

University of Pittsburgh

# Where are the Smart Wheelchairs?

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Where are the Smart Wheelchairs by Richard C Simpson June 9, 2011

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The first peer-reviewed journal article describing a smart wheelchair was published in 1986 – 25 years ago this year

There have been over 50 “smart wheelchairs” built since then

So where are the smart wheelchairs?

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**1986**



**2011**



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**1986** **2011**

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**1986** **2011**

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**Where are they?**

- We have cars that parallel park on their own
- We have robot vacuum cleaners that detect drop-offs
- Why do I keep getting emails like this?

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My nephew, Andrew, has cerebral palsy and we are intending to purchase a 'smart chair' for him in the next few months. I read your 2005 paper in JRRD and wondered whether anyone has revisited this subject in the past 4 years. In particular, I wondered if there you were aware of any advances, particularly in the commercial availability of smart chairs, in the past 4 years.

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## Research Smart Wheelchairs

**Tao**



**TinMan**



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## Call Centre Smart Wheelchair

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## Why don't we have smart chairs?

- Sensors
- Universal Communication Bus
- Reimbursement
- Evidence

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## Sensors

These days, the cost is in the sensors.

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## Sensors

- People who don't work with robots don't appreciate how good our senses are
- Affordable sensors
  - Can't detect drop-offs
  - Can't pass through narrow doorways
  - Don't work outdoors

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## Sensors

- Accurate sensors
  - aren't affordable
- Machine vision is a research problem unto itself
- The Geoff Fernie problem
  - There's only one way to get 100% reliability

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## Universal Communication Bus

- There is no "USB" for wheelchairs
  - The good old days of analog...
  - Most wheelchairs now used a proprietary CANBus
- No incentive for manufacturers
  - No competition for input devices
  - No worries about liability or tech support

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## Universal Communication Bus

- How do we create an incentive?
  - The lesson of Section 508
  - Tie it to wheelchair funding
    - "We will reimburse more if..."
    - "We won't reimburse unless..."

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## Reimbursement

- It's hard enough to get reimbursement for a regular power wheelchair
- We don't have any evidence that smart wheelchairs improve outcomes
  - Collisions are rarely the only problem
  - 32 Skills on Wheelchair Skills Test 4.1
    - About 6 involve obstacle avoidance

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## Reimbursement

- The lesson of the iBOT
  - The “category without a distinction”

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## Evidence

- Smart wheelchairs are not rigorously tested
  - Most of what we have are small studies done in the lab with able-bodied users
  - We don't even have Level V evidence that smart wheelchairs *really* make a difference *in the real world*

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Testing in the field is hard

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## Field Trials

- Cost and Duration
  - Each smart wheelchair costs a lot of money
  - Can only enroll a small number of people
  - We're looking for small effects
  - Really long studies

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## Field Trials

- Measurement
  - What do you measure?
    - Even bad wheelchair users don't crash that often
  - How do you measure it?
  - How do you combine or prioritize measures?

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## Field Trials

- The lesson of Honeywell
  - Tested smart home technology
  - Small sample size
  - Short study duration
  - No control group
  - No evidence

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Testing in the lab isn't any easier

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## Lab Trials

- Training
  - We gave each participant a LOT of training
  - It still wasn't enough in all cases
- Sample size
  - Getting target users into the lab isn't easy
    - By definition, they don't get around very well

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## Lab Trials

- Getting people to hit things is hard
  - Blindfolds help
  - Driving backwards helps
- Moving obstacles
  - Hard to implement
  - Hard to assign responsibility for collisions

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## Lab Trials

- Single subject experimental designs
  - Difficult to generalize
- Group experimental designs
  - Small and heterogeneous subject population

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## Contact information

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