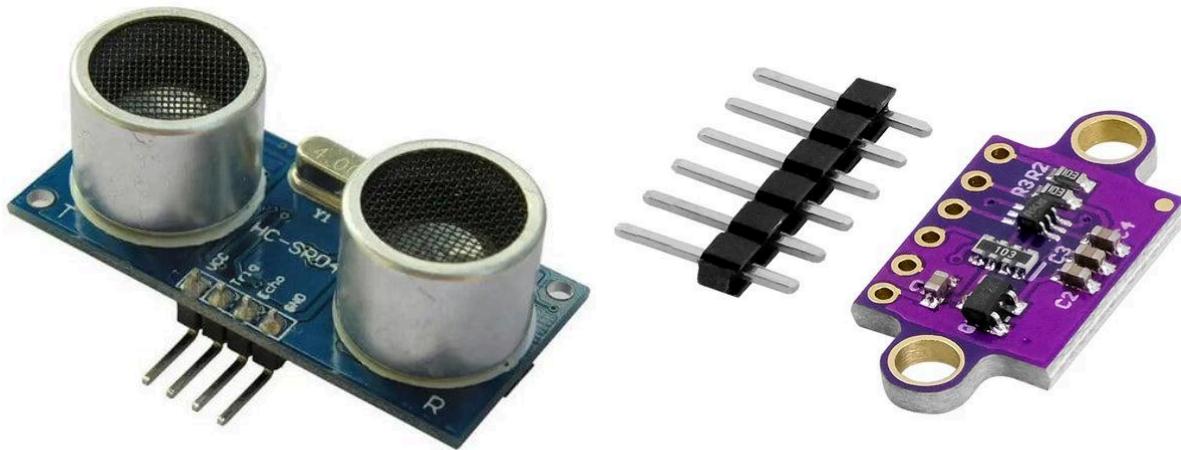


Ultrasonic vs. ToF Sensor Notes



Introduction

In its current configuration, the Zotbin utilizes an ultrasonic sensor to measure fullness by emitting sound and measuring the time it takes for the echo to return. In contrast, a time-of-flight (ToF) sensor/camera emits infrared light and measures the time it takes for the reflected light to return, or calculates distance via phase shift. We will evaluate the pros and cons of replacing the current ultrasonic sensor setup with one that includes a ToF sensor instead.

Performance Metrics

Trial	Measurements (cm)	Ultrasonic Sensor (cm)	Time of Flight (ToF) Sensor (cm)
1	5	5.54	4.90
1	5	5.56	5.20
1	5	5.97	5.00
1	5	5.54	5.50
1	5	5.54	4.90
1	5	5.54	4.90

1	5	5.56	5.00
1	5	5.45	5.20
1	5	4.61	4.90
1	5	5.97	5.20
2	10	11.64	10.10
2	10	9.95	10.10
2	10	9.95	10.00
2	10	11.64	9.90
2	10	14.10	9.90
2	10	12.83	10.00
2	10	11.64	10.30
2	10	12.40	10.00
2	10	12.40	10.20
2	10	11.99	10.00
3	15	15.98	15.40
3	15	15.98	14.80
3	15	15.98	14.90
3	15	15.97	15.00
3	15	15.54	15.00
3	15	15.54	15.20
3	15	15.56	14.90
3	15	17.17	15.20
3	15	17.58	15.20
3	15	17.60	15.40

Ultrasonic Sensor:

- Trial 1: avg 5.58 cm, std dev 0.38 cm, median 5.55 cm
- Trial 2: avg 11.86 cm, std dev 1.25 cm, median 11.82 cm
- Trial 3: avg 16.29 cm, std dev 0.83 cm, median 15.98 cm

ToF Sensor:

- Trial 1: avg 5.07 cm, std dev 0.20 cm, median 5 cm
- Trial 2: mean 10.05 cm, std dev 0.127 cm, median 10.00 cm
- Trial 3: mean 15.10 cm, std dev 0.21 cm, median 15.10 cm

Conclusion

The Time of Flight (ToF) sensor is significantly more accurate than the ultrasonic sensor. This is evident through the data shown above. Although the measurements were generally smaller than realistic measurements in the ZotBin environment, scaling up the measurements will only make the difference in errors more evident. Regarding library support, there appears to be adequate library support in Arduino, such as through the Adafruit or the Pololu libraries (the [Pololu library](#) was used to test the ToF sensor in the Zotbins lab). However, library support through ESP-IDF is much more limited. A potential way to address this is to employ Arduino-as-a-component in ESP-IDF, thereby allowing us to use any of the widely available Arduino ToF libraries for Zotbins. This may be preferred if we want to avoid purchasing a specific sensor that contains the library pre-downloaded from the factory. On the other hand, doing so may introduce unnecessary bloat. Next steps may be to ensure the viability of Arduino vs. using a native ESP-IDF compatible library/sensor.