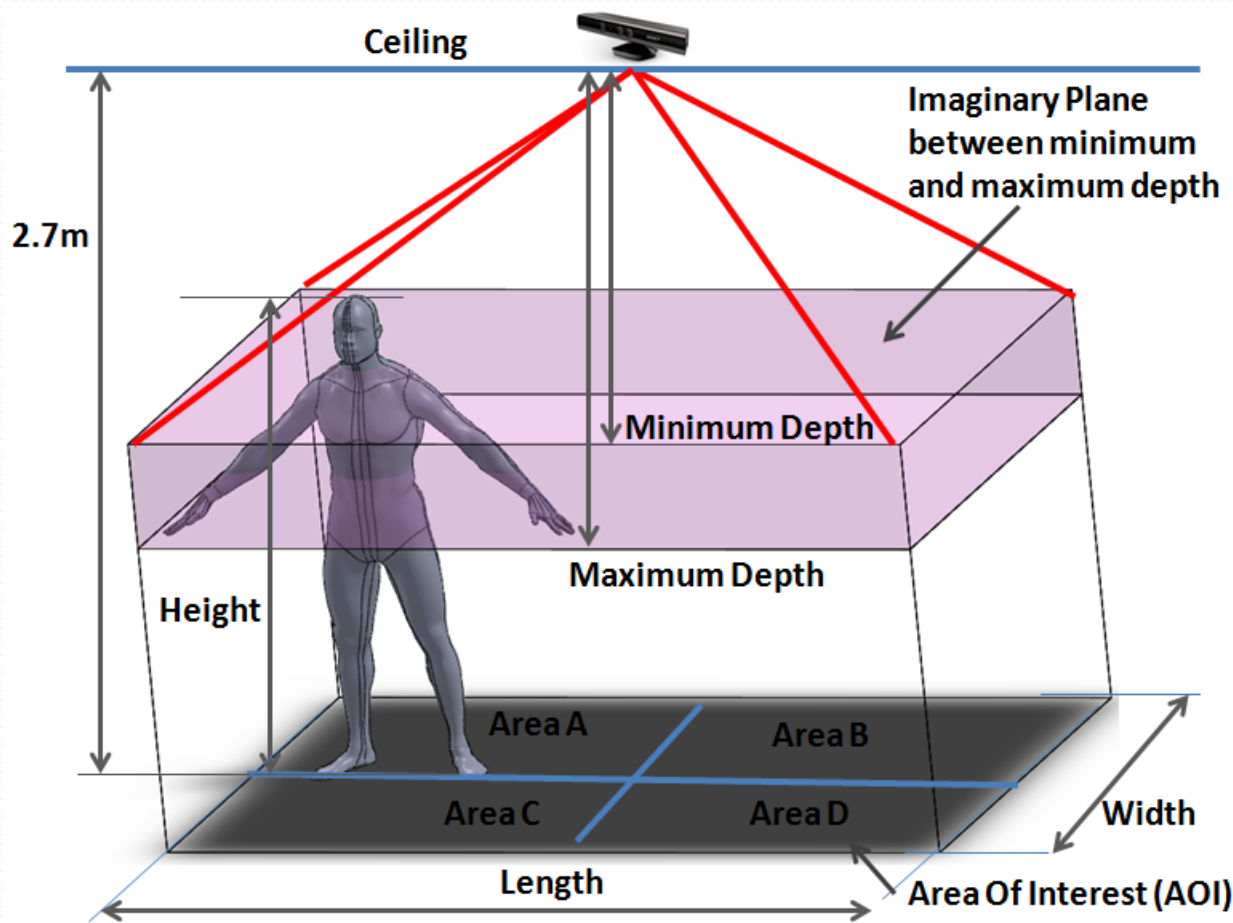
1. **Nurse:** improve work satisfaction, reduce workload
2. **Patient:** receiving more nursing caring, decrease mortality, reduce length of stay (LOS)
3. **ICU:** less LOS, less cost

