

Access Invaders: Developing a Universally Accessible Action Game

Dimitris Grammenos, Anthony Savidis,
Yannis Georgalis, Constantine Stephanidis



Human-Computer Interaction
Laboratory



Centre for Universal Access &
Assistive Technologies



Introduction (1/3)

- In the past few years, the accessibility of electronic applications and services by disabled people has become a topic of paramount importance at an international level
 - several governments and international political bodies have adopted legislative and policy measures for application software and Web accessibility
 - ★ e.g., Access Board in the US (Section 508), European Commission (eEurope 2005)



Introduction (2/3)

- One of the basic needs of most people, beyond working and independent living, is entertainment
- Presently, computer games constitute indisputably one of the major related sources
 - Unfortunately, computer games are usually quite demanding in terms of motor, sensor and mental skills needed for interaction control, while they often require mastering inflexible and complex input devices and techniques
 - ★ These facts often render games inaccessible to a large percentage of people with physical (or situational) disabilities



Introduction (3/3)

- So far, little attention has been paid to the development of computer games that can be played by all players, independently of their personal characteristics, requirements, or (dis)abilities
- Concerning HCI issues, computer games have fundamental differences from all the other types of software applications, for which accessibility guidelines and solutions are already becoming widely available



Typical technical approaches

- From a technical point of view, two main general approaches have been adopted to address the issue of computer games accessibility:
 1. Mainstream games are developed to be compatible with the use of assistive technologies
 - such as screen readers, mouse emulators or virtual keyboards
 2. Special-purpose games are created, optimally designed for people with disabilities
 - e.g. audio-based games for the blind and switch-based games for the motor-impaired



Typical technical approaches: critique

- The first approach typically achieves very limited accessibility and suffers from low quality in use
- The second approach, though being the most promising from a quality point of view, has two key drawbacks:
 - (a) the cost of developing high quality games is prohibitive when the potential target group is limited
 - (b) there is an evident hazard of segregation between able-bodied and disabled gamers, leading to potential social exclusion



Existing accessible action games (1/2)

- Currently, there are no computer games that can be concurrently played by people with different disabilities sharing the same computer
 - Recently, a few games for both visually-impaired and fully sighted players have been developed
 - ✦ e.g., All inPlay card games; 3D shooter Terraformers
- Several audio-only games adopting the Space Invaders theme exist for the blind
 - e.g., a.Shooter, Sonic Invaders, Alien Outback
 - All are single-player sound-only games, with no configuration capabilities



Existing accessible action games (2/2)

- A game with both audio (in Japanese) and visual output is **Space Invaders for the Blind** by Taito
- A 3D Space Invaders game has been developed by **Mccrindle & Symons** which combines audio and visual interfaces with force feedback
- Regarding people with motor impairments and low vision, only **Alien Invasion** is available
 - Can be played with a range of standard and adaptive technology controls
 - Allows players to adjust the parameters of the major game elements
 - Offers large character sizes for low vision players



Universally Accessible Games (1/2)

- The concept of Universally Accessible Games (UA-Games) has been proposed to overcome the limitations of previous approaches to game accessibility
- Primarily emphasizes game accessibility, but also puts forward the objective of creating games that are concurrently accessible to people with diverse abilities



Universally Accessible Games (2/2)

- **UA-Games are interactive computer games that:**
 1. **follow the principles of User Interfaces for All**
 - are proactively designed to optimally fit and adapt to different individual gamer characteristics without the need of further adjustments or developments
 2. **can be concurrently played among people with different abilities, ideally also when sharing the same computer;**
 3. **can be played on alternative technological platforms and contexts of use using a large variety of devices**
 - including assistive technology add-ons



Potential of UA-Games

- a)** They open up and enhance an entertaining social experience that would otherwise be unavailable to a significant percentage of people
- b)** They allow for social interaction among people who may never have (or could have) interacted with each other
- c)** They considerably expand the size and composition of the potential market of the computer games industry





From Space Invaders to Access Invaders (1/3)

- **Action games constitute a real challenge for Universal Access**
 - **They have highly dynamic content**
 - ✦ Have many different moving objects with alternative characteristics
 - ✦ usually require complex controls
 - ✦ are based on reflex-based reacting
- **Also, devising ways for two players with different disabilities to play, cooperatively or against each other, the same action game, is a very challenging research issue**





