

# Human Pacman: A Mobile Entertainment System with Ubiquitous Computing and Tangible Interaction over a Wide Outdoor Area

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# Outline

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1. Introduction
2. Background
3. System Design and Game Play
4. Human-Computer Interface Issues
5. Conclusion

# Background

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- ❑ Derived from work on ubiquitous computing
- ❑ Pirates! Played on PDA's with proximity sensing technology
  - Little immersive experience and no Augmented Reality (AR) or Virtual Reality (VR)
- ❑ Previous work in AR include AR2 Hockey, AquaGuantlet
  - Small space with limited movement and interaction
- ❑ ARQuake is an AR-extension of Quake with wearable computers with GPS and can be played indoor/outdoor
  - Single player with little social interaction
- ❑ Transitioning between Reality-Virtuality continuum
  - The Magic Book
  - Touch-Space

# Novel Features of Human Pacman

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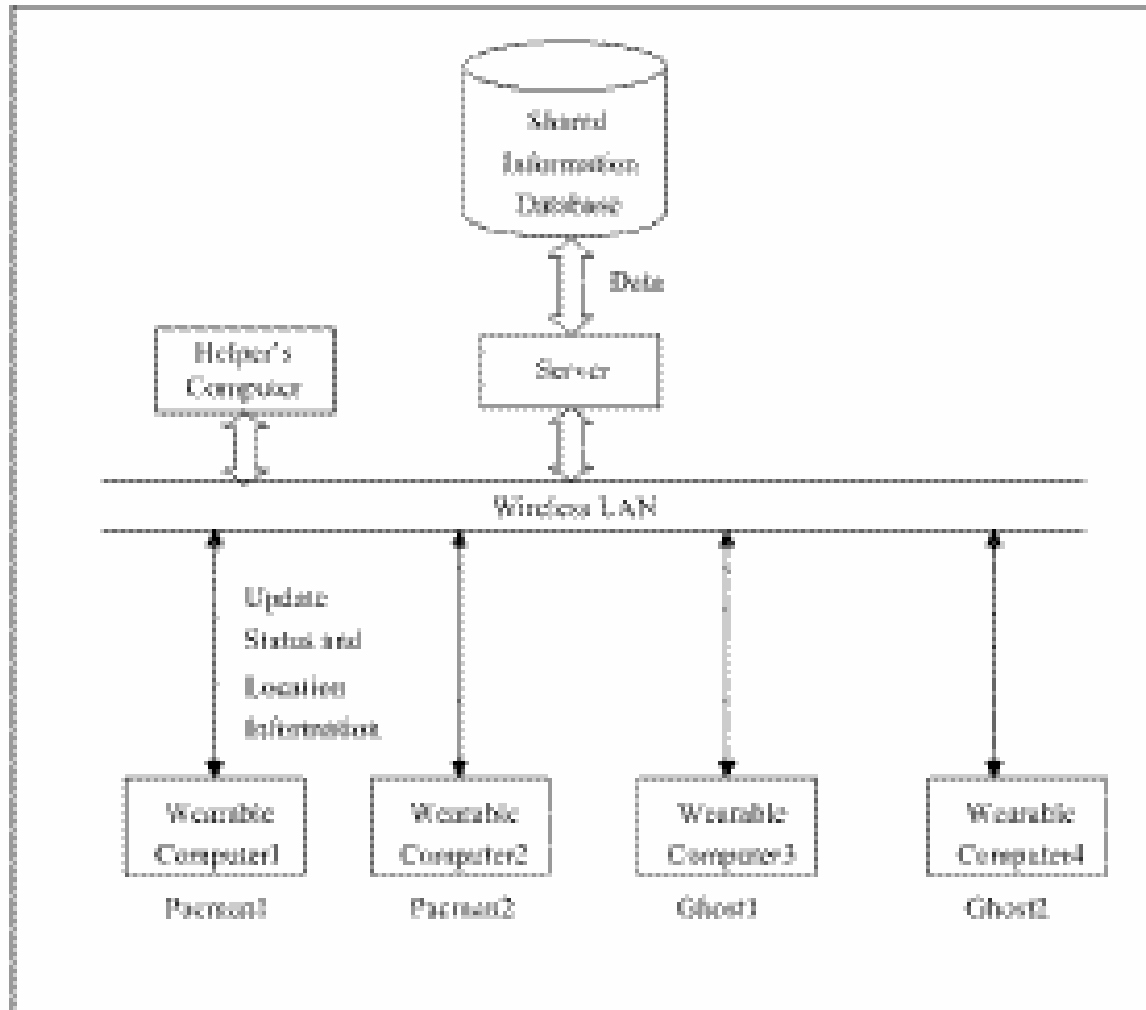
- Physical Gaming
- Social Gaming
- Mobile Gaming
- Ubiquitous Computing
- Tangible Interaction
- Outdoor Wide-Area Gaming Arena
- Seamless Transition between real and virtual worlds

