

---

# Household Survival: Immersive Room-Sized Gaming Using Everyday Objects as Weapons

**Brent Berghmans**

**Axel Faes**

**Matthijs Kaminski**

Hasselt University - tUL

Faculty of Sciences - Computer Science

Diepenbeek, Belgium

{firstname.lastname}@student.uhasselt.be

**Kashyap Todi**

Hasselt University - tUL - iMinds

Expertise Centre for Digital Media

Diepenbeek, Belgium

kashyap.todi@uhasselt.be

## Abstract

Generic multi-button controllers are the most common input devices used for video games. In contrast, dedicated game controllers and gestural interactions increase immersion and playability. Room-sized gaming opens up possibilities to further enhance the immersive experience, and provides players with opportunities to use full-body movements as input. We present a *purpose-centric* approach to appropriating everyday objects as physical game controllers, for immersive room-sized gaming. Virtual manipulations supported by such physical controllers mimic real-world function and usage. Doing so opens up new possibilities for interactions that flow seamlessly from the physical into the virtual world.

As a proof-of-concept, we present a 'Tower Defense' styled game, that uses four everyday household objects as game controllers, each of which serves as a weapon to defend the base of the players from enemy bots. Players are provided with: 1) a broom to sweep away enemy bots directionally; 2) a fan to scatter them away; 3) a vacuum cleaner to suck them; 4) a mouse trap to destroy them. Each controller is tracked using a motion capture system. A physics engine is integrated in the game and ensures virtual objects act as if they are manipulated by the actual physical controller, thus providing players with an immersive gaming experience.

---

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the Owner/Author.

Copyright is held by the owner/author(s). *CHI'16 Extended Abstracts*, May 07-12, 2016, San Jose, CA, USA

ACM 978-1-4503-4082-3/16/05.

<http://dx.doi.org/10.1145/2851581.2890372>

### Author Keywords

Immersive games; Tangibles; Everyday objects; Purpose-centric interactions.

### ACM Classification Keywords

H.5.2. [User Interfaces]: Input devices and strategies, Interaction styles.

### Introduction

Room-sized gaming has opened up new possibilities for blending the physical and virtual environments, to provide extremely immersive experiences to users. Touch interactions such as grabbing, punching, or kicking virtual objects is one technique for providing these realistic experiences. While these interactions are sufficient for some games, they are still quite limited. Video games often support multiple virtual tools, gadgets, and equipment, for gameplay. For instance, first-person shooters provide players with a range of weapons, each exhibiting its own appearance, function, and ability.

To bring this aspect to physical room-sized gaming, we envision the usage of various everyday objects, each with its own qualities, functions, and affordances. To illustrate our concept, we present a mixed-reality room-sized game, using everyday objects as controllers. *Household Survival* is a 'Tower Defense' styled game, where players employ a set of household objects to fend off enemy bots, and protect their base. Each of these objects has unique virtual attributes that are representative of their real-world function. By using this purpose-centric approach, we can provide players with unique immersive gaming experiences.

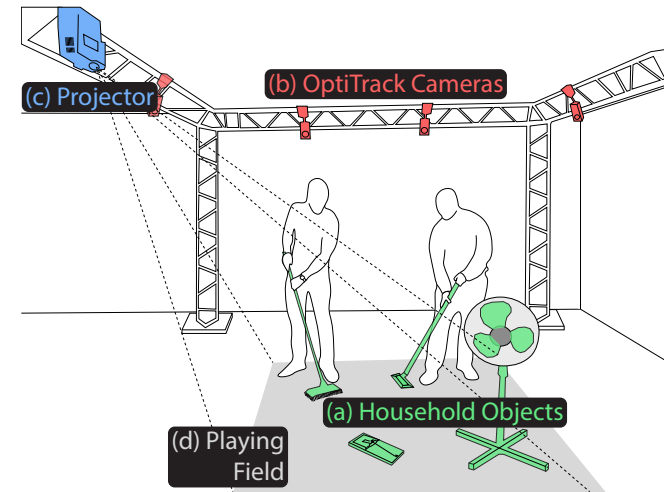
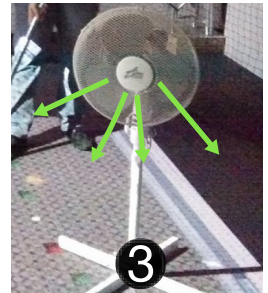
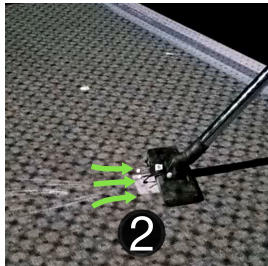
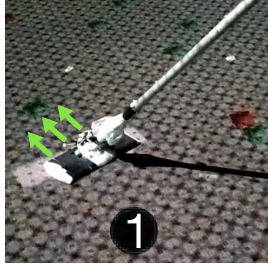


