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Senior Capstone Project Report

Abstract

Small sailboats have a small flag at the top of their mast which is used to indicate the direction of the wind to the sailor. This can be hard to use for beginners, and causes problems on sunny days when the sailor can be blinded, and on windy days when the wind can pick up and quickly change directions. In this project I built an inexpensive wind vane with a user friendly display. My design took out some of the concerns and inconveniences from sailing, which makes it safer and easier for people who are new to sailing to use.

Introduction

Wind vanes are crucial on sailboats for sailors to determine the direction of the wind relative to the boat's bearing. Typically, when sailing a smaller sailboat, a sailor needs to look up at a small flag or wind indicator at the top of the mast to see the direction of the wind. For a sailor, constantly looking up is problematic. It is never a good idea to take your eyes off of where you are headed, and eyesight is often blocked by sun hats. This puts strain on your neck and back, and can hurt your eyes on sunny days. The device I made connects the wind indicator to an LED display that's easily visible to the sailor. The display consists of 12 LEDs in a ring, representing a compass that shows the direction of the wind relative to the boat. Having a display directly in front of the sailor takes away the need to constantly look up. The design of having LEDs in a ring instead of using a screen to display a numeric angle, is because I wanted the display to be helpful for novice sailors as well as seasoned captains to easily see the direction that the wind is blowing regardless of how bright a sunny day might be.

Background

The device I made can be purchased, however the type used on sailboats can cost from 500 to 1,000+ dollars. Most wind vanes that are available for purchase are complicated and have a lot of bells and whistles that are not necessarily needed to captain a small personal sailboat when all you need is something to replace a flag. Also, store-bought devices usually have a digital screen display that gives you numeric angles. Translating the angle to a direction can be difficult for beginners to get used to. Digital screens can also be difficult to read in sunlight, adding an unnecessary obstacle.

There are also various DIY instructions on how to make a general weather vane for home use. In my case, all I needed was the wind indicator. DIY wind indicators, or weather vanes for home use, either have the same problems as store-bought sailboat wind vanes, or they're too simple. A lot of simple wind vanes only point in the direction of the wind, and lack a display. My design uses a simple DIY wind vane that connects to an LED display. LEDs are easy to see in daylight, and by having the lights show the direction that the wind is blowing, sailors don't need to worry about translating numbers into a direction.

Methods

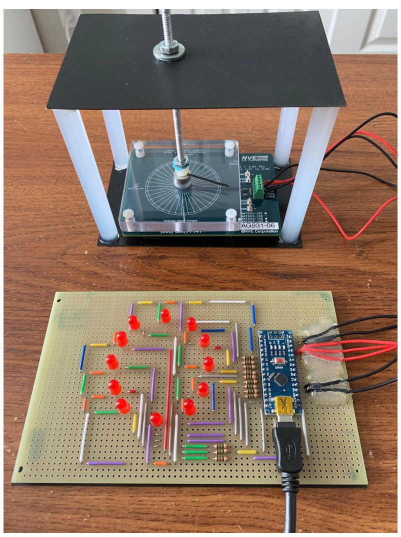
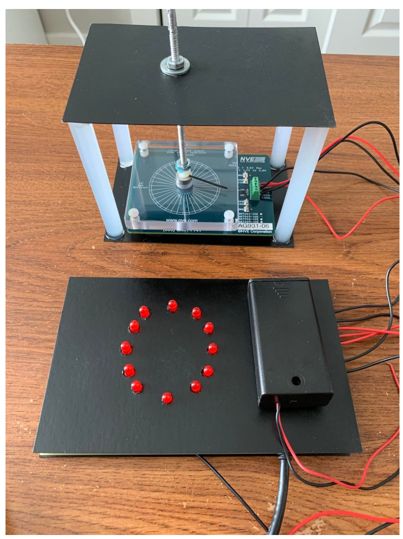
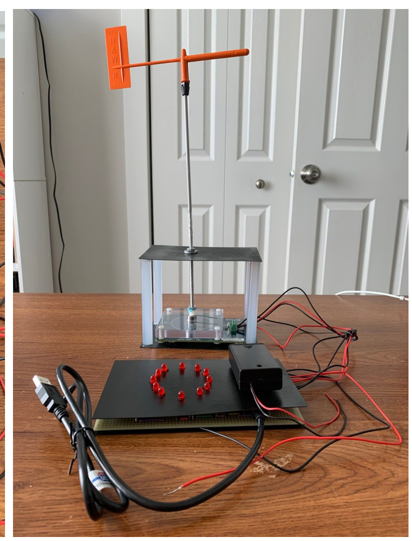
The wind vane works by utilizing four main parts, the wind indicator, the angle sensor, the Arduino Nano, and the LED display. The wind indicator is a plastic piece that resembles an arrow. This is connected to a thin, lightweight aluminum rod which is supported by a metal plate. The plate reduces as much of the weight from the wind indicator as possible so that it can spin unhindered with the wind. Under the plate, the end of the rod is connected to the magnetic angle pointer. The pointer turns with the wind indicator, and as it moves, the direction is read by the angle sensor beneath it. I chose this type of sensor because it's near frictionless, which is what I need in order to get the best reading of the wind possible.

The reading is then sent to an Arduino Nano chip, which is low cost and easy to program. I downloaded Arduino IDE onto my laptop in order to program the chip using C language. As this was the most difficult part of the project for me, utilizing the built-in examples in Arduino IDE and a book called *Programming Arduino* [9] were the best resources for helping me learn how to program a board and learn C. The Arduino Nano chip connects to each of the 12 LEDs in the circular ergonomic display, which was built by hand-soldering all of the pieces, including the chip, to a proto board. The chip's programming determines which of the lights should be lit based on the information received from the magnetic angle sensor. This makes for an affordable and accurate wind vane with an easy to use display.