# System Design and Game Play

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- Centralized architecture
  
- Four main entities
  - Central server
  - Wearable computers
  - Laptops
  - Bluetooth embedded objects
  
- Underlying program built on client-server

# System Architecture



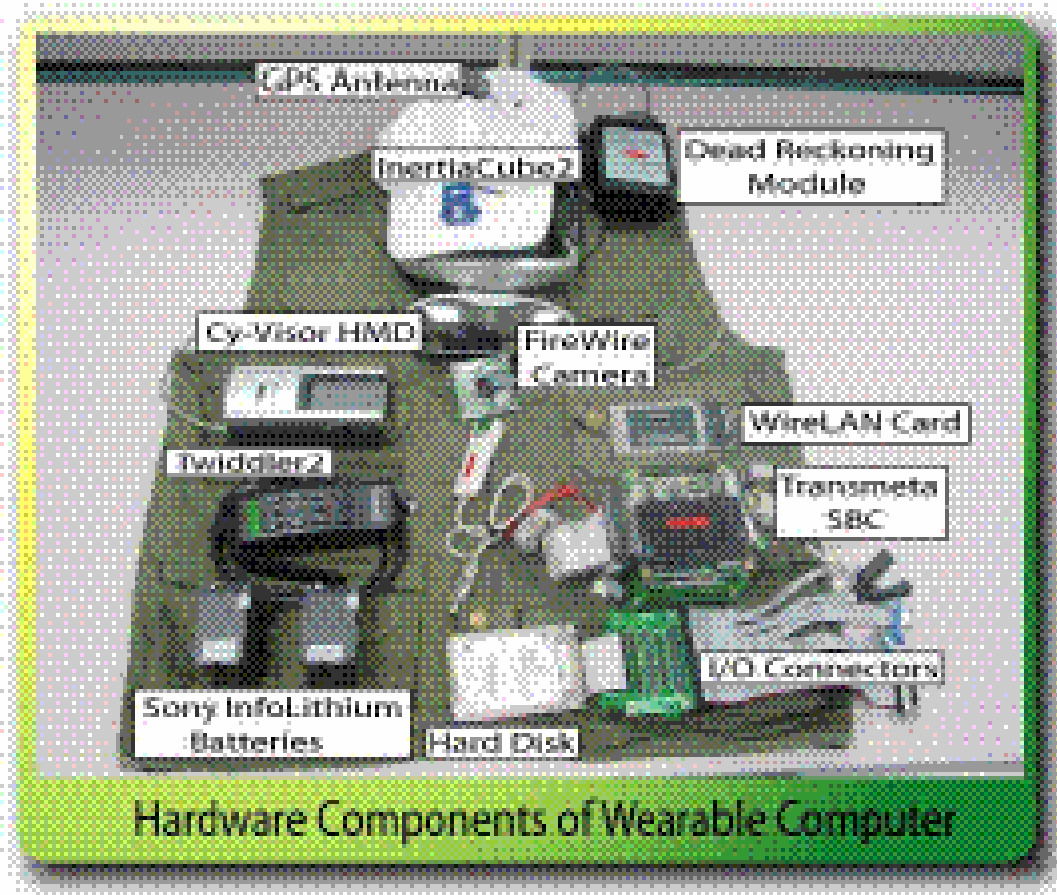
# System Architecture Details

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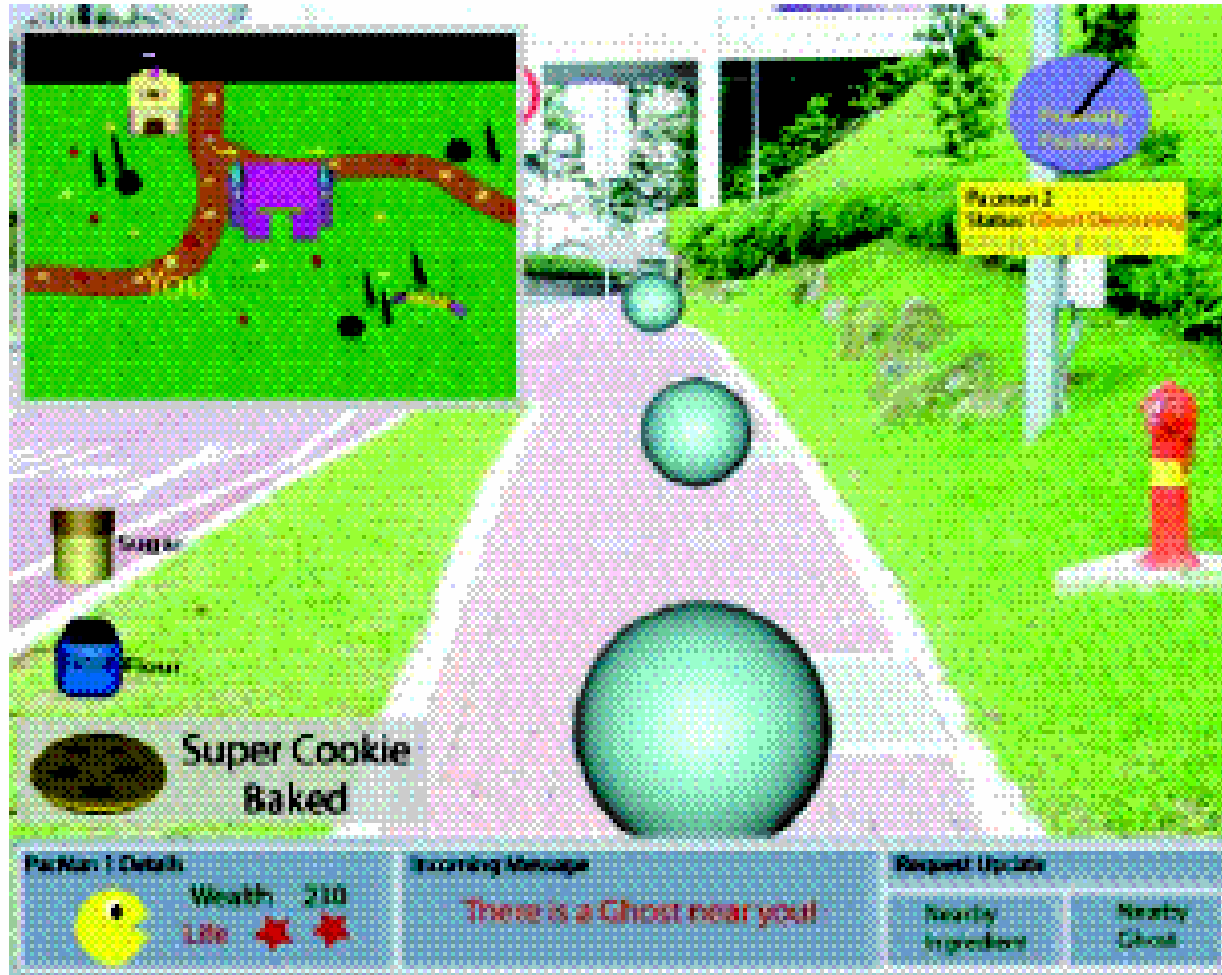
- ❑ Underlying program built on client-server architecture
- ❑ Clients are wearable computers & laptops
- ❑ Server is a desktop computer communicating via wireless LAN
- ❑ Players' physical location and status is updated on a regular basis to server
- ❑ Server maintains current player information and facilitates communication between players and Bluetooth-enabled objects

# Wearable Computer

- Motherboard and Crusoe processor
- Handheld keyboard & mouse
- Head-mounted display with firewire camera
- Inertia sensor
- GPS and dead-reckoning device
- Bluetooth device



# First-person View



# Main Concepts

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- ❑ Team Collaboration: Each Pacman/Ghost is in coalition with one Helper
- ❑ Ultimate Game Objectives: Similar to traditional Pacman: collect all virtual plain cookies while avoiding ghosts
- ❑ The Nature of Pac-World: dualistic fantasy world with both Augmented Reality (AR) and Virtual Reality (VR)
  - Pacman and ghosts can switch between two modes, while helpers can only view in VR mode
  - Real-time link between physical world and virtual world



