

Digital Sports Using the “Bouncing Star” Rubber Ball Comprising IR and Full-color LEDs and an Acceleration Sensor

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1. Background and Purpose of this project

Since ancient times, many people in the world loves a ball as an entertainment equipment. Design of the ball has been established and sophisticated as sport equipment used in soccer and baseball, in the sports that many people enjoy enthusiastically.

Recently, a technical breakthrough has transformed the ball. Electronic devices have been started to be installed inside the balls. In our project, we focus on the creation of a new ball and entertainments for human beings using a ball comprising electronic devices.

The previous studies carried out on our ball are as follows:

- ① Lumica Glow Football (Lumica Corporation)
- ② A ball containing infrared (IR) LEDs: IR Roboball MK2
- ③ A ball containing IR LEDs: RCJ-04 (EK Japan Co., Ltd.)
- ④ A ball containing a three-axis acceleration sensor in Kyukon

We propose a ball that contains the abovementioned elements in one ball in order to realize a quality entertainment environment for human beings.

The appearance of our ball (surface color, flashing speed of light and graphical effect around the ball) changes dynamically according to the acceleration data, and the position of the ball.

To change the appearance, the ball is composed of full-color LEDs, whose color is controlled by a microprocessor connected to an acceleration sensor inside the ball. The ball is designed to emit IR light so that it can be detected. In order to obtain high elasticity, silicone was used as material to manufacture the ball “Bouncing Star” (Hane-Boshi in Japanese). Furthermore, we created effective computer graphics for determining performance using this ball. We also created new digital sports content “Space Ball” using Bouncing Star.

2. Formation and Mechanics of <Bouncing Star>

The diameter of Bouncing Star is 98 mm, its weight is 525 g. The electronic devices are placed inside the central core. The middle and outer layers are made of silicone materials.

The central core of Bouncing Star is composed of a 3D wiring circuit. Six circular printed wiring boards (diameter 60 mm) are used to construct a grid sphere. At the center of the sphere, a chargeable battery is located. We also arranged a PIC, an acceleration sensor, a terminal for battery charging, switches for the selection of program, six full-color LEDs, and 12 IR LEDs inside the grid.

3. Illumination of Full-color LEDs Depending on Acceleration

The color of the LEDs is controlled by the microprocessor (PIC16F88) that receives acceleration data from the sensor. The data reflect the player’s actions such as throwing, kicking, bouncing, catching, rolling, and rotating the ball such that the light emitted from the LEDs changes in response to the actions.

Nine different light-emission modes are programmed in the microprocessor used for Bouncing Star.

4. Image Recognition Using IR LEDs: Recognition of Position and Bounce of Ball

Inside Bouncing Star, six IR LEDs are placed so that the ball can be easily image recognized from any angle. An IR ray camera can recognize the ball. Position of the ball can be gained in the area of the camera can capture the image. Under the present conditions, we can recognize the position of the ball, status of light emission, ball bounce when people bounce the ball on the floor or play the game catch by the image recognition technique (OpenCV) using two high-speed cameras and PCs which detect the IR rays emitted from the ball.

5. Interaction Between the Ball and Computer Graphics: Creation of Space Ball Content

The computer graphics projected on the floor or ground is dependent on the conditions of Bouncing Star. After we examined various graphic effects, we created a sports content titled Space Ball. In Space Ball, two players compete with each other. They can stand anywhere outside of a 4×4 (m) square, in which 10×10 small grids are projected. When a player throws the ball in the square or kicks it inside, the color of the grids, through which the ball passes, changes in real time. If the player can bounce the ball on the remaining grids, he/she can gain more points.



Fig.1 Image captured from a game of Space Ball
Image recognizing camera and LCD projector are placed on the balcony (height 10 m) of the third floor of the closest building.

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