Results

The wind vane is simple and easy to use. The indicator is able to spin easily in the direction that the wind blows with minimal friction. It's connected to the magnetic angle sensor which identifies the direction it's being pointed so that the Arduino Nano chip knows which light to illuminate on the ergonomic LED display. The sailor will be able to know the direction of the wind from the illuminated light instead of having to look at the wind indicator which would be installed at the top of a mast on a sailboat. The wind vane is also battery powered. The battery pack is attached to the top of the display for easy access. All it needs are two AA batteries to function.

Most of the pieces are adjustable and removable. If you wish to take out the angle sensor, you can simply loosen up the nuts which secures the aluminum rod supporting the indicator. You then unfasten the sensor from its restraints on the plate beneath it. This is to ensure that you can reach the screws to replace the wires which connect to the Arduino. The ends of these small wires can break, and may need to be restriped over time, or the wires can be changed out for longer ones depending on the height of the mast. It’s also this way so that the sensor can be fixed or replaced if it breaks, without damaging the rig. The same can be done on the ergonomic display. Its top plate as well as its bottom plate can be removed for easy access to the proto board beneath. This is useful if one of the lights goes out and needs to be replaced with a new one.

Discussion

I hoped to learn more about programming boards, C language, and working with metal on my project. I know that a lot of companies tend to use C/C++ when working with equipment. By working on this project I now not only know the basics of how it works, but also the methods you need in order to do it. I tend to overcomplicate things, and I learned that you don’t just need to understand the language, but you also need to know how the chip works and how to test it.

When I first got my Arduino Nano, I had no idea what I was doing because I tried to program the chip to do what I wanted right away after I had mostly figured out the language. However, I didn't really know what I was doing, so nothing was working. I had to step back and try out a few of the built-in examples first to make sure that the board was functioning. Then I tested to see if I could make one light turn on, then two, four, then twelve. The steps were necessary in order to test that the simple things worked before tackling all of the lights at once.

I also gained more experience in building things in a project. I got to strengthen my skills in soldering and improvising when I built my rig for the wind indicator. I got to design my rig, and work out how the set up would work and look like. Sadly I didn't get the chance to learn how to weld due to the school being closed down, however I found that a glue gun or epoxy works for this project just as well.

Conclusions

This project followed my initial plan and didn't stray too far from it. I was successfully able to implement all vital elements of this project and develop a solid prototype. The only change in my strategy that I had to make in this project was how I built my rig to hold the wind indicator. My original design was to make it completely out of metal. I intended to cut out sheet metal, drill custom holes where I needed them, then weld the plates to metal supports in order to hold it up. I was not able to do this because the school was closed down, and the school has the equipment I would have needed to do these things (saw, drill press, blowtorch). Since I no longer had access to these school resources, I had to improvise using epoxy and plastic instead.

I had several extra features that I could have implemented, but didn't have time to complete. I would've liked to establish wireless communication between the wind vane and the display via a 433MHz RF transceiver or similar wireless device (Bluetooth, XBEE). A remote would've been added if this were the case, because if the wind vane was wireless and sitting at the top of a mast several meters in the air, a remote would be needed in order for it to be activated from the bed of the boat. Compensation for the rocking of the boat would have also been a key feature, since it might throw off the results of the angle sensor during use on the water. I also would have wanted to store all electronics on both parts of the device in sunproof/waterproof containers to keep the devices protected from the elements while still allowing signals to pass through, and the display to remain visible. Lastly, a solar powered battery so that the sailor won't need to climb the mast to change the battery when they are out on the water.

References

[1] EL-PRO-CUS. 2013-2020. RF Module – Transmitter & Receiver. Retrieved from https://www.elprocus.com/rf-module-transmitter-receiver/

[2] GitHub. 2020. NveCorporation / Blinky-AngleSensor-Demo-Kit-Software. (July 2018). Retrieved from https://github.com/NveCorporation/Blinky-AngleSensor-Demo-Kit-Software

[3] Instructables Circuits. 2020. Accurate Wireless Weather Vane. (2016). Retrieved from https://www.instructables.com/id/Accurate-Wireless-Weather-Vane/

[4] Michael Margolis. 2012. Arduino Cookbook (2nd. ed.). O'Reilly Media, Sebastopol, CA.

[5] NVE Corporation. 2016. Interfacing Angle Sensors to Microcontrollers. Video. Retrieved from https://www.youtube.com/watch?v=NrJyLgZ5egI

[6] NVE Corporation. 2018. "Blinky-Flashy" Angle Sensor Demo. Video. Retrieved from https://www.youtube.com/watch?v=WjNxMBVSBC0&list=PLr5hek1vaGEkWg9Nv60MA6ZxODXXa-8fM

[7] NVE Corporation. 2020. AG935-07E: 60-LED "Blinky" AAT003 Angle Sensor Demo Board. Retrieved from https://www.nve.com/webstore/catalog/product_info.php?cPath=27_29&products_id=677

[8] Polycase. 2018. Protecting Outdoor Electronics in Warm Weather. (June 2018). Retrieved from https://www.polycase.com/techtalk/outdoor-electronic-enclosures/protecting-outdoor-electronics-in-warm-weather.html

[9] Simon Monk. 2012. Programming Arduino: Getting Started with Sketches. McGraw-Hill, USA.