Figure 1: Hardware setup of the 'Household Survival' game.

### Related Work

This work builds on previous research and developments in immersive gaming, tangible interactions using everyday objects, and the blending of physical and virtual environments.

Technological advancements in sensor-based input and vision-based systems have led to commercial success of devices such as the Nintendo Wii and Xbox Kinect. These have improved the immersive experience of screen-based video games. PlayAnywhere [3] used a projection-based system to enable gaming on table surfaces. More recently, and most relevant to our work, RoomAlive [2] illustrates the possibilities of room-sized gaming, where the physical and virtual spaces blend into each other. Players can interact using touch interactions, instrumented pointing devices such as a gun, or standard game controllers. In contrast, we propose the use of uninstrumented everyday objects



to enable physical interactions that blend with the virtual environment.

iCon [1] is a platform that enables the utilisation of everyday objects as instant tabletop controllers. It allows mapping actions such as click, drag, and rotate, to tangible interactions such as lift-and-place, move, and twist. While it takes into account the affordances offered by the physical object, the real-life purpose of the object is not considered. [4] provides a toolkit that enables the use of everyday objects as input devices to video games. Users can specify their own moves, or interactions, to control the gameplay. Again, while it promotes the use of household objects, it does not specifically consider the real-world purpose of these objects.

Our work emphasises the integration of both function and style if interaction with everyday objects in immersive-room sized gaming experiences, in a way that the real-world purpose of physical objects is taken into account.

### Household Survival: Immersive Gaming using Everyday Objects as Game Controllers

We have developed an immersive room-sized game prototype titled 'Household Survival' to serve as a testbed for the proposed *purpose-centric* interactions. A 'Tower Defence' styled multiplayer game is implemented, where players aim to fend off enemy bots, to protect their base. Bots are spawned continuously, and approach the players' base, located on the other end of the playing field. Each player uses one of the everyday objects as weapon, to divert the path of the bots, obstruct them, or to destroy them. Our game uses four different household objects as weapons (Figure 2), to fend off enemy bots. Each of these has its own capability, which mimics the purpose of the object in real life.

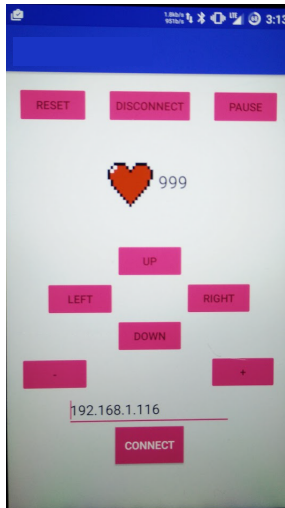
**Figure 2:** Household objects used as game controllers (weapons). Players can use (1) a broomstick, (2) a vacuum cleaner, (3) a fan, or (4) a mousetrap to fend off enemy bots. The arrows indicate the resulting physical forces emulated