From Space Invaders to Access Invaders (2/3)

- In this context, a universally accessible version of the classic action game Space Invaders has been designed and developed
- Access Invaders
 - alternative input / output modalities and interaction techniques that can co-exist and cooperate in its user interface
 - tailorable player profiles and game content
 - highly customizable
 - ✦ each game parameter can be adapted both based on the player's profile and the current game level
 - ... (next slide)





From Space Invaders to Access Invaders (3/3)

■ Access Invaders

- ...
- non-visual gameplay supported
 - ✦ full acoustic rendering of game information is provided through spatial audio and a built-in screen reader
- multi-player games
 - ✦ where people with different (dis)abilities can play cooperatively, sharing the same computer
 - ✦ the game's interaction parameters can be independently adjusted for each player
 - ✦ unlimited number of concurrent players supported



User requirements

- **User categories and requirements considered:**
 - a) people with hand-motor impairments
 - b) blind people
 - c) people with deteriorated vision
 - d) people with mild memory / cognitive impairments and novice players
 - e) people belonging in more than one of the previous groups

- **Sources of user requirements:**
 - relevant bibliography
 - interviews with experts and representatives of user groups
 - observation of users while playing related computer games



Game design (1/2)

- The game was firstly designed in a context-independent way
 - i.e., at an abstract level, minimizing references to specific interaction modalities, metaphors, techniques or devices
- Then, the abstract design elements were mapped to low-level, physical, interaction styles, meeting the requirements of each target user group
 - accessibility barriers related to the game's interface, but also to the game's content were identified and possible design strategies for overcoming them
- The Unified Design method was adopted
 - reflects a procedural design discipline of abstract task definition with incremental polymorphic physical specialization



Game design (2/2)

- **Indicative electronic prototypes of the game were developed**
 - showcasing alternative interactive properties of its user interface for the different target user groups
- **The prototypes were informally evaluated with the stakeholders that participated in the design process using the thinking aloud method**
 - During the evaluation, participants were prompted to express their thoughts, comments and feelings
 - The outcomes of this process aided in validating, correcting and updating design decisions, as well as in developing new ideas for improving the accessibility of the final game