2. Method

2.1 The Clinical Activity Tracking System (CATS)



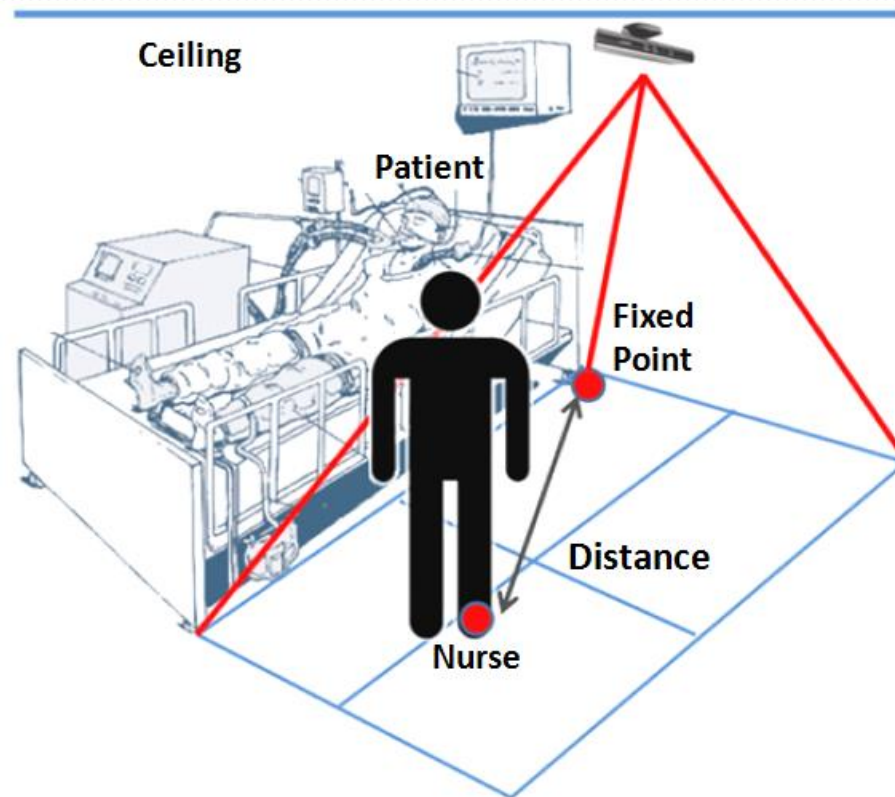
2.1 The Clinical Activity Tracking System (CATS)



1. Height: 1.5-1.9 m
2. Depth: 0.96-1.66 m (Min -Max)
3. Blob size: $> 0.5 \text{ m} \times 0.5 \text{ m}$ or $< 0.2 \text{ m} \times 0.2 \text{ m}$ are removed

2.2 Metrics

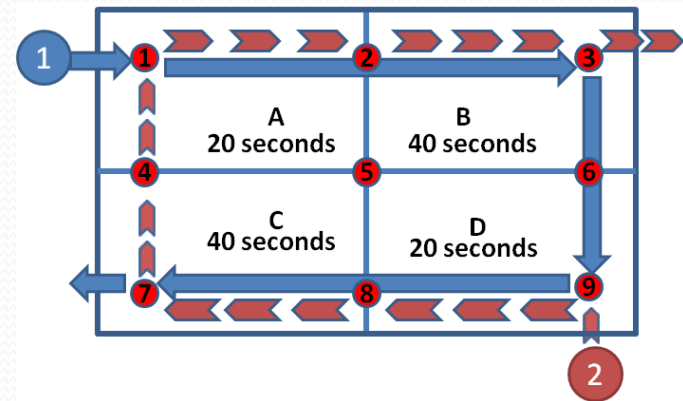
1. **Distance:** Distance is defined as the distance between the nurses and a Fixed Point
2. **Dwell time:** Time is recorded along with object's position if any object shows up in the depth image.



The distance between each nurse and the fixed point

2.4 Testing Process

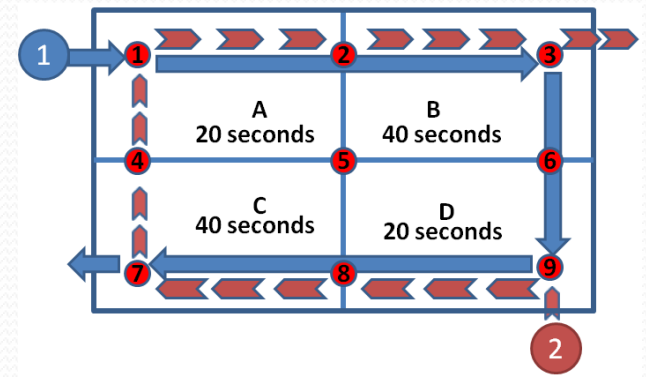
1. Find the tracking area and find the best system parameters, such as Maximum Depth, Minimum Depth and blob filter.
2. Validation for different walking paths
3. Validating CATS suit for different heights, ranging from 1.50-1.90 m.
4. Validating CATS suit for multiple tracking (2 candidates).



