Building RFID-Based Augmented Dice with Perfect Recognition Rates

Steve Hinske¹, Marc Langheinrich², and Yves Alter¹

¹ Inst. for Pervasive Computing, ETH Zurich, 8092 Zurich, Switzerland
steve.hinske@inf.ethz.ch
² Faculty of Informatics, University of Lugano (USI), 6904 Lugano, Switzerland
langheinrich@acm.org

Abstract. We report on the construction of real-world dice equipped with radio frequency identification (RFID) technology that support the automated readout and processing of rolled results. Such augmented dice help to build “smart” tabletop games that are able to unobtrusively detect the players’ actions, allowing them to better focus on the gameplay and the social interaction with other players. Since the technology is completely integrated into the play environment, the look and feel of the dice is unaltered. This article provides an overview of the challenges in building augmented dice and describes the various prototypes that we built. Our latest model resembles a regular die of about 16mm side length and achieves a perfect recognition rate of 100%.

Keywords: Augmented dice, radio frequency identification (RFID) technology.

1 Introduction

For millennia people have enjoyed playing games and the social integration provided by such gatherings. Be it for a nice chat, the inner urge for competition, or simply for the feeling of belonging to a group – playing games can be regarded as one of the main recreational activities of mankind. Hitherto, a countless number of games have been invented: some focus on the players’ physical skills, others on their mental abilities, some simply test the players’ luck. Given the latter category, dice have become the standard game piece whenever an element of randomness is required – either as a part of the game (e.g., Monopoly) or as its core element (e.g., Yathzee).

Depending on the game and the random component required for advancing the game, there are several die types in use with the “D6” being the most prominent one. Many games use one or two six sided dice to simply advance game figures on a board, yet more complicated uses of dice rolls are also common, e.g., looking for a particular combination of eyes, requiring the sum to exceed or undercut a certain value, or comparing several dice with each other. Some games require the usage of many dice which can result in spending quite some time on “eye counting”. While modern electronics might allow for other approaches to provide this random
component (e.g., an electronic random number generator that simply displays the results of the above mentioned calculation at the push of a button), people might prefer the use of traditional dice for three reasons: the haptic and spatial experience; the transparency of the process (one can see the numbers being “generated”); and the feeling that one can influence the result (i.e., the idea of having a “lucky hand”).

So-called “augmented dice” aim at combining both aspects, that is, to allow players to continue using typical dice in the traditional sense, while the results can be automatically retrieved and forwarded to the gaming application. The idea is to embed computers and sensors into both the gaming environment and, due to the continuous miniaturization of these technological components, even into individual game pieces. This allows us to map the users’ real-world activities onto a virtual game model that in turn can drive displays or other game elements.

This paper describes our continuing work on RFIDice [4], our initial prototype of an RFID-enhanced traditional D6. Compared to our earlier models, we were able to significantly increase the recognition rate while reducing the form factor, making our augmented die no bigger than a standard, off-the-shelf D6. To the best of our knowledge, we are the first to present RFID-enhanced augmented dice that could actually be used in real-world gaming applications.

2 Using RFID Technology for Realizing Augmented Dice

There are basically three approaches to build an augmented die:

- A **visual approach** using, for example, a scanner or video camera to capture and analyze the results shown on the die sides.
- An **internal sensors** approach that employs some kind of integrated sensor (e.g., an accelerometer, or force pressure sensors) that internally detects the position and sends it to an application.
- An **external sensors** approach that detects some (non-visual) quality of the rolled die using, e.g., sensors embedded in the tabletop surface.

We have discussed the advantages and disadvantages of the three approaches previously [4] and thus only summarize them briefly in Tab. 1. The use of external sensors offers high robustness, a small die size, and low costs, at the expense of a limited rolling area, however. We believe that these advantages outweigh this limitation and thus decided to explore the use of external sensors in our system.

<table>
<thead>
<tr>
<th><strong>Criterion</strong></th>
<th>Visual approach</th>
<th>Internal sensors</th>
<th>External sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of rolling area</td>
<td>limited</td>
<td>unlimited</td>
<td>limited</td>
</tr>
<tr>
<td>Maintenance of die</td>
<td>n/a</td>
<td>batteries, damaged h/w</td>
<td>n/a</td>
</tr>
<tr>
<td>Configuration / calibration</td>
<td>yes</td>
<td>possibly</td>
<td>n/a</td>
</tr>
<tr>
<td>Robustness of die</td>
<td>very high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Size of die</td>
<td>small</td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td>Costs of one die</td>
<td>very low</td>
<td>high</td>
<td>low</td>
</tr>
</tbody>
</table>

Table 1. Advantages and disadvantages of different approaches for building augmented dice