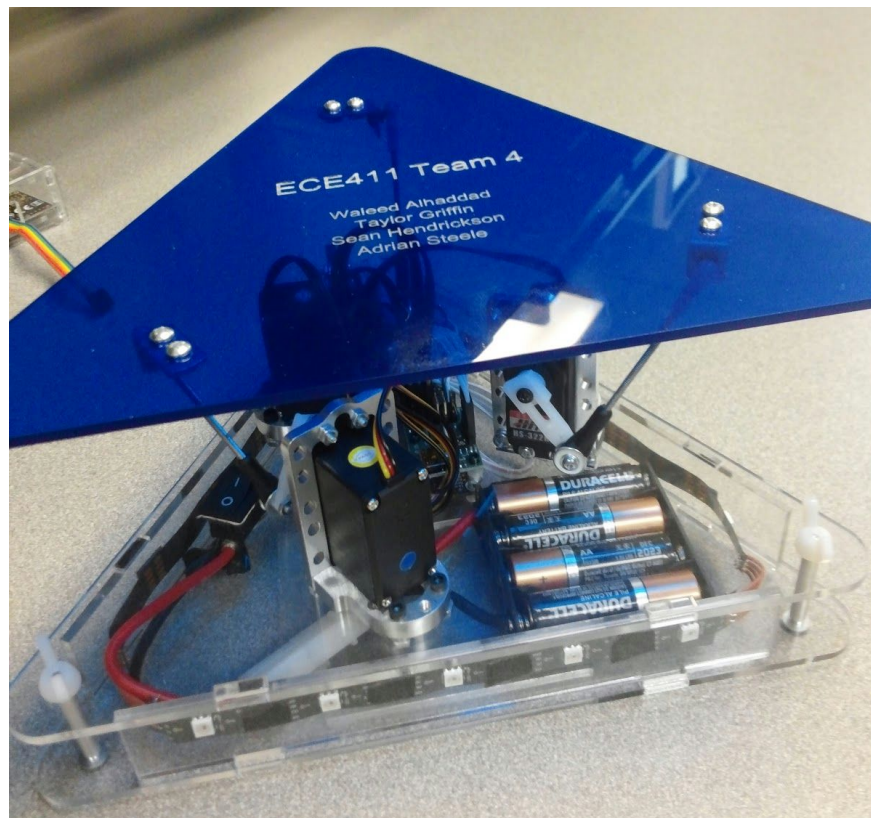# Self Leveling Device

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Needs

We are trying to create a device that keeps a top mounted tray level in real time. Currently some examples that we have seen are slow to level so we want to improve upon this design to create something with minimal latency. We aim to improve efficiency by reducing the number of required calculations to find the level state. We think we'll be successful because the diverse engineering background of our team members. This device could be useful as a serving tray and could potentially help serving staff or keep any sort of object level that needs to be. Failing the class is our risk, and if we succeed, this project will be good to put on a resume as well as the fact that we will have learned a lot from this experience. The cost will be affordable for students, and the time to research and build is approximately 8 weeks (1 term). Laying out the PCB, attaching the components, and successfully getting the servos to move will be our "midterm" and a successful demonstration of our product will be the "final" exams.

Objectives

Our objective is to produce a device that has a triangular base with a triangular top mounted tray. Servos will be attached to each point of the tray. It will receive input from an accelerometer that will give us the device tilt. We will process this information and give commands to the microcontroller which will communicate to the servos the proper adjustment necessary to level the device. The device will be portable and capable of balancing a small item.

Background

All of the devices that are similar to ours have been square. Most of them incorporate a system where servos are attached between a base and tray. We haven't seen any of these devices for sale; all have been custom built projects. In most of the devices, they are using arduino as the main controller.

Marketing Requirements

The device should be easily held with two hands.
The device should hold an object on the table to balance.
The device should be responsive.
Should be simple and intuitive to use.
Should be visually appealing.
Should be inexpensive.
Should be safe.

Constraints

Must have at least one input (sensor) and at least one output (actuator).
Must have at least 2 layers on PCB.
Must have a microprocessor located on PCB.
Must have more than 25% surface mount components.
Must have top-side silk screen.
Must not start from existing design file.
Must have live documentation and use revision control.
Must be published with MIT license.

Engineering Requirements

Functionality

The device should maintain a level position while powered on.

Performance

The device should level itself within 3 degrees.

Should move to a level position within 2 seconds of becoming unlevel.

Table should remain level up to 15 degrees relative to the horizontal.

Economic

Total parts cost will not exceed $200.

Energy

The system will should run off batteries for at least 1 hour.

Health & Safety

Power system and components should be inaccessible to user.

Environmental

Should be manufactured with lead free solder.

Manufacturability

PCB should be greater than 1.5 sq. inch and smaller than 140 sq. inches.

Operational

Device should be smaller than a cubic foot.

Device should not weigh more than 5 lbs.

Reliability & Availability

Table should hold .25 lb. without breaking.

Social & Cultural

Should have visual feedback system to relay angle state to user.

Usability

User should not need instructions to use device.

Marketing Requirements	Engineering Requirements	Justification
2, 3, 4	The device should maintain a level position while powered on.	When the device is powered on it will be expected to work until it is powered off.
2, 3	The device should level itself within half a degree.	This level of accuracy should be possible with the current available accelerometers and servos available.
2, 3	Should move to a level position within 2 seconds of becoming unlevel.	This speed should be possible with the current microprocessors and servos available.
2, 3	Table should remain level up to 30 degrees relative to the horizontal.	We believe typical servo range will allow for a range on the table of about 30 degrees.
6	Total parts cost will not exceed $150.	The bill of materials should be small and affordable for students to build.
4, 6	The system will should run off batteries for at least 1 hour.	We expect power drain to be low enough to get an hour or more of battery life at max usage.
4, 5, 7	Power system and components should be inaccessible to user.	The user just has to press the on button to turn it on and the button will be safe to access away from device components
7	Should be manufactured with lead free solder.	The device should be made with components that are safe to be handled by both the user and manufacturers.
1, 6	PCB should be greater than 1.5 sq. inch and smaller than 140 sq. inches.	The device is portable that can be held by two hands so small PCB will be used and device total cost will be decreased.

1, 5, 6, 7	Device should be smaller than a cubic foot.	In order to keep weight to a minimum, the device should be as small as possible while still being easily held.
1, 6, 7	Device should not weigh more than 5 lbs.	The device needs lightweight components to minimize the need for powerful actuators. This in turn keeps cost and power consumption to a minimum.
2, 4, 6, 7	Table should hold 1 lb. without breaking.	The device will be inexpensive and lightweight and to cater to these needs the maximum weight of the object to support should not be very heavy.
3, 4, 5	Should have visual feedback system to relay angle state to user.	This allows the user to be able to see the maximum angle that the device can operate at and adds visual appeal.
2, 4, 7	User should not need instructions to use device.	The device is built toward the general public and should be easy to use for anyone of any age.
4, 5, 7	Should include assembly instructions.	Allow the user to put together a device of their own and understand how it works.

Marketing Requirements
1. The device should be easily held with two hands.
2. The device should hold an object on the table to balance.
3. The device should be responsive.
4. Should be simple and intuitive to use.
5. Should be visually appealing.
6. Should be inexpensive.
7. Should be safe.