

## The iTron Family of Geocast Games (Extended Abstract)

Robert J. Hall  
 AT&T Labs Research  
 Florham Park, NJ, USA  
 hall@research.att.com

**Abstract**—Geocast games are a new class of digital multi-player games, inherently involving vigorous physical activity in outdoor natural settings such as parks, camps, or athletic fields. They are designed for commercial location-aware smartphones carried or worn by players, without requiring consoles or internet connections. The *iTron Family* of geocast games illustrates how physical athletic play can be combined with real-time strategic, imaginative, and creative cognitive play from the domain of digital games to produce sports of the future appealing to a wide range of ever more sophisticated players.

### I. INTRODUCTION

Digital games attract players by providing rich virtual worlds that foster imaginative and creative play, require logical and strategic thinking, and encourage various types of social interaction from individual competition to full cooperation and points in between. On the other hand, while physical activity and motor skill development are inherent in athletic and sports games, they are nonexistent or severely limited in digital games that tie players to a couch or internet connection. This may lead to problems with physical health, childhood development, and repetitive stress injuries.

The Geocast Games Project (see [1]) seeks to meld the best features of these two previously separate worlds to create *sports of the future*: real-world (RW) physical activities blended with virtual world (VW) events computed and presented via carried or worn smartphones. Geocast games are built using the GeoGames Architecture (GGA) [2]. Two key principles underlying the GGA include (a) the scalable ad hoc geocast protocol [3] implements field communications which do not require infrastructure support, and (b) game control is fully distributed among players' smartphones, rather than requiring an extra console or laptop.

This paper presents the *iTron Family* of geocast games. Inspired by venerable early games like *Snake* [4] and the lightcycle competition from *Tron* [5], all members of the family are based on the idea of players moving in RW and leaving a growing trail of walls behind themselves along their path in VW. While the idea of leaving a trail is not new, its embodiment in multi-player outdoor games is. Furthermore, while some iTron variants are competitive, involving athleticism and real-time strategy, others are relaxed, cooperative, and artistic. Still others combine competition with creativity, or randomness with strategy.



Figure 1. A 3-player iTron game in progress.

### II. THE ITRON FAMILY

**The Base Game.** In *iTron*, players must keep moving in RW within a defined VW boundary established at game start. As they move, a dot represents their current position, and they leave a trail of walls in VW. Player position, boundary walls, and trails are displayed relative to an image, map, or other visual representation of the RW play area surrounding the player on the screen of the smartphone. The game enforces a minimum, nonzero average rate of movement.

The object of the game is to last as long as possible before virtually contacting a wall or trail. Figure 1 shows both RW and VW views of a 3-player game in progress. One player, whose trail ends in a black square, has intersected the trail of another and so is out. Another player, checking his wrist-worn smartphone, is plotting his next movement.

A common iTron strategy is to wall off one's opponents from open areas and then to move into one of those areas, slowly following a relatively dense area-filling path to give one's opponents time to crash in their more cramped areas. However, this base strategy is affected by many real world and real-time factors, such as speed and agility of the players, presence of terrain obstacles like fences or vegetation, as well as speed and accuracy of the device's location system.

Figure 2 shows the end state of a 6.5-minute, 6-player game. Played over a large area, terrain features such as fence lines, hill drop-offs, and forests played significant roles in the outcome. Some players moved through forests or hopped fences to avoid trails, while others were unwilling or unable to do so. Note that the size and structure of the terrain require both robust multihop peer-to-peer communications and distributed control to support the intended game experience; competing game architectures do not suffice in such terrain.

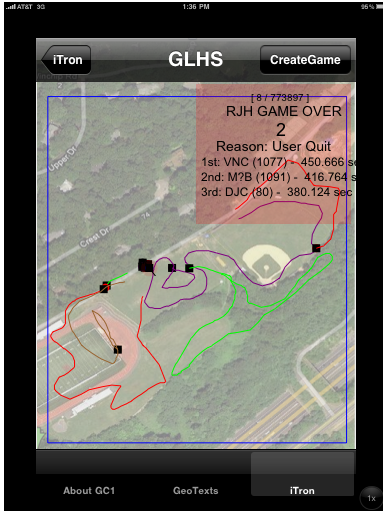


Figure 2. The end of a 6-player *iTron/Intense* game. Game area is 328 m  $\times$  444 m, with  $\approx$  12 acres accessible to the players.

