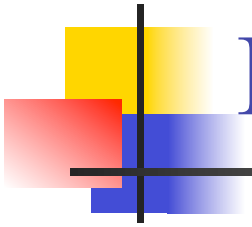
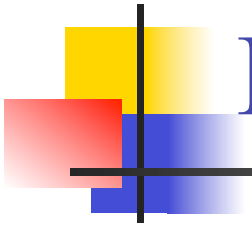
Health Monitoring of Residents in an Assisted Living Facility (ALF) using Ultra Wideband Radio RTLS

William D. Kearns, PhD
Department of Aging and Mental Health Disparities
Louis de la Parte Florida Mental Health Institute
College of Behavioral and Community Sciences
University of South Florida
Tampa, Fl 33612



Research Objectives

- Develop an objective (software based) measure of quantifying wandering behavior to further the study of dementia
- Use it to detect movement patterns in elders that may be linked to dementia
- Provide long term care surveillance through automata and computer networks
- Interface with Electronic Health Record



Requirements

- Precise and reliable positioning
- Wearable device must have:
  - Long battery life
  - Minimal obtrusiveness
  - Can’t be turned off by the user
  - Must be easy for ALF staff to use
- Data analysis must be intuitive & make theoretical sense

Pilot Study: Method

- Subjects
  - 14 Elders (12 F) with no history of SMI; 6 with a diagnosis of dementia
  - Mean age 82.2 (SD 9.92) Median 86.5 years
  - 7 ADL's and 1 IADL were assessed: ambulation, bathing, dressing, toileting, eating, grooming and transferring
    - Mean ADL score 5.4 (SD=1.78); Median 6
  - 1 ambulatory, 8 used wheelchairs, 5 used walkers

Method

- Setting
  - Assisted Living Facility (ALF) offering hotel services to its residents
  - Monitored room was a common space connecting 2 dormitory areas to a dining area and outside door
  - Tags were put on at breakfast/medication time and removed before retiring
  - Persons walked and watched TV & listened to music and sat at tables or on couches

Method

- Measures (investigator blinded)
  - Dementia diagnosis
  - ADL level
  - Revised Algase Wandering Scale-Community Version
  - MMSE taken at end of study by naïve graduate asst.
  - Movement path tortuosity (Fractal Dimension)
    - **Movement Measurement Apparatus** -
      - **Ubisense Ultra Wideband RFID research pack**
      - **14 compact tag wrist transponders measuring 38mm x 39mm x 16.5mm with a weight of 25 gm**
      - **4 wall mounted Ubisensors**
      - **1 Power of Ethernet switch**
      - **1 Dell Inspiron 1501 notebook computer**
  - Wireless network interface & local ISP (Brighthouse Networks) for unattended SFTP transfers