# Views of picking up sugar jar



# Pacman, Ghost and Helper

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- ❑ Pacman moves about physically in AR mode, collecting (virtual) cookies, finding and collect (physical) ingredients
- ❑ Ghosts track down and devour Pacman by tapping shoulder capacitive sensor pad
- ❑ Physical touch interaction exemplifies tangible physical interaction between humans
- ❑ Helper is a new character who acts as advisor for Pacman or Ghost

# Player and Helper

- ❑ Informs player of positions of enemy units and special ingredients
- ❑ Relays other important information
- ❑ Promotes collaboration and interaction between humans



# Actual Game Play

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- ❑ Starting the game – Pacmen and Ghosts start from different physical locations
- ❑ Collection of plain cookies – Physical player walks through cookie and corresponding AR and VR cookies disappears
- ❑ Devouring Enemy Players – Physically touch enemy's capacity sensor pads
- ❑ Ending the game – When either team meets their goal or time limit of ten minutes

# Ingredients

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- ❑ Ingredients include flour, butter, sugar and “special” ingredients such as chocolate chip and almond to make “special” cookies (butter and super)
  - Butter cookie → 1 minute immunity from ghosts
  - Super cookie → 30 seconds lag then 3 minutes of ghost-devouring power
- ❑ When Pacman is within 10 metres of object, they are notified and can begin to hunt for it
- ❑ Pacman picks up object, which sends message to players wearable computer, which sends corresponding message to server