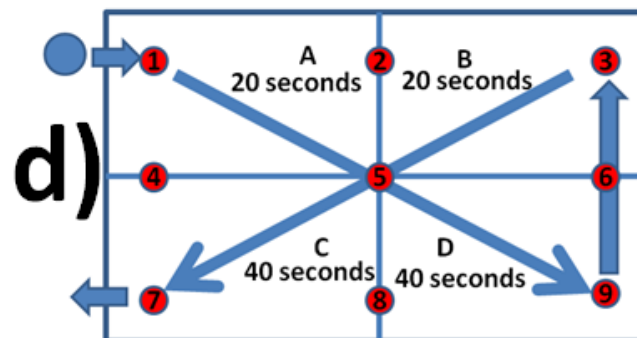
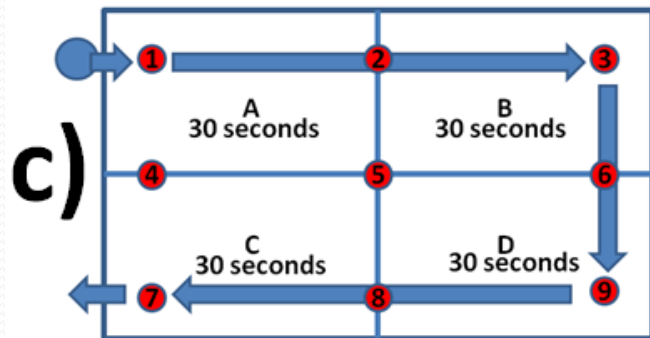
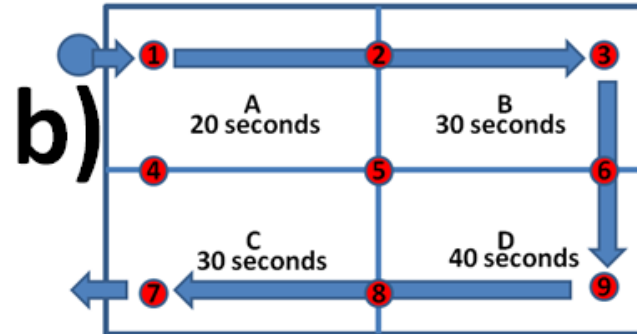
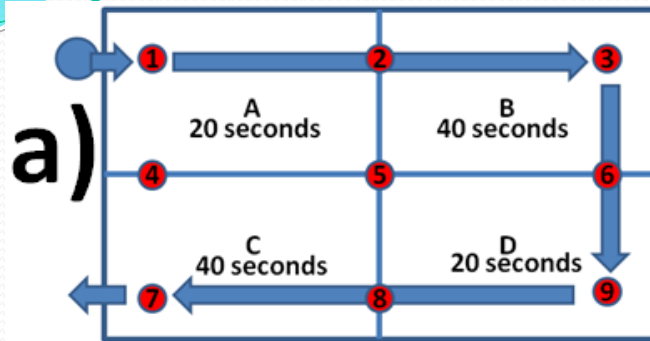
2.5 Absolute percentage error (APE) of motion tracking

$$APE(t) = \left| \frac{\text{Distance}(t) - \text{Average Distance}(t)}{\text{Average Distance}(t)} \right| \times 100\%$$

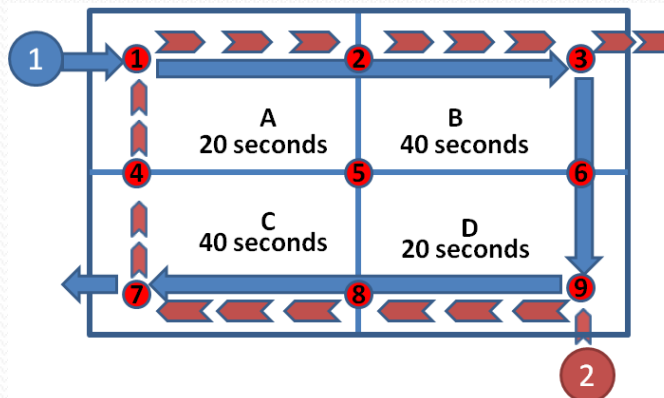
- There are 5 iterations, which generates 5 distances. Each person repeat the movement 5 time.
- The Median, inter-quartile range (IQR) and 90% confidence interval (CI) of the APE are calculated.