UWB Active RFID

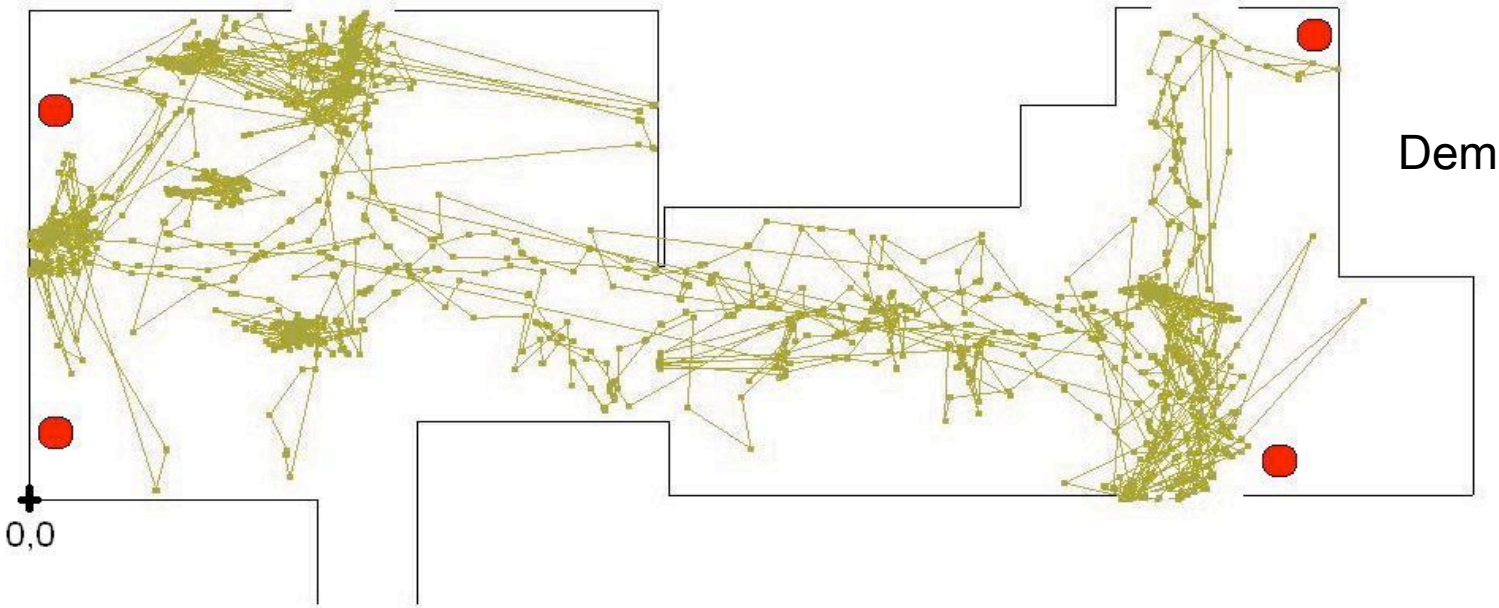
Movement Analysis

- 854,336 records out of 1.4M were usable
- Analyzed by SPSS ver. 17 & Fractal Dimension Analysis program (Nams, 2006)
- Movement Dependent Measures:
  - Path tortuosity (Fractal Dimension)
  - Distance traveled
  - Rate of travel in M/sec.

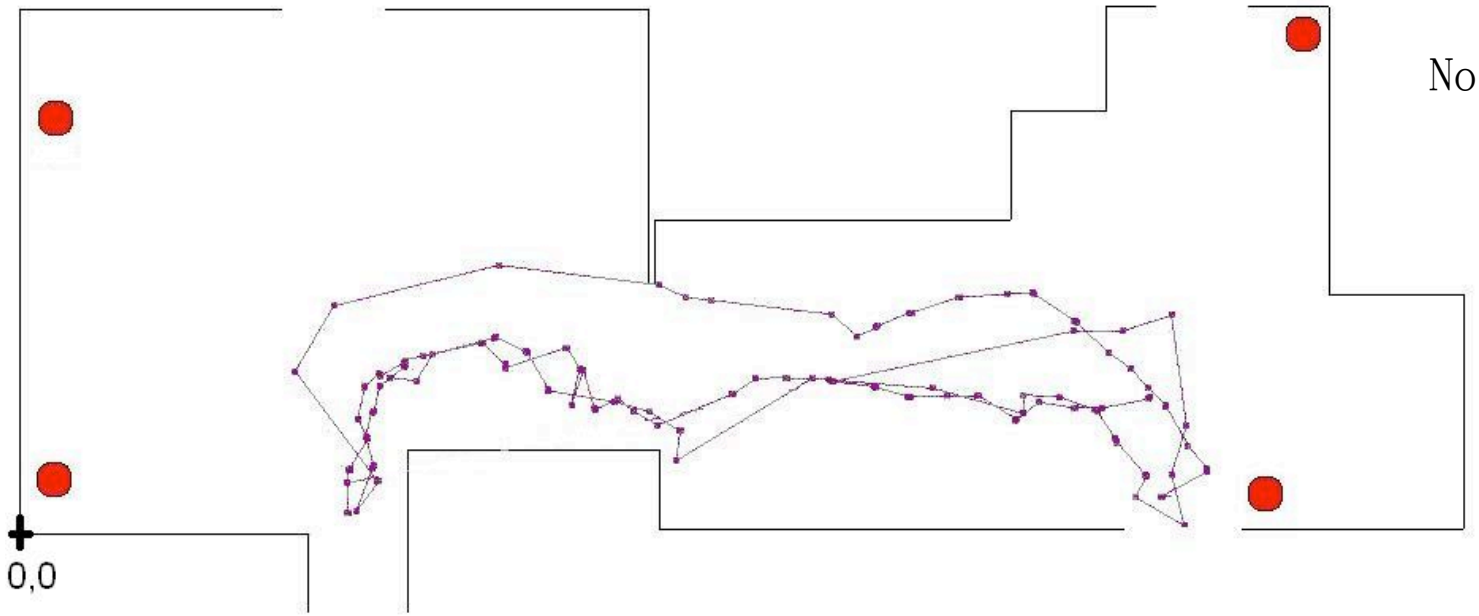
Nams VO. Improving accuracy and precision in estimating fractal dimension of animal movement paths. *Acta Biotheor.* 2006;54:1-11.

