Figure 2. The wizard observes player's actions and controls the games accordingly. The swimming and running games are presented on the left.

the gestures for controlling the game. For example, when QuiQui needs to fly and is depicted holding two leaves in his hands, the player most likely tries to flap his or her hands to control the character.

Intuitiveness also relates to having natural mappings between the avatar and player movements even in cases where the avatar does not act as a mirror image of the user, or the perspective or orientation of the virtual world differs from the real world. For example, when QuiQui is flying in the air, there is no obvious mapping for the user to move sideways. Since games should allow the player to explore unknown worlds, the natural interaction style between an avatar and a player must be found through iterative design and testing with children.

Usability testing with functional prototypes. We initially used fully functional prototypes in traditional usability tests with 28 children ages 5–9 to evaluate how they controlled an avatar [7, 9] flying in different directions. However, this approach required time-consuming reiteration of the vision algorithms due to incorrect assumptions of intuitive control gestures. In the first prototype, children could make QuiQui fly upward by flapping both hands up and down. Steering QuiQui to the left or right was achieved by flapping only one hand.

Flying upward was an easy task for most children, but controlling sideways movement proved to be difficult and frustrating. When analyzing the videos we found the gesture most frequently attempted by the children was to lean to the side while flapping their hands as shown in Figure 1. The next version of the game implemented this manner to control QuiQui. In a subsequent test children gave less frustrated comments and spent on average 34% less time completing the game level, indicating a significant improvement.

Wizard of Oz prototyping. From our experiences, we found testing the intuitiveness of game controls does not necessarily require functional prototypes. We have used WOz methodology to first gather children's movements during simulated playing sessions and only then applied that data in refining the vision technology [8].

We carried out the WOz study with 34 children (14 boys and 20 girls) ages 7–9 at a local elementary school. The evaluated prototypes were single-player games where the player controls QuiQui, who swims, runs, jumps, and tries to escape from spiders. The study was conducted as a form of pair-testing to make the situation more relaxed for the children.

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