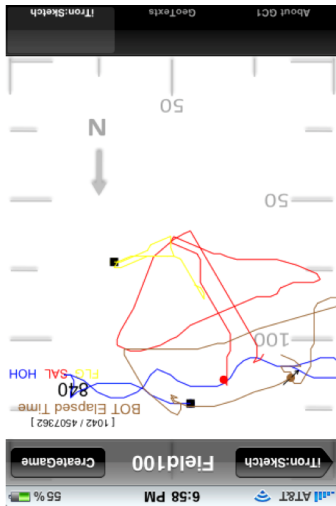


Figure 3. An 80m  $\times$  60m sailboat in 4-person *iTron:Sketch/Intense*. Screen is shown upside down, because the boat is oriented with South up.

**Parkour vs Intense variants.** All *iTron* games can be played either on a relatively small, open field area, such as on a football field with boundaries of tens to a few hundred meters. Since a player can sprint the length and width of the field easily, such games tend to become intense and highly athletic. An example of this style game is the *iTron* game shown in Figure 1. I term this style of game *Intense*. On the other hand, games can be played over larger areas having complex terrain features like forest, hills, drop-offs, fences, etc. Such games require significant gymnastic skills when played at a high level, due to the need to deal with terrain. The larger area implies that players do not tend to sprint the whole time, so they last longer and may involve more time for strategy and tactical planning. An example of this

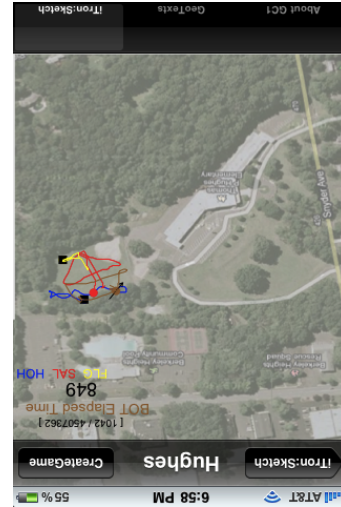


Figure 4. The Hughes sailboat shown “floating” above the (human) fish in the swimming pool below. (4-person *iTron:Sketch/Parkour*)

style of game play is shown in Figure 2. Such types of game are termed *Parkour*, because the athleticism and gymnastic movements are reminiscent of parkour [6].

Since any *iTron* family game can be either *Intense* or *Parkour*, we adopt a naming convention for family members that appends this adjective to the end of the name, as in *iTron/Intense* vs *iTron/Parkour*.

**iTron:Sketch** is a cooperative variant where groups work together to sketch figures in VW. There is no time limit, and players may move through walls and trails without penalty. Each player in a game chooses a trail color, the group plans a coordinated set of movements, and then they execute them in RW. Figure 3 shows a sketch of a sailboat. One device used brown to draw the body of the boat, one used blue for the water, one red for the sails, and one yellow for the flag.

The player can observe the evolving VW picture over either a blank synthetic map (*iTron:Sketch/Intense*), as in Figure 3, or over a photorealistic satellite image as shown in Figure 4 (*iTron:Sketch/Parkour*). In *iTron:Sketch/Intense*, the artistic focus is entirely on the figure itself, while in *iTron:Sketch/Parkour*, (a) the drawing itself may require gymnastic athleticism, and (b) the RW features shown in the image background are conceived as part of the artistic statement, with drawn figures integrated appropriately.

For example, in Figure 4, the concept is a boat floating on the surface above human fish swimming in the pool shown “below” the boat in the image.

Note that *iTron:Sketch* can be played non-competitively, or it can be a judged competition among teams.