Results

- MMSE correlated -.47 with Fractal Dimension path tortuosity ($p<.05$)
  - MMSE ranged from 8-28 (mean=20.36 SD=4.9; median=20.5).
  - Fractal Dimension ranged from 1.19 to 1.84 (mean=1.47 SD=.21; median=1.42)
- All subjects above the median Fractal Dimension of 1.42 were classified as wanderers by the RAWS-CV
- Method of locomotion was unrelated to Fractal Dimension: Wheelchair, walker or ambulatory status unimportant
- Amount of walking & travel rate unrelated to MMSE score

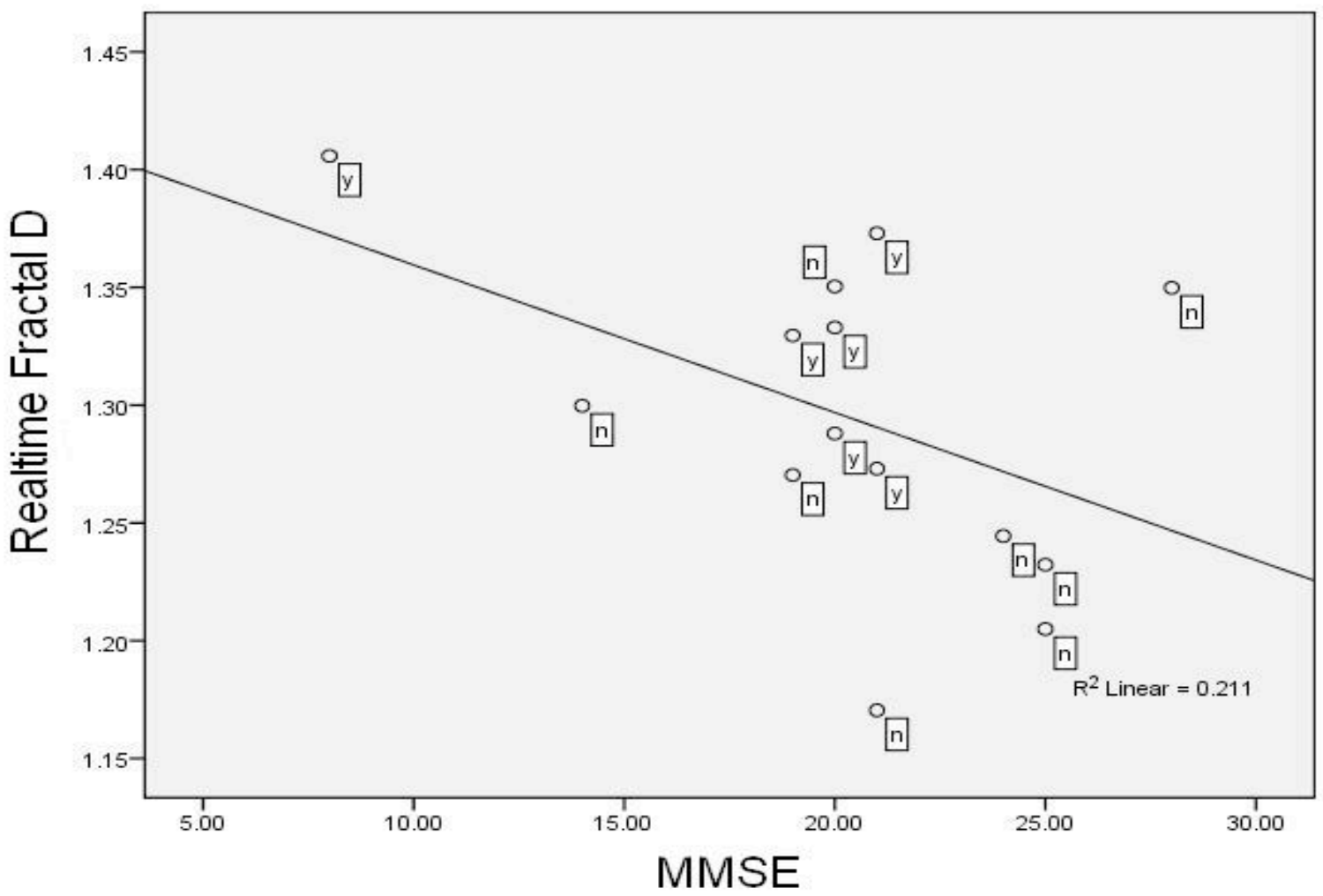


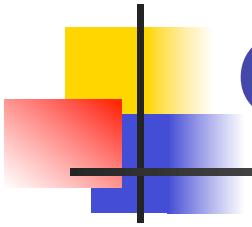
Dementia



No Dementia

Path Tortuosity & Dementia





Conclusions

- Decreased cognitive functioning is associated with more path variability in elders
- Path variability can be obtained from elders in ALFs, homes and nursing homes through Ultra Wideband RFID and transferred successfully to remote monitoring facilities
- Path variability may provide a way to sense cognitive decline before it becomes visible