

1600 Final Project Proposal: Robotic Timer/Zen-Garden

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1. High-level overview

- We plan to make a robot that lets you tell time visually. It will be a ball magnet that is dragged across sand from one side of a box to another, and the distance left for the ball to travel is how much time is left on the timer. We will add functionality to vary how long the ball takes to cross from one side of the box to another, which basically allows you to set higher interval timers.
 - Our thought process is to have a belt controlled by servo/stepper motors, that will allow the ball to move in 1D from one side of the box to the opposite side of the box. The belt will have an electromagnet on it that will allow us to control the ball magnet that will be in a box of sand above it. We will have a few buttons that allow for different actions. There will be a button to reset the timer, a button to start/pause the timer, and a few buttons to change between different intervals of time.
- Extension: We create a sand drawing machine. We will have a ball magnet in a box of sand, and it will be able to move in all directions and draw patterns in the sand.
 - This is an extension of the previous idea, and would require us to build a 2D movement system.

2. Requirements

- **Use of PWM, ADC, or DAC:** The servo/stepper motor will be controlled using PWM. (If this does not count we can use a potentiometer to determine the time interval)
- **Watchdog Timer:** We will use a watchdog timer to reset the system at the end of each loop if the watchdog is not petted, where each loop causes the motor to turn a fixed amount.
- **Interrupt Service Routine:** Pressing a button will send an interrupt that will reset the system by moving the magnet back to its initial position. In addition, we will use a timer/counter to send interrupts at a constant frequency that depends on the time interval, and the ISR will cause the motor to turn a fixed amount.
- **Use of Serial Communication, WiFi, or Timer/Counter:** A timer/counter will be used to keep track time and know when to move the ball magnet.

3. Proposed Final Deliverable For The Project – what physical object will you demo, and what are the criteria by which we will know that the demo is successful?

- We will have a long box, where at the bottom our electronics are contained and at the top, which is open to be visually inspected, there will be a ball magnet on a bed of sand. There will be buttons on the side of the box. The criteria upon which the demo is successful is:
 - The ball will move from one side of the box to the other at exactly the specified time, to show it can work as a visual timer.
 - The reset button is functional and allows us to reset the system.
 - The ability to change the time interval for the timer, and have the ball move across the box of sand at different speeds.
- Extension: It will be a squarish box that contains sand, and has a single ball magnet on top. Our electronics will be contained at the bottom of the box. There will also be buttons on the side of the box. The criteria upon which the demo is successful is:
 - The ball can draw patterns in the sand
 - The reset button is functional and allows us to reset the system.
 - The ability to change the speed the ball draws patterns in the sand.

4. Proposed Demo for Progress Milestone

- We are able to start and pause the progress of the timer, and are able to reset the timer. However, the timer will not necessarily be accurate, and the look of the object may not yet be complete, as in the ball magnet on a bed of sand may not yet be included.

5. Discussion of Uncertainties, such as challenges you anticipate in implementing the project, timeline considerations, faulty components, etc. You don't have to provide a contingency plan for each uncertainty, but you should offer some idea of what a scaled-back project would look like.

- For the 1D axis system, there may be issues in figuring out what size gears we need to attach to the motors in order to be able to appropriately translate the motor rotation into linear distance.
 - Solution is to work with someone knowledgeable in gear mechanics
- We anticipate that there will be software issues. There are a lot of registers that need to be set up in order to use a watchdog timer, a TC peripheral and interrupts. Lots of errors can crop up, if some registers are set incorrectly.
 - Solution is to work out and plan what registers we need to set and with what values before we start coding so that we can make sure we are doing things correctly. Also we should make the code as readable as possible to make it easier to debug.
- Extension: There will most likely be issues in trying to set up a 2D axis movement system, as we need to account for the weight of one of the rails that will sit upon another rail.

6. List of Parts to be Ordered and Total Cost

- Other parts like the gears and box will be laser cut/3D printed from the BDW

Item	Quantity	Cost	Link
Thick band	2	\$9.49	Amazon
Magnetic ball (10 mm)	2	\$3.92	Wish