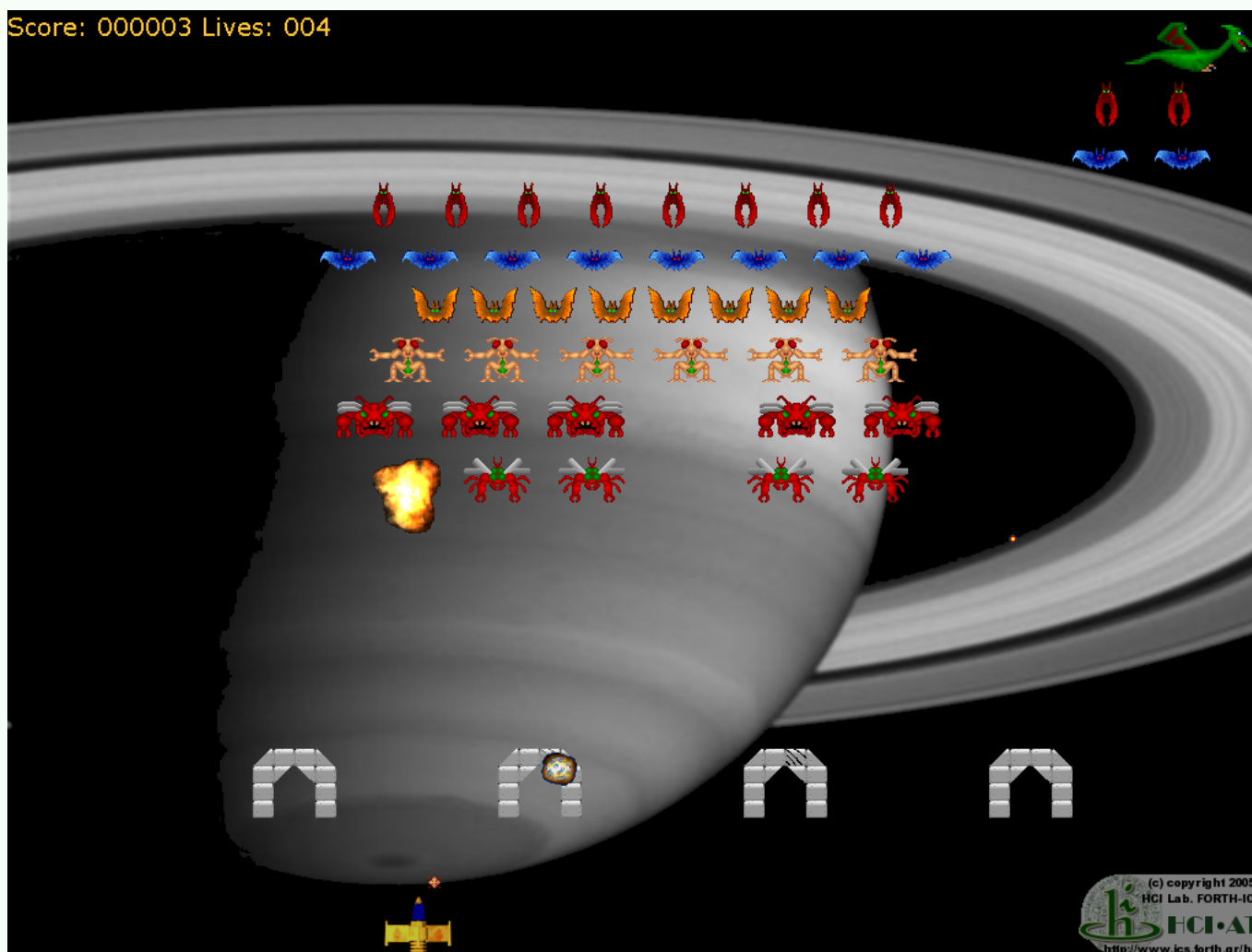


Adapting the Game to the Player's Needs

- The main mechanism of game adaptation are profiles
 - Once a profile is selected the game's interaction and content adapt to its characteristics
- In practice, the game is viewed by players as a collection of different games integrated into one, from which they can select the one that is most suitable for them
 - From a developer's point of view, it is a single application with unlimited alternative manifestations
- Access Invaders currently offers 7 predefined profiles
 - new ones can also be created



Examples of profiles (1/4)



Typical single-user game

Examples of profiles (2/4)



Content enlargement and visual simplification for players with low-vision

Examples of profiles (3/4)



Audio-based game for blind players

Examples of profiles (4/4)



Cooperative game of multiple players with different (dis)abilities

Adapting the User Interface (1/2)

- **The game can be controlled using:**
 - keyboard, mouse, joystick, game pad & binary switches
- **The interface includes two basic interaction objects:**
 - menu and text entry
 - ✦ Both can be manipulated with any device
 - ✦ Font size and family is configurable
- **Automatic scanning is provided for people who can use only a single switch**
- **Interaction objects are augmented with speech output capabilities**
 - for supporting non-visual interaction



Adapting the User Interface (2/2)

- The player's spaceship is controlled through three logical commands
 - “move left”, “move right” and “fire”
 - they can be issued using any device or even combinations
- To achieve accessibility for people with limited motor functions, the game can also be played using only two, or even a single logical command



Adapting the game content and logic

- As a result of an analysis of the currently available accessibility guidelines for applications and games, and of several hours of play testing with end-users, a number of adaptation categories were identified
- Alternative combinations of these adaptations can serve the accessibility needs of each of the addressed target user groups





Game content adaptation categories (1/2)

■ Speed

- Make individual game elements, or the gameplay, faster or slower

■ Quantity

- Change the number of aliens and shields that are present

■ Size

- Make the game elements bigger / smaller

■ Layout

- Alter the absolute / relative position of game elements

■ Firepower

- Supply the aliens / player with faster / slower and more/less powerful weapons or stop them from firing





Game content adaptation categories (2/2)

■ Visual complexity

- Use of backgrounds and graphics with large solid colour areas

■ Contrast

- Use of colour combinations that provide high contrast

■ Sound

- Association of spatial feedback to game elements through 3D sound





Game logic adaptation categories

■ Interaction among game elements

- Set which type of aliens can destroy the player's spaceship and vice versa, and whether the spaceship's bullets can pass through the shields or collide with them