2.3 Walking patterns for test candidate



Different motion paths and timing for the single candidate tests.



The walking pattern for multiple candidates.

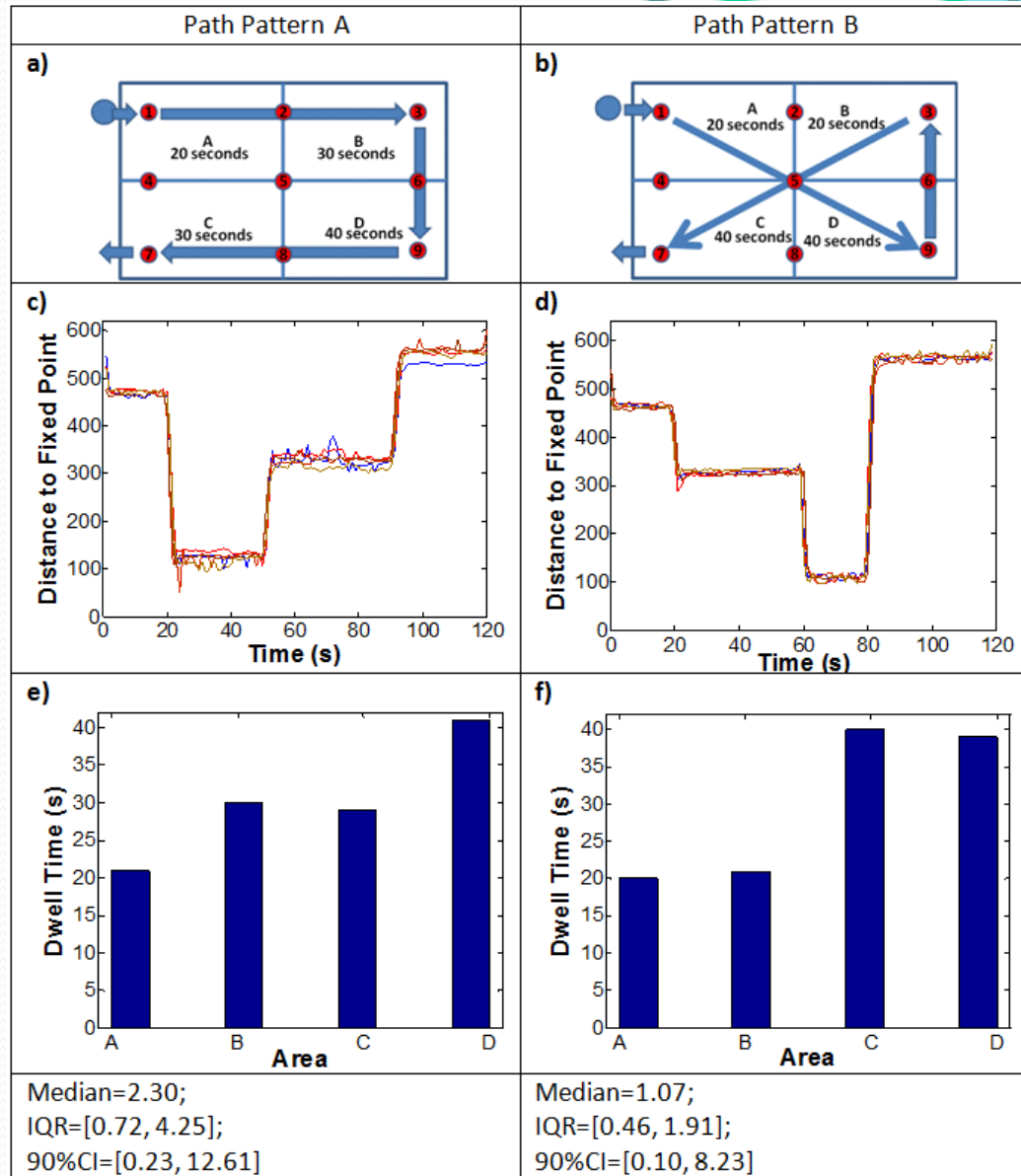
3. Results

3.1 Area covered and system parameters

Candidates Body Part	Depth		Total Tracking Area(m ×m)
	Minimum Depth(m)	Maximum Depth (m)	
