MR Auto Racing
Mixed Reality Game for Public Installation

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Abstract: Mixed Reality Auto Racing is game for two to four players. The track is built from tangible objects (e. g. little cardboard houses) by the players and can be changed and rebuilt during the game. The game has been developed as a public Mixed Reality installation which can run by itself; it is controlled by the players without instruction. The focus of development was experimenting with input and output possibilities of the increasingly invisible computer in a gaming context; in this case using an established and robust method (video tracking) and everyday hardware (joysticks, projector, web cam). The mixture of the real and virtual space through the tight interconnection of tangible and projected objects in one place emerges as an interesting concept.

1 Description

MR Auto Racing (Figure 1) is game for two to four players who come together face-to-face in one place (e. g. around a table). The racing track is built by the players from tangible objects (e. g. little cardboard houses) (Figure 4) or can also be drawn (e. g. on a piece of paper) (Figure 5). Changes to the track can be made by all players in the time period between races (but not during an ongoing race) by re-arranging the objects or by erasing and re-drawing them. The projector and web cam are suspended above the track. The cars which are racing on the track are controlled by ordinary joysticks in the usual way (fire button to accelerate, left/right to steer, down to drive backwards). The race is over after five laps or three minutes. To enable a fast change of players between races player names are not entered or saved and there are no different leagues or levels.

2 Focus

The focus of development was experimenting with different input and output possibilities of the increasingly invisible computer in a gaming context. The real and virtual space is merged by tightly connecting real and virtual objects (i. e. cardboard houses and projected cars) in one place. Although the objects which are controlled by the players and by the computer are still not identical, they approach each other closely in the perception and interaction of the players.

This coupling of the real and the virtual as well as the input and the output results in a high directness, naturalness, and low cognitive load. The expected effect on the players is their easy and effortless participation without the need for instruction.

Figure 1: Title screen

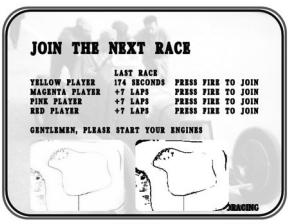

Figure 2: Press fire to join

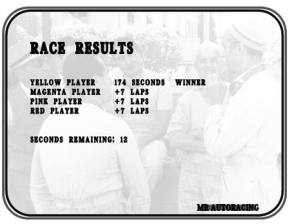

Figure 3: Results display

In this way, a joyful and intense social interaction should be brought about and facilitated between the players who are brought together in place and also in a somewhat close bodily proximity. In this, we see a huge difference to 'traditional car racing in video games' [Met05; cmp. for a different view ibd.]. The character of the game resembles more that of a party game than that of a competitive contest.

The integration of the game into a context is limited to one special application; all cognitive transfers are done solely by the players, not automatically by the computer.

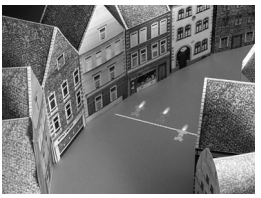

Figure 4: Track made from cardboard houses

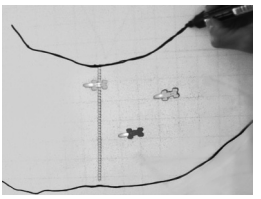

Figure 5: Track drawn on paper

The game could be categorized as a tabletop action game, a genre which does currently not get the attention of other genres e. g. tabletop strategy, role playing or mobile games. Mixed Reality Pong [Kal01] uses a very similar conceptual approach; a slightly different focus has Neon Racer [Ber05]; in using MR to facilitatate social interaction the game has an approach like SCORPIODROME [Met05] and AirKanoid [CFR05]. Similar is also Urb [UI99], a system for supporting the urban design process.

3 Stages of the game

The process of the game is divided into repeated phases (Figure 6):

Load: The game loads, the projector positioned, the web cam is calibrated, the threshold value adjusted; this happens only once during startup.

Build/Draw: The track is (re-) built or drawn; the video image shown is updated every few seconds, it can easily be checked if the track is recognized correctly.

Join/Start: Players join the game by pressing the fire button; when at least two players have joined, a 20 second countdown begins to the start of the race, up to which other players can still enter the game (Figure 2).

Race: The race is over when the first player completes five laps or after three minutes. The laps are counted at two checkpoints to prevent the players from cheating by taking short cuts: One checkpoint is the start/finish line, the other (invisible) checkpoint is in the middle of the back straight.