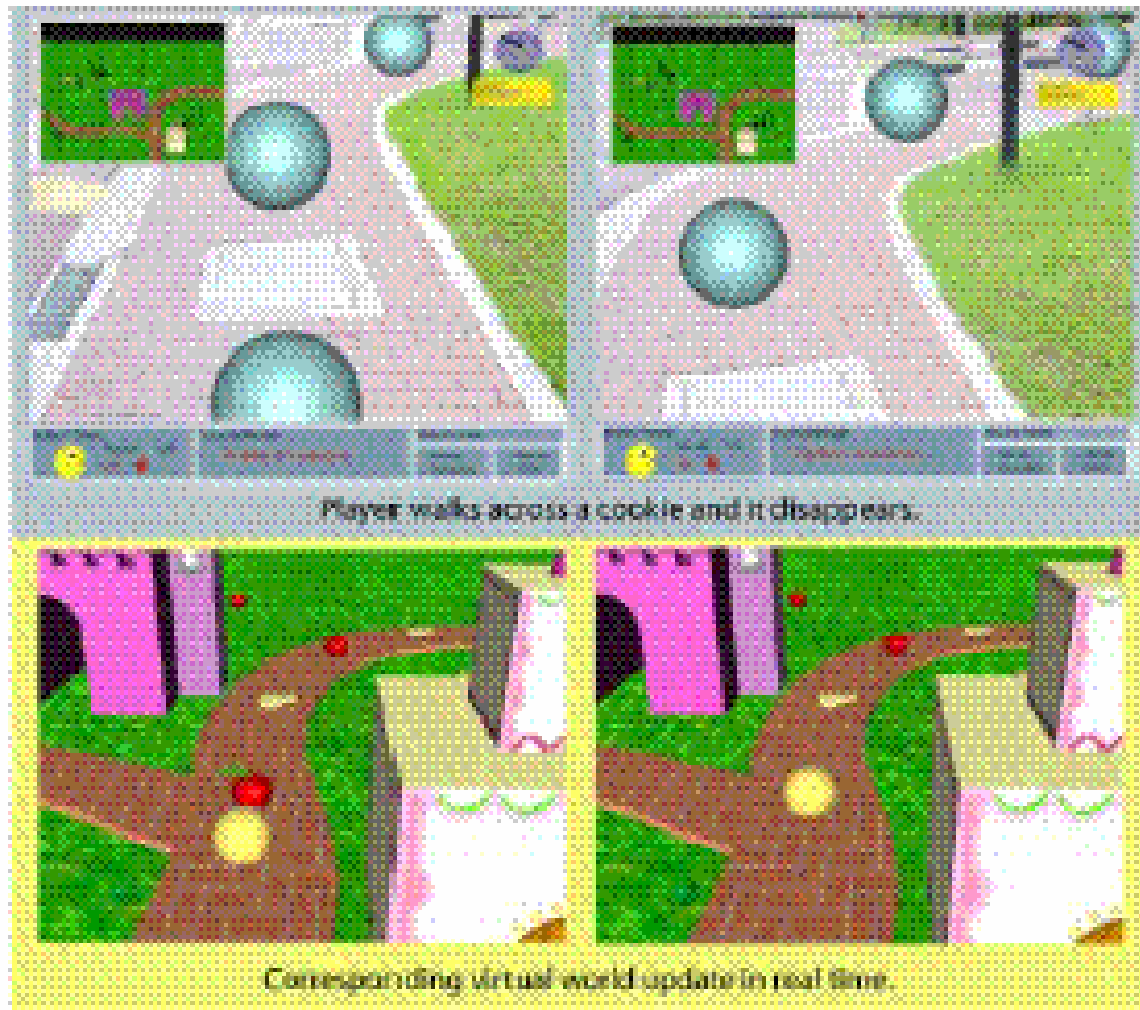
# Collaboration between players

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- Pacman/Ghost and Helper Collaboration
  - Helpers have complete view of Pac-world including positions of all players and ingredients
  - Helpers collaborate among themselves to achieve team goals
- Pacman and Pacman Collaboration
  - Exchange ingredients between Pacmen
  - Not allowed to transfer special cookies

# Corresponding AR and VR Views

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# Problems in Implementation

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1. Disconnection in communication often interrupts flow of the game
2. Bandwidth limitations constrains type of multimedia transmissions
3. Unstable outdoor conditions results in high-error rate in the network

## Solutions:

- Carefully select area for game play
- Embedded components can process and store local data

# Implementation Considerations

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- Maintaining power to wearable computers
  - All mobile computing devices require power
  - Not a big problem since game duration is very short
- Disadvantages of using the head-mounted display
  - Hassle of wearing headgear
  - Low-resolution
  - Eye-fatigue
  - Dim-lighting conditions
  - Also not major issue since game duration is short

# Tangible Interface

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- ❑ GUI's still dominant paradigm for interactions with computers
- ❑ Computer-Augmented Environments started visions of merging electronic systems into the physical world; followed up by various projects including "Brick", "Tangible Bits" and "mediaBlocks".
- ❑ In Human Pacman, the Tangible Interface is explored by using Bluetooth devices and capacitive sensors
- ❑ Bluetooth devices support automatic device discovery → detection of close physical proximity
- ❑ Capacitive sensors detect physical touch actions

# Context Awareness in Outdoor Environments

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- Pioneered at Olivetti Research and Xerox PARC
  - Active Badge System and PARCTab
  - Expensive and confined to indoor area
  
- Emergence of cheap GPS and networked sensors has resulted in similar projects
  - Most use primitive 2D maps and text-based informational displays
  - Smart Sight (tourist assistant) included audio/visual navigational aid around campus, but relied on laptops
  
- Human Pacman captures Context Awareness in 3 ways:
  - Location awareness GPS and DRM
  - Perspective awareness from Inertia device
  - Information context from omniscient helper player

# Addressing Human-Computer Communication Challenges

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- **Address:** How do I address one (or more) of many possible devices?
  - Bluetooth devices have unique address
  
- **Attention:** How do I know the system is ready and attending to my actions?
  - graphical feedback in HMD is highly effective for displaying messages/status
  
- **Action:** How do I effect a meaningful action, control its extent and possibly specify a target or targets for my action?
  - induced by touch or by clicking on-screen icons

# Addressing Human-Computer Communication Challenges (2)

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- **Alignment:** How do I know the system is doing (has done) the right thing?
  - real-time graphical feedback
- **Accident:** How do I avoid mistakes?
  - most actions are very “obvious” – i.e. have to physically pick up an ingredient

# Conclusion

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- ❑ Physical and mobile gaming is gaining popularity over traditional PC or TV-based gaming
- ❑ Mixed-reality games that allowed transition between reality and AR or VR
- ❑ Tangible interfaces and physical interactions between human players
- ❑ Social gaming and collaboration is appealing
- ❑ Can be extended to educational applications, i.e. “learn by experience” simulations

# Discussion

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- Social/cultural issues?
  - Now that “physical touch” is part of the game, to what limits can we use this?
  - i.e. can physical domination be used to win games?
  
- Issues with outdoor environment
  - Unpredictability
  - Danger
  
- What other physical other interfaces could be used to increase the user experience?
  - i.e.. Force-feedback haptics