Head (0.96 m- 1.16 m)	2.7-1.74=0.96	2.7-1.54=1.16	1.38×1.00
Chest (0.96 m- 1.46 m)	2.7-1.74=0.96	2.7-1.24=1.46	1.90×1.40
Thigh (0.96 m- 1.96 m)	2.7-1.74=0.96	2.7-0.74=1.96	2.30×1.60

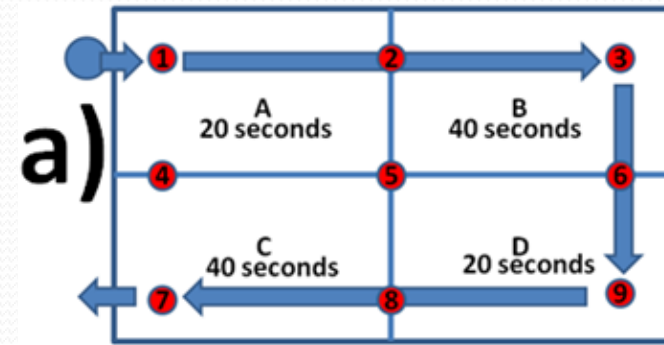
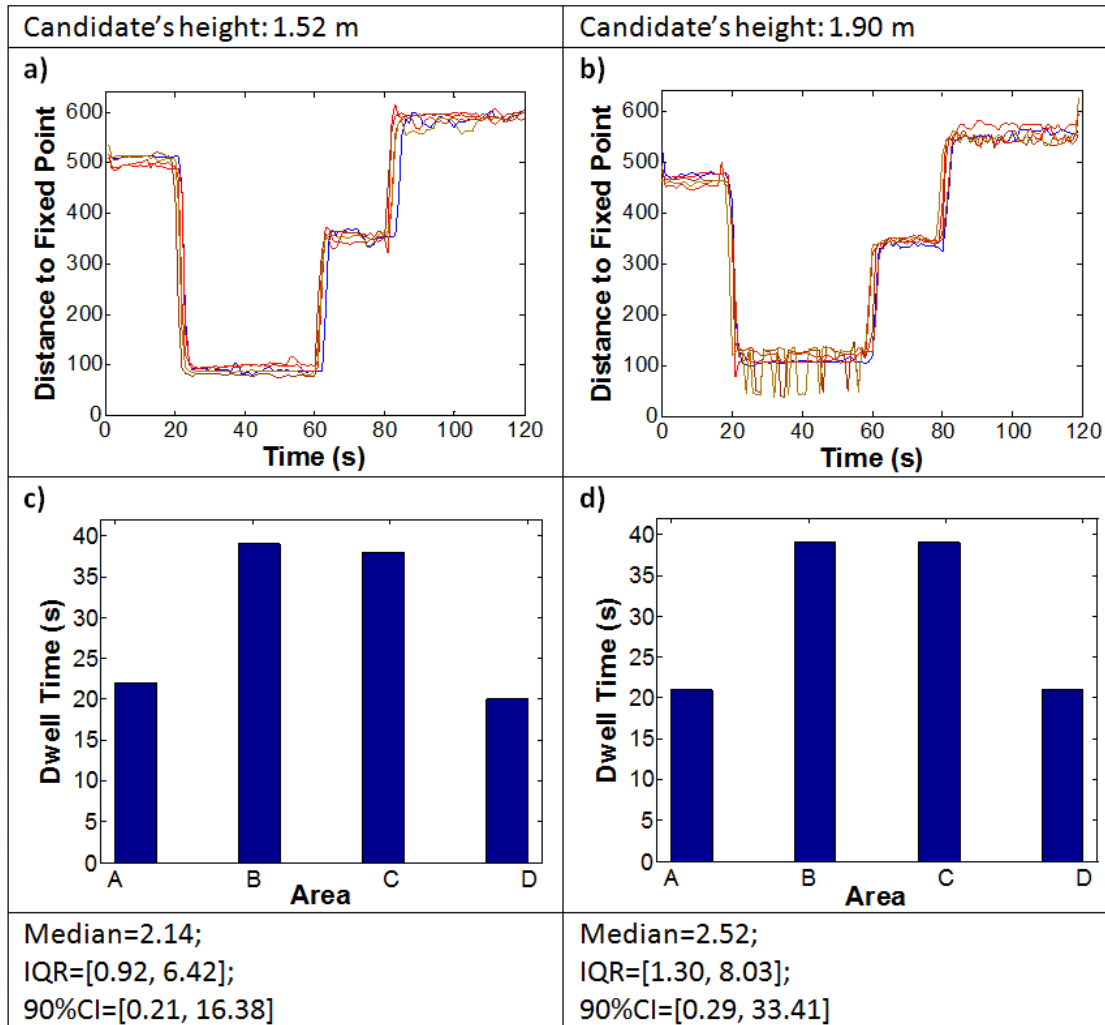
Tracking area based on maximum
and minimum depth variables