■ Analogue vs. digital control

- Select whether the aliens / spaceship move in discrete or continuous positions

■ Hints

- Make the player's task easier by providing added-value information, e.g., audio radar, visualisation of the path of objects, oral descriptions

■ Stamina

- Provide the player with additional "lives", make the spaceship more resistant to incoming fire and the aliens less



Parallel Game Universes (PGUs) (1/2)

- **Multiplayer action games constitute an open research challenge**
 - since it is not only the interface that changes, but also the game's content and rules
- **Two (or more) people should be able to play the same game, being aware of each other, while at the same time each one follows different rules and perceives distinct content**
- **A possible solution to this problem is to allow each player to play in a different “game universe” and then somehow project each universe to the other(s)**



Parallel Game Universes (PGUs) (2/2)

- The term “Game Universe” is used to denote an instance of the game after it has been adapted to suit the requirements and needs of a particular player
 - For example, the alternative profiles of Access Invaders could be considered as different game universes

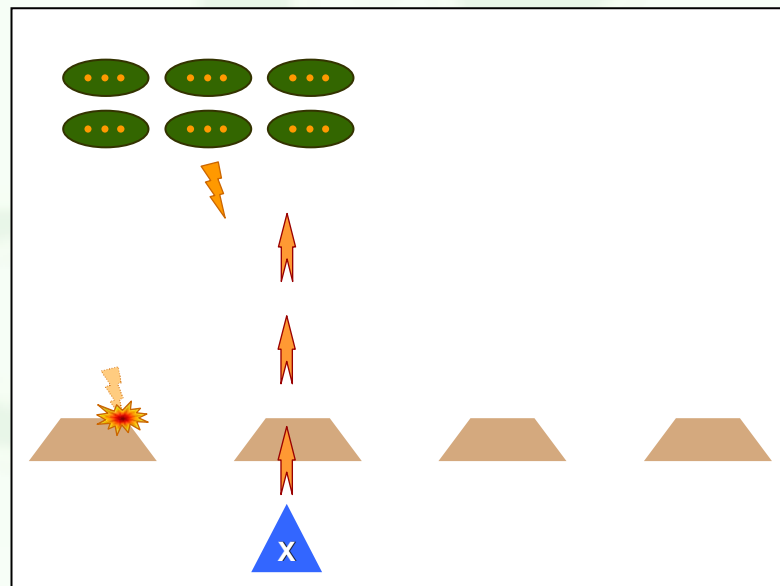


PGUs – Example (1/4)

■ Two friends want to play the game together

● Player X

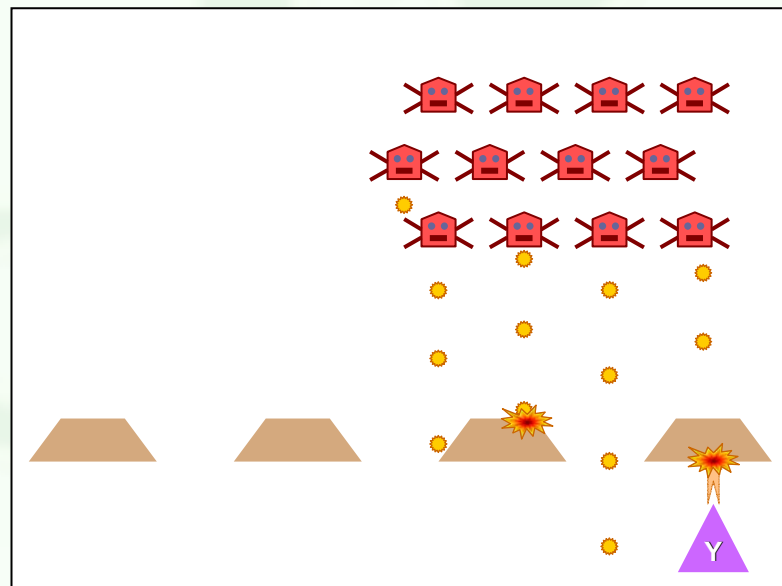
- ✦ due to severe motor-impairments, can use only a single switch
- ✦ a manageable difficulty level includes a small group of aliens that move slowly and fire very scarcely, while the player's bullets do not collide with shields



PGUs – Example (2/4)

● Player Y

- ✦ does not have a specific impairment
- ✦ in order for the game to be challenging enough, he wants to confront numerous fast, fire blazing aliens



