Assistive Mobility Devices: Smart Walkers

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Outline

- Introduction
- Standard Walkers
- Smart Walkers
- Literature Review
- Summary
- Comparison
- Analysis
- Discussion Topics
- Questions
Introduction

- One of the problems that affect the most of the elderly population is the reduction of mobility.

- Mobility affects
  - Person’s locomotion capacity
  - Ability to realize personal tasks
  - …
  - Interaction of a person with his surroundings
Introduction (cont.)

- Assistive devices for people with mobility problems
  - Alternative devices
  - Augmentative devices
- Depending on the degree of disability of user
Alternative Devices

- In the case of total incapacity of mobility
- These devices mainly include:
  - Wheelchairs
  - Solutions based on autonomous especial vehicles
Alternative Devices (−)

- The continuous and sometimes unnecessary use of wheelchairs cause problems:
  - Loss of bone mass
  - Degradation of blood circulation
  - Degradation of physiological functions
  - Skin sores
  - Osteoporosis
  - ...

- Psychology problems
Augmentative Devices

- In the case of reduced mobility capacity
- Augmentative devices
  - Canes
  - Walkers
Augmentative Devices

- In the case of reduced mobility capacity
- Augmentative devices
  - Canes
  - Walkers
- Walkers are the focus of this talk.

- Maintaining the standing position has both physical and psychological benefits.
  - Self-esteem
  - Relationship issues
Walkers

- The walkers play an important role among augmentative devices
  - Large number of users
  - Simplicity and rehabilitation potential

Augmentative devices can use person’s remaining locomotion capability, avoiding the early and deteriorative use of wheelchairs
Different Types

- Classification based on ground contact configuration
  a. Only with legs
  b. With legs and wheels
  c. Three to four-wheeled walkers
Problems

- Problem with standard walking aids:
  - The pushing energy required to move
  - The lack of stability, especially in braking
  - The possibility of collision with obstacles
  - The difficulty with orientation

- In case of walkers with legs
  - Unnatural and discontinuous gait pattern
  - Strength needed to lift the walker
Solutions

- Robotic walkers and guiding devices, using a great variety of sensors and actuators
- Techniques used to solve problems mentioned
  - Navigation strategies
  - Mapping
  - Control
  - Auto-localization
  - Other concepts mostly used in the field of mobile robotics
Smart Walkers

- Smart walker = Robotic versions of walkers

- Functions realized by the smart walkers in the literature:
  - Physical assistance
  - Sensorial assistance
  - Cognitive assistance
  - Health monitoring
Functions (1/4): Physical Assistance

- All smart walkers, has some kind of physical support functions
- Two types of physical assistance:
  - Passive
  - Active
Passive Physical Assistance

- Goal: Improve stability during gait by introducing structural enhancements
  - Enlargement of base of the device
  - Placement of heavy elements at lower planes

- Replacement of the conventional handles by forearm support platforms
  - Degree of freedom of elbow is eliminated
  - Higher fraction of user’s weight can be supported
  - Risk of glide will be reduced
Active Physical Assistance

- Common problems with walkers with three to four wheels
  - Braking requires muscular strength, motor coordination and good reaction time.
  - Strength necessary to push the walker can be high

- Active assistance: Installing motors on wheels
  - Control the brakes
  - Provide pushing energy
  - The motors are controlled by advance user interface
Functions (2/4): Sensorial Assistance

- These devices are equipped with ultrasonic, vision or infrared sensors
  - Detect static and dynamic obstacles
- The control system assists users to avoid them
  - Sound or vibration alerts
  - Operating directly on the device actuators
- Helpful especially for users with visual problems and environments with multiple obstacles
Functions (3/4): Cognitive Assistance

- Assisting user navigation and localization
  - Structured environment
  - Outsides
- Some programmed to follow pre-defined paths
  - Clinics
  - Certain location in a house
  - Auto-localization in a map using markers

- Helpful especially for people with cognitive issues (memory, orientation, …)
Functions (4/4): Health Monitoring

- Monitor health parameters of the user in a smart map
  - keep a medical history of the user
  - Inform the medical staff or caregiver in the emergency situations

- What does a smart map look like?
  http://www.youtube.com/watch?v=eZlrrA9bsvg&feature=related
Literature Review

- Many elderly people that are destined to use a walker, can suffer from multiple health issues

Most of the walkers on literature are multifunctional
PAM–AID

- The Personal Adaptive Mobility Aid (PAM–AID)
- Designed for people with mobility problem and visual impairments, focus is:
  - The user has to have the max control of the device
    - It doesn’t have motorized locomotion
    - The electronic system only controls the orientation of the front wheels
PAM–AID (cont.)

- Info about the environment is provided in the form of two types of voice message to the user
  - Description of the environment
  - Presence of obstacles
VA–PAMAID

- First commercialized version of PAM–AID
- The Department of Veterans Affairs (USA) customized and renamed it to Veterans Affairs Personal Adaptive Mobility Aid (VA–PAMAID).
GUIDO

- Second commercialized version of PAM-AID
- Map navigation
- The third mode of operation is introduced
  - Parked mode
  - Assist the transfer of the user from a chair
PAMM

- PAMM = Personal Aid Mobility and Monitoring
- Offers extra support with
  - Health monitoring
  - Scheduling (reminding time of medicines)
PAMM (cont.)

- Using various health monitoring sensors, it is able to monitor the user’s activity level
  - Speed
  - Applied forces
  - Pulse rate
More Smart Walkers

- Mobil Smart Walker
- The Medical Automation Research Center (MARC)
Summary

- Assistive Mobility Devices → Augmentative Devices → Standard Walkers → Problems/Solutions → Smart Walkers → Literature Review → Limitations.

- Walkers (even better if smart !) can use person’s remaining locomotion capability, avoiding the early and deteriorative use of wheelchairs.
Reference


## Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>Mobil</th>
<th>PAM–AID</th>
<th>VA–PAMAID</th>
<th>GUIDO</th>
<th>PAMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground contact configuration</td>
<td>3–4 wheeled</td>
<td>3–4 wheeled</td>
<td>3–4 wheeled</td>
<td>3–4 wheeled</td>
<td>3–4 wheeled</td>
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<tr>
<td>Support for users with visual impairments</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Parked mode</td>
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<tr>
<td>Health monitoring</td>
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<tr>
<td>Forearm support</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Legend: Y = Yes, N = No
Analysis

- Human–machine interface (–)
  - How practical are advanced interfaces?
  - Training
    - False positive/negative
- How costly are these devices(?)
Next Steps

- The focus needs to be changed on human machine interface, rather than ...
- SIMBIOSIS walker
  - The main focus is on interface (++)
  - Forearm support platform (+)
  - ...

Discussion Topics

- Of the functions discussed for smart walkers, which are the most practical?

- What are the potential limitations?

- Could (robotic) smart walkers be accepted as companions for older adults? What would need to be added/changed for acceptance?

Thank You!

Questions?