3.2 Validation of different paths



The consistency of tracking with different paths

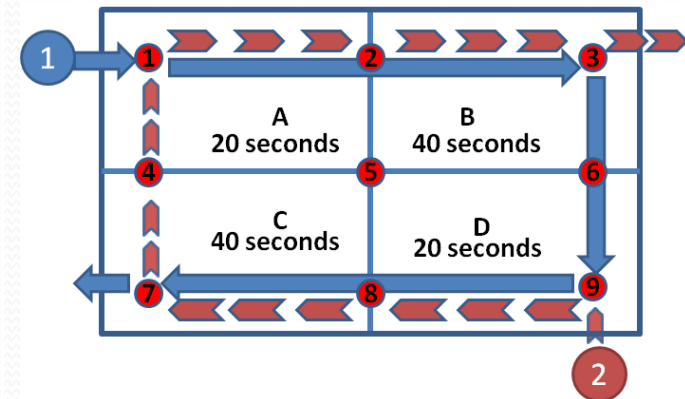
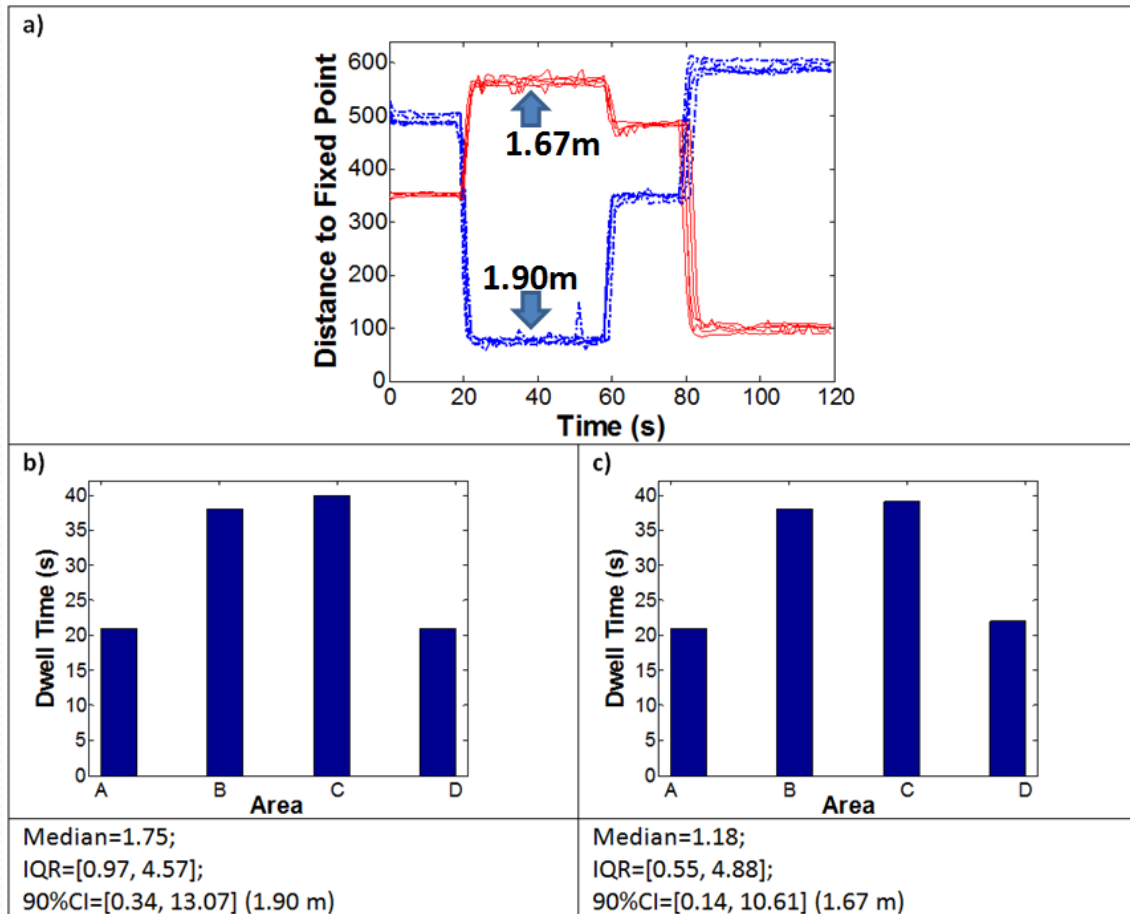
3.3 Validation of candidate heights