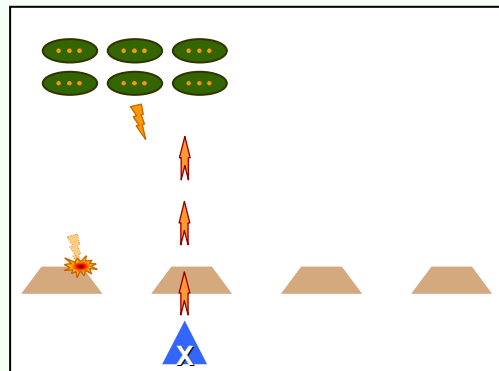
PGUs – Example (3/4)

- If the players attempt to share the very same game
 - if it is adapted to X, then it will be rather boring for Y
 - if it is adapted to Y it will be extremely difficult - if not impossible - for X

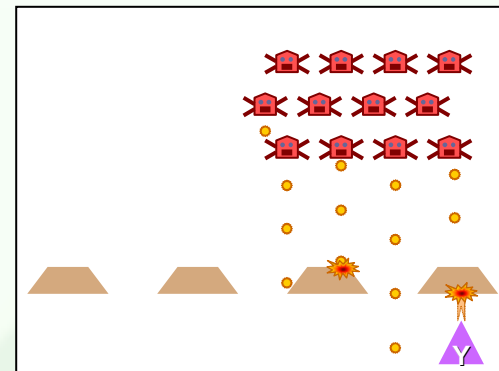
- A solution, following the concept of PGUs, is to merge the 2 distinct game versions into 1, where
 - 2 groups of aliens exist:
 - ✦ a big, fast & powerful which can destroy and be destroyed by Y
 - ✦ a small, slow and quite harmless that plays against X
 - The bullets of each player will not affect the aliens fighting against the other
 - Y's bullets will collide with the shields, and X's will not



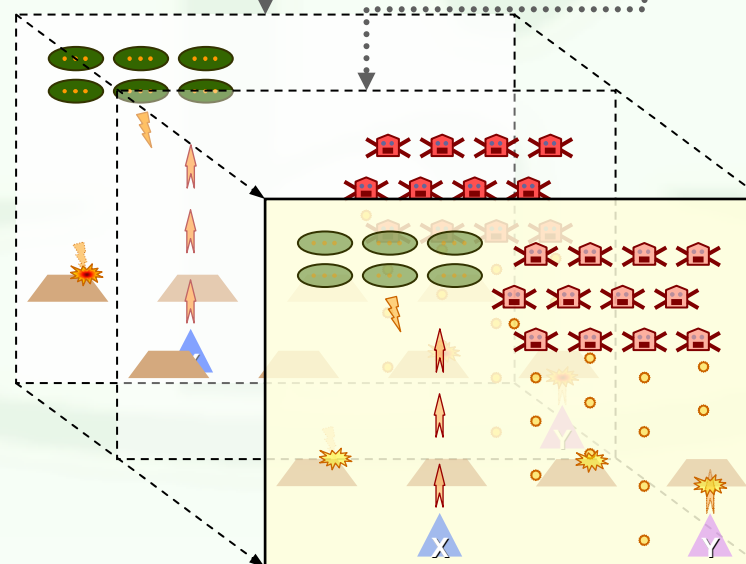
PGUs – Example (4/4)



Single player game (X)



Single player game (Y)

Multiplayer game ($X \cap Y$)

Future Work

■ Short term

- support of tactile output through Braille display, force feedback joystick and stylus
- interactive application for editing profiles and game levels

■ Medium term

- interactive profile selection
 - ✦ the game will be able to help players in selecting a profile and game parameters that best suit their needs
- dynamic gameplay adaptation
 - ✦ includes monitoring the player's actions and dynamically adjusting the gameplay to better match the player's skills

■ Longer term

- research and elaboration of the concept of Parallel Game Universes



Related Links

➔ Access Invaders

www.ics.forth.gr/hci/ua-games/access-invaders/

➔ Universally Accessible Games (UA-Games)

www.ics.forth.gr/hci/ua-games



Access Invaders: Developing a Universally Accessible Action Game

Dimitris Grammenos, Anthony Savidis, Yannis Georgalis, Constantine Stephanidis

Questions?