Results: The results and a few statistics are displayed for 20 seconds (Figure 3); players have time to talk with each other about their experiences and to suggest and discuss possible track changes.

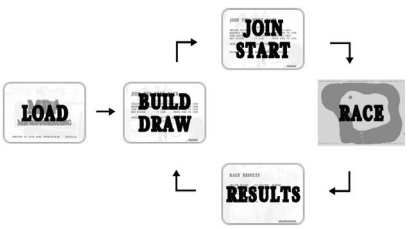

Figure 6: Stages of the game

4 Technical issues

MR Auto Racing has been developed as a public installation, which can run by itself under the control of the players without the need for instruction. All game features are available to the players through their joysticks; all players share the same possiblities. Every race must be joined by pressing the fire button on one of the joysticks when on the join in screen (Figure 2); a player is automatically removed from play after 20 seconds of inactivity during a race. The computer does all organizational tasks like putting all cars to the starting line, starting the race, counting laps, and the calculation of the results after the race (overall winning time, position of each player, and number of unfinished laps).

As input the computer gets the video images of the track (i. e. tangible objects or line drawing) as well as the signals off the joysticks.

As output the computer projects the cars on the track and produces car like sound effects (during the race), displays results (after the race), the track (during rebuild or redraw), and the number of open slots resp. how many players have joined the game (before the race).

The interface hardware and software algorithms are robust and probably suitable enough for public installation. The recognition of the track is accomplished by video tracking (Figure 7, a): The dark lines and areas in the video images are taken to represent obstacles or the borders of the track and are checked regularily for collision with the cars (Figure 8). A pixel-based collision-detection algorithm is used (Figure 7, e).

The joysticks, the projector and the web cam are everyday off-the-shelf hardware components. The keyboard is only used once during startup of the game to adjust the camera contrast (Figure 7, b-d). During and between races the game is completely controlled by joysticks and countdown timers; the computer remains literally invisible throughout the game.

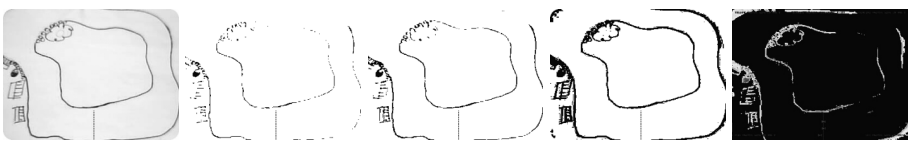

Figure 7: Unprocessed (a) and processed video images (b-d), internal collision map (e)

5 Experiences

First tests have shown that the game technically works under different circumstances and setups. The players enjoyed playing the game, and the competition was tough (Figure 9). The joystick control of the cars is common in 2D racing games, but not all players are familiar with this. The driving properties of the cars are not physically correct. The top-down perspective on a table or on the floor is the same for all players and seems to work well with most of them. Due to the position of the camera, some collisions may appear a little off the mark. After some races and track rebuilds some players prefered the comparability between races to the possibility of changing the track every time.

MR Auto Racing will be available for public play at the GI Mixed Reality workshop in September 2007.

6 Conclusion and outlook

The mixture of the real and virtual space through the tight interconnection of tangible and projected objects in one place emerges as an interesting concept. Further development and evaluation will focus on this relationship and coupling of reality and virtuality and their merging in the perception of the player or user.

Some ideas for improving the game are: Different colors or objects are recognized by the video tracking as different surfaces like sand, puddles and oil spills or obstacles like jumps and tunnels. Different car types or models can be selected which have different driving properties. The driving properties (e. g. acceleration, top speed) of the cars are improved by collecting powerups which appear on the track. Different modes of (team-) play can be selected. Instead of joysticks, steering wheels or other interface devices are used. More statistics are shown, e. g. all lap times, fastest lap. Pit stops to refuel and to change tyres. Different weather conditions like rain and wind influence driving.

While some of these ideas appear to be realistic and could improve game play, it should be estimated which changes serve the game to facilitate or intensify the social interaction (Figure 10). A more complex game might easily take on a competitive character and drive away some groups of players.

Figure 8: Collision with house

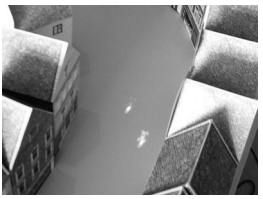

Figure 9: Pink overtakes yellow

Figure 10: Player interaction while building the track

7 Acknowledgments

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