**iTron:SketchFast** is a timed variant of *iTron:Sketch* in which teams compete to plan and draw a given figure fastest. Judging the winner involves both best time and an artistic assessment of whether a team successfully drew the figure. Objective measures like completion time and image feature

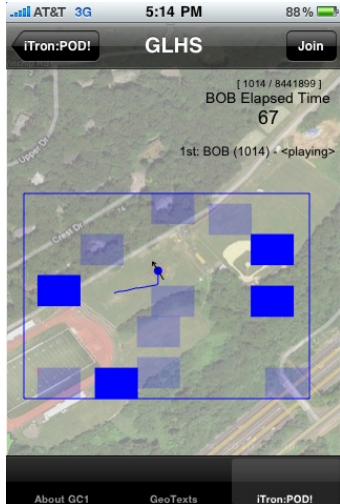


Figure 5. A iTron:POD! game in progress, showing fully-materialized pods (solid rectangles) and forming pods (faint rectangles).

counts can be combined with subjective measures based on judgement of artistry and style using, for example, point systems similar to those used in gymnastics or figure skating.

Of course, iTron:SketchFast has both */Intense* and */Parkour* variants. In the latter, style points can also be awarded for creative or skilled handling of terrain features.

**iTron:POD!** (“Pits of Doom”) is a richer variant of base-iTron that adds new virtual elements and randomness to make the player’s task successively more difficult over time.

Essentially, iTron:POD! proceeds like base-iTron, including boundaries and multiple players leaving trails, except that over time *pits of doom (pods)* begin to appear in VW. These are rectangular areas that act like boundaries; the player may not be within them. There is a 15-second warning as a pod appears, during which it appears drawn faintly. This gives a player who happens to be located in it a chance to run out of it. As more and more pods finalize, the allowed area becomes a random maze further complicated by trails and boundaries. Later in the game, pods *move* as well, further complicating real time planning. Each game’s pod positions and movements are generated pseudorandomly, seeded by game time, so each game is different in detail.

iTron:POD! can clearly be played either in */Intense* mode or in */Parkour* mode. In the latter, terrain features add yet another dimension of complexity that must be dealt with in real time by the players.

**Solitaire Mode.** All iTron variants can be played by one player, in *solitaire mode*. For example, one can play iTron:POD! simply to see how long one can last as the available space grows smaller and more complex and the hazards increase in number and unpredictability. In iTron:Sketch, one can execute ever larger and more artistic figures (see Figure 6). Using multiple devices at once, and significant planning and pre-placement of devices, one can even make

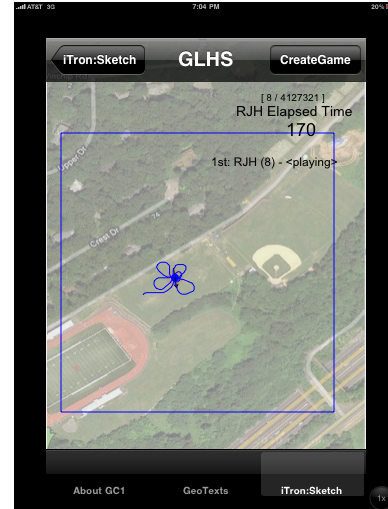


Figure 6. A flower sketched in iTron:Sketch/Parkour/Solitaire.

multi-color complex figures in solitaire mode.

Solitaire mode can be played completely for its own sake, but can also be used for skills practice as preparation for multi-player play.