Path Pattern

The consistency of tracking different heights

3.4 Validation for multiple candidates tracking



Multiple candidates monitoring using different walking pattern

4. Conclusion

- CATS can be used to accurately track test candidate motion and dwell time inside the tracking area.
- CATS was able to detect different walking patterns, people of different heights, as well as multiple simultaneous candidates.
- Two evaluation metrics were developed to monitor patient-nurse interaction, distance and dwell time .

4. Conclusion

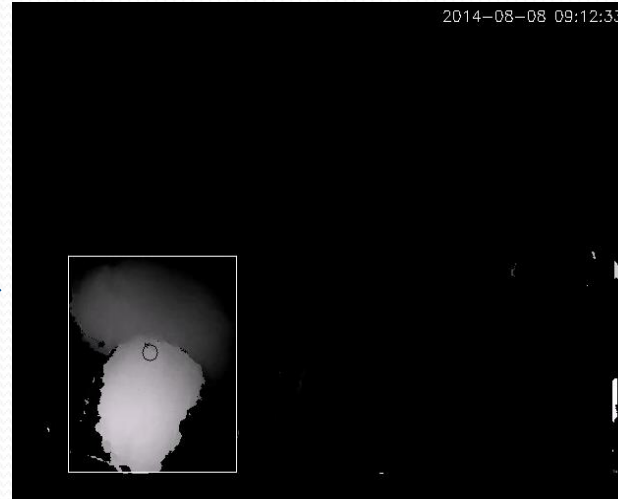
Important Notes:

1. CATS cannot identify the person in the tracking area because of the health and privacy issue of the working area.
2. CATS can only detect some of nursing activities because of the limitation of detection area.

5. Clinical Trial in ICU

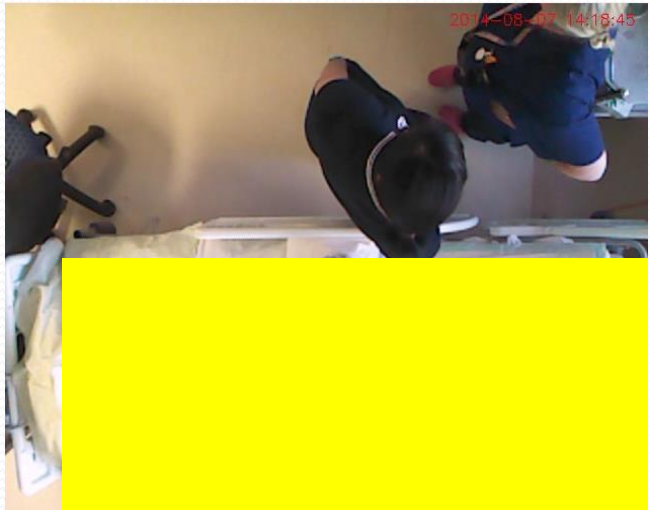


5. Clinical Trial in ICU



- Multiple tracking
- Non-invasive
- Protect privacy
- Reliable

Right side of patient bed



Left side of patient bed

Acknowledgement

This work was supported by EU FP7 IRSES (FP7-PEOPLE-2012-IRSES) program, project title: eTime - Engineering Technology-based Innovation in Medicine, Grant No. 318943.



Thank You!

Questions?