Mighty Mouse

and the

Maze of Doom

1¢ per play

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Our automaton puts Mighty Mouse (MM) against the Maze of Doom. MM must navigate across the treacherous maze with help from his human partner at the joystick. The joystick controls two motors that move a guiding magnet across the surface of the maze. MM will follow the magnet unless it brings him close to a dangerous wall. In the case of a wall, MM will seize control of the guiding magnet and drag it and himself back to safety. Come help MM navigate the amazing Maze of Doom!

There are three main parts to our project. There is the joystick apparatus, the maze table and the computational components. The joystick is used control the direction and speed that MM travels along the maze. The maze table moves a magnet to guide the mouse on the surface of the maze. Two crickets communicate via infrared to read the position of the joystick, move the mouse, and detect maze walls. The result is an interactive mouse and maze game that can be played again and again with new mazes.

(Fig. 1.1: Maze of Doom)  (Fig. 1.2: Maze of Doom mechanics)

The joystick is constructed entirely out of wood and glue. A wooden rod extends out of a small hole in a wooden box (see Fig 2.1). The wooden rod is pushed in different
directions to move around a wooden block inside the box (Fig 2.2). The block moves back and forth along two parallel wooden rods through holes in the block. These rods extend through small slots cut through opposite sides of the box. They are connected at each end by small guiding blocks that lie just outside the slots of the box. This entire assembly allows the block to move freely in two dimensions.

Initially the joystick was assembled in Lego. The Lego joystick served as a prototype for the wooden design. Although it would have been too difficult to construct the Lego design in wood, it gave insight into the problem of 2D motion. Unfortunately we do not have a picture of the Lego joystick to include in this report.

(Fig. 2.1: wooden joystick)  (Fig. 2.2: wooden joystick mechanics)

The maze table was perhaps the most difficult part to construct in our project. Plastic racks were cut out on the laser cutter by carefully measuring the distance between the teeth of the motor gears and writing a Python script to generate the coordinates of the polygon. At the end of each of the racks is a hole that slides along metal rails on opposite sides of the maze table (see Fig 2.3). Connecting the two racks together is a...
cricket-controlled double-motor apparatus that moves along the teeth of the racks (see Fig 2.4). This apparatus was constructed with Lego, and contains the guiding magnet, two motors and helps keep the racks perpendicular. The plastic walls of the table are reinforced with wood to make for a durable product. The surface of the table is a square sheet of Plexiglas. The mouse sits on top of this surface and follows the guiding magnet. The maze table is able to move the mouse around on the entire surface of the maze.

(Fig 2.3: maze table mechanics) (Fig 2.4: double-motor apparatus)

The computational aspects of the joystick are rather simple. Two reflective sensors on perpendicular walls are used to measure the position of the block in two dimensions. These sensors had to be carefully calibrated to provide a smooth range of motion for the joystick. Initially the joystick was calibrated to allow for two speeds along each of the four directions, as well as an idle state, for a total of 25 different movements. However, it was soon discovered that the motors only had enough torque to move the racks along the rails when operating at full power. In the final design, only 9 different
movements were possible with the joystick.

The computational aspects of the maze table were also quite simple. Based on the position of the joystick, the two motors would move the guiding magnet just under the surface of the table. In addition, a light sensor is used to tell when the mouse is approaching a wall of the maze. If the mouse runs into a wall it ignores its joystick-controlled movement and backs up until it safely away from the wall.

The two crickets use wireless infrared (IR) communication. This was setup as a simple client/server model. The joystick cricket acts as client and sends a byte that encodes the joystick’s position in two dimensions via the infrared port. The maze table cricket acts as a server and listens on the IR port for information from the joystick cricket. IR communication allowed for the use of more sensors/motors to perform a common task. With this communication the mouse can respond not only to the position of the joystick, but also to the walls of the maze.

The sliding racks were the most difficult part of this project. The main problem was that the racks would sometimes get twisted, so that they were not parallel with the sides of the maze table. This would cause the mechanism to lock up and lose all motion. This problem was particularly bad when guiding the mouse around the corners of the maze. However, it was found that a little bit of bicycle wax could reduce the friction enough to prevent this problem from occurring. Originally, two more powerful motors were used, but it was soon discovered that these motors were too heavy and always caused the racks to lock up. Guides on the motor mounts also help keep the racks from
twisting. It is interesting to note that the magnet effectively reduced the weight of the double-motor apparatus, and allowed for more free movement of the racks.

Another obstacle we encountered occurred while creating the joystick. The initial Lego design was too complicated to be built in wood. The design had to be simplified, yet still be functional. The initial prototype wooden joystick had a big problem. The wooden rods would begin to slide at an angle with the box, similar to the problem experienced with the maze table. Fortunately, we were able to mount guides on both ends of the rods that force them to slide parallel with each other and perpendicular to the slots. This solved the problem entirely.

To give us one final scare before our project presentation, we had one of our motors break down. Before class on presentation day, we were frantically trying to superglue a gear to new motor. We discovered the glue would bond very quickly to your fingers, but took several minutes to bond to plastic. We eventually got the gear set and waited for it to dry. After it had tried, we found that the motor was glued into position and could not rotate. By giving the gear a solid twist, we were able to break the bonds that prevented the movement. We re-assembled the motor apparatus just in time to demo our project!
This product allows for much creativity and interactivity, and can be used as an educational tool by seeing the mechanics at work. It is creative in the sense that you can make your own maze either by drawing out lines on a sheet of paper, or directly on the Plexiglas with a dry-erase marker. And it is interactive in that you get to control the mouse’s movement with a joystick. With a maze in place (see Fig 1.1), the game is very similar to those at the Cabaret Mechanical Theatre, with the added advantage of embedded communication. However with the clear Plexiglas surface (see Fig 1.2), it is much like the Ganson style, where the mechanics are part of the aesthetic appeal of the game. By watching the game at work, one can learn about the translation of rotational and linear movement, friction, and controlling movement in two directions. Also, the wireless joystick invokes critical thinking about the computational elements of the game.

If we had more time there are several ways we could expand on this project and make it more interactive and robust. Initially, we had pictured guiding the mouse through
the maze to an objective, such as a wedge of cheese. When the mouse reached the cheese, it would then do a dance or a squeak a song. We could try to make the mouse dance by using electric magnets and reversing the polarity. To squeak a song we could simply use the built-in speaker on the cricket. To make our game more robust we would need to replace the Lego motor apparatus with something more solid. Also, more powerful, light-weight motors could allow for a smoother range of motion. In addition, the holes on the racks could be drilled to optimally cut down on twisting and friction. However, even with only simple motors and sensors, we were able to make a fully-interactive maze game.