**Other Family Members** are described in the full paper.

### III. EVALUATION AND DISCUSSION

The iTron Family members described above have all been implemented in the GC1 prototype for the Apple iPhone 3G(s), with some initial porting to the Android platform as well. They have proven popular among over 200 players over many trial days. The full paper will discuss evaluation in detail; however, a few observations are worth relating here. *Slow and inaccurate sensors available in commercial smartphones impact game play.* For example, a common pitfall is running close to a boundary, stopping short, and watching one’s GPS position slowly drift across it, due to the slow rate ( $\approx 0.5$  Hz) of fix computations. Successful players learn to compensate for this, and I have added an on-screen reminder zone to help. *Different types of terrain and sizes of play areas have a big impact on game play.* Small, clear-field games tend to be fast-action “sprints”, while larger games with complex terrain are more strategic and gymnastic, reminiscent of parkour. This observation bears out and justifies the naming convention described above and treating */Intense* variants as distinct family members from */Parkour* variants.

Outdoor games like the iTron Family members, which depend on sensing and field communications, open up new avenues for cheaters. This interesting and complex issue is beyond the scope of this paper, but is discussed in [2].

### IV. RELATED WORK

The field of healthy games is large and growing. An early and well known effort was the Nintendo Wii [7]. Wireless

controllers incorporating infrared and accelerometers allow players to participate in on-screen virtual sports and other athletic activities. Microsoft's more recent Kinect [8] technology uses motion tracking to allow players to make natural motions without holding controllers. It can also detect more complicated motions as well, such as lateral movements. These two systems do indeed increase the level of physical activity, but still tie players to being indoors near their consoles. By contrast, geocast games, and the iTron games in particular, enable and require real running, jumping, climbing, and other outdoor activities that are impossible inside a living room. Because they are implemented using the scalable ad hoc Geocast field communications protocol, they can be played anywhere people take their smartphones, including mountains, parks, and beaches.

FunGoPlay [9] is an online virtual world in which players can earn points and rewards by taking specially instrumented play equipment outside and performing athletic actions. While this technology gets players outside, the athletic activities are essentially traditional ones. Only after reconnecting to the on-line game does VW activity take place. This contrasts with Geocast Games like iTron where VW elements participate directly in the athletic play.

There are many short-range multi-player games that require players to stay in close physical proximity, usually due to being implemented over bluetooth or simple wifi broadcast communications like WiFi-direct [10]. Such games can be played outdoors, but do not allow truly athletic sporting activities, because if players get more than a few meters apart, the devices lose connectivity and the game must stop. By using the Geocast field communication protocol, Geocast Games, such as *iTron/Parkour*, can take place over large areas, where relaying and redundancy built into the protocol, as well as the fully distributed control architecture allow the game experience to continue even with wide separations among players.

Several multi-player games are designed to be played by people moving around RW but with elements obtained and played in the VW. For example, *MyTown* [11] allows people to virtually acquire RW property as they move around the RW. While this does encourage movement through the real world, it is not athletic activity. Moreover, the game's central-server architecture requires all players to be in contact with the Internet in order for game experiences to continue. Players are therefore limited to areas covered by mobile data networks. Geocast games, by contrast, can be played anywhere people have location-aware smartphones.

Two other Geocast Games families have been designed and prototyped. [2], [12]. *iTESS* is basically hide-and-seek but augmented with virtual weapons and surveillance drones. *Butterflies* is a game where one tries to collect good virtual butterflies while trying to avoid bad butterflies, with the butterflies increasing in intelligence as the game progresses. The implementation challenge here is to implement complex

creature behaviors in a fully distributed architecture. These games play quite differently from the iTron variants, but all are multiplayer outdoor athletic video games.

## V. CONCLUSIONS

This paper has described eight members (sixteen if we distinguish solitaire variants) of the iTron Family of Geocast Games, which are healthy video games designed to incorporate real world athletic activity and virtual world cognitive elements. Many further variants are possible, all based in whole or in part on the idea of movement in the RW leaving a trail of walls in the VW. Such variants to be implemented in the future will include artificial creatures with complex AI-based behaviors, weapons and other virtual elements to blow holes in walls or eliminate opponents, ways to temporarily allow one to pass through walls, or even additional ways to build walls. Team variants of *iTron* and *iTron:POD!* are possible. All such variants are of potential interest and will work toward the goal of building sports of the future that attract those looking for an experience that melds the best of the RW athletic experience and the VW game experience.

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