1. **Broomstick:** A classic broom is used to brush aside the enemy bots. The broomstick allows players to accurately drag virtual objects across the play field, to a desired location.
2. **Pedestral Fan:** A pedestral fan is used to blow away game objects. Unlike the broom, the fan blower does not allow for fine-grain control over the direction in which the objects are dispersed. Instead, they are scattered in the direction of the blowing air.
3. **Vacuum Cleaner:** Objects in the vicinity of the nozzle experience the suction forces of a vacuum cleaner. When these objects are close enough, the vacuum cleaner pulls them into the tube, hence destroying them.
4. **Mousetrap:** Made using K'nex components <sup>1</sup>, this is used to trap objects that go over it. Like a traditional spring-loaded trap, the game's mousetrap can not continuously capture objects. Instead, it can do so only when it is in the 'loaded' state. The game uses a visual overlay, rendered over the physical object, to display the active and inactive states.

The above four objects allow for compelling physical interactions in our game prototype, and provide a testbed to illustrate our concept.

We also envision the integration of several other everyday objects. These have not been implemented by us, but can be easily integrated. Water bottles and mugs could be used to pour out liquids, and submerge or drown opponents. Alternatively, they could be used to collect ephemerally-flowing objects such as reward coins. A clothes iron could smooth out wrinkles from a terrain, or to burn opponents.

<sup>1</sup><http://www.knex.com>



a



b

**Figure 3:** The smartphone app (a) and Android Gear app (b) enable users to fine-tune calibration, track scores, and provide other game options

As a last example, a hair dryer could blow away objects, or to dry up wet terrains.

### Implementation

The implementation of the ‘Household Survival’ games consists of accurate tracking of physical objects, physics-based game logic, and floor projection of the scene.

### Object Tracking

Reflective markers are attached to each of the everyday objects, and they are tracked, as rigid bodies, using an OptiTrack Motion Capture System. This allows us to accurately estimate the position and orientation of the objects, in relation to the playing field.

### Field Calibration

Two stationary rigid bodies mark the field extremities. These are used for calibrating the playing field, at the start of the game. An accompanying smartphone application (Figure 3a), implemented for Android, allows users to fine-tune the calibration of the field and physical objects.

### Physics Engine and Unity Game

Data captured using the tracking system is interpreted by the game. The physics engine takes into account physical characteristics and nuances of each everyday object, and accordingly enables interactions with game objects. The game itself is implemented using the Unity engine, in .NET/C#. We use a ceiling-mounted short-throw projector to display the virtual environment on the floor.

### Scoreboards and Game Options

Players have two options of keeping track of the current score. Firstly, a scoreboard is rendered on the game scene. The position of this scoreboard is represented by a tangible object, and can be moved around by players, if it obstructs the field view. Additionally, an accompanying Android Wear

application (Figure 3b) enables users to glance at the scoreboard, on their smartwatch, and provides game options such as pause and restart.

### Conclusion

This project has illustrated the benefits of taking a purpose-centric approach for integrating physical objects into virtual environments, and using them as game controllers. ‘Household Survival’ is a room-sized immersive game that provides players with a set of household objects that can be used as weapons, to fend off enemies and defend the base. The game seamlessly blends the physical and virtual worlds, and enhances gameplay and user experience.

### Acknowledgements

This game was developed as a student project for a university-level course. We thank Prof. Dr. Kris Luyten and Donald Degraen for providing us with all necessary materials, valuable ideas, and guidance throughout the development of this project.

### References

- [1] Kai-Yin Cheng, Rong-Hao Liang, Bing-Yu Chen, Rung-Huei Laing, and Sy-Yen Kuo. 2010. iCon: Utilizing Everyday Objects As Additional, Auxiliary and Instant Tabletop Controllers. In *CHI '10*.
- [2] Brett Jones, Rajinder Sodhi, and Michael et al. Murdock. 2014. RoomAlive: Magical Experiences Enabled by Scalable, Adaptive Projector-camera Units. In *UIST '14*.
- [3] Andrew D. Wilson. 2005. PlayAnywhere: A Compact Interactive Tabletop Projection-vision System. In *UIST '05*.
- [4] Haiyan Zhang and Björn Hartmann. 2007. Building Upon Everyday Play. In *CHI EA '07*.