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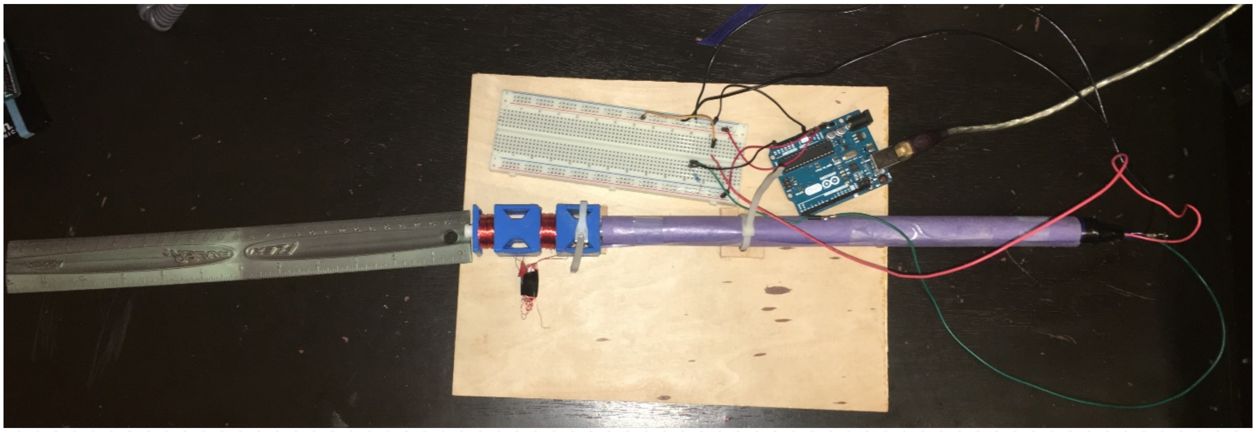
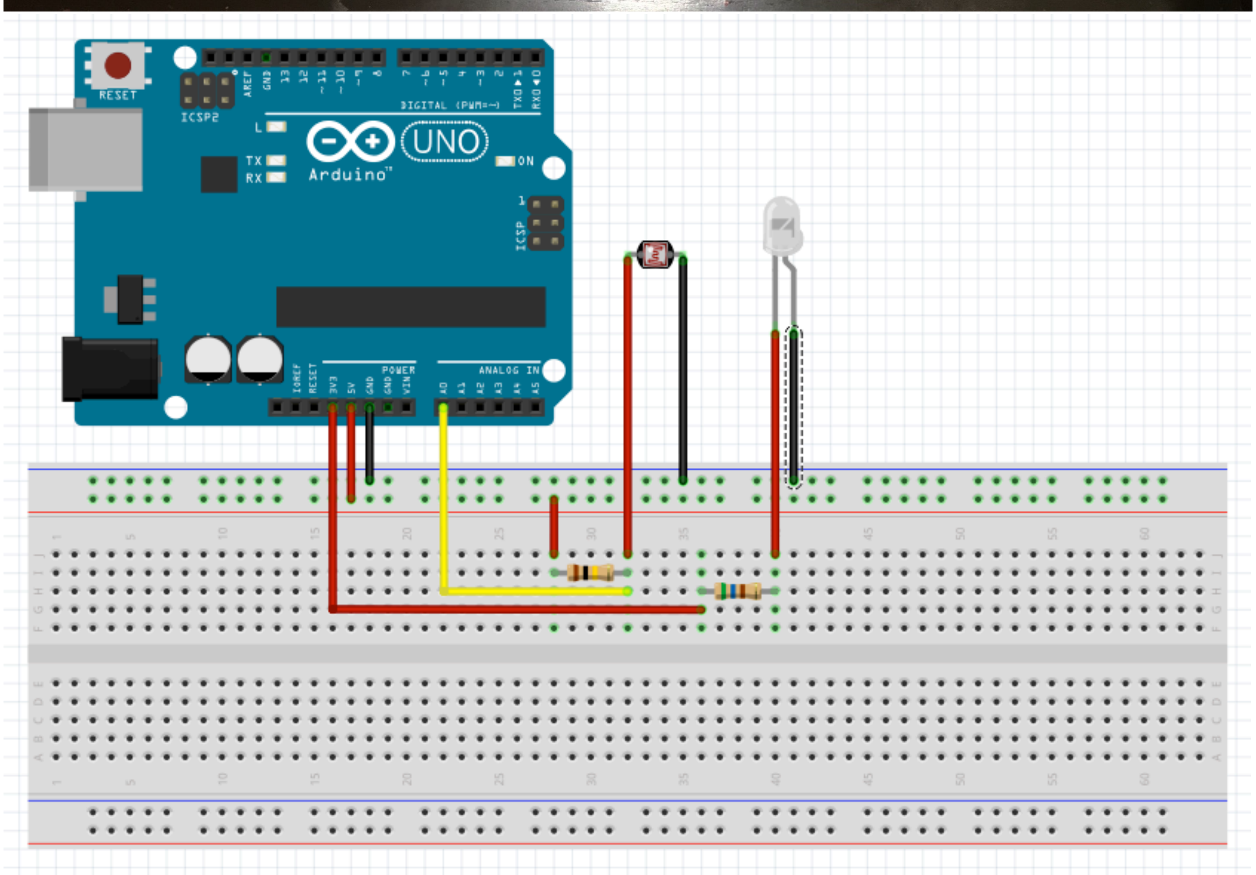
Test Results from Existing Sensor (Mark I)

The existing structure consisted of a clear plastic tube wrapped in blue electrical tape and in construction paper in order to prevent light from escaping and entering the chamber. A CdS photoresistor (photocell) was attached to a 100K resistor in series and a 5 volts source and a white LED was attached to a 560 resistor in series a 3.3 V source. The photocell was placed in a 1 cm black tubing and both the photocell housing and the LED were placed at one end of the plastic tubing and black electrical tape was used to secure them and to prevent light from entering the tube. A 1 cm black rode with 2 white caps on either ends was placed in a 3D printed sliding holster so it could slide back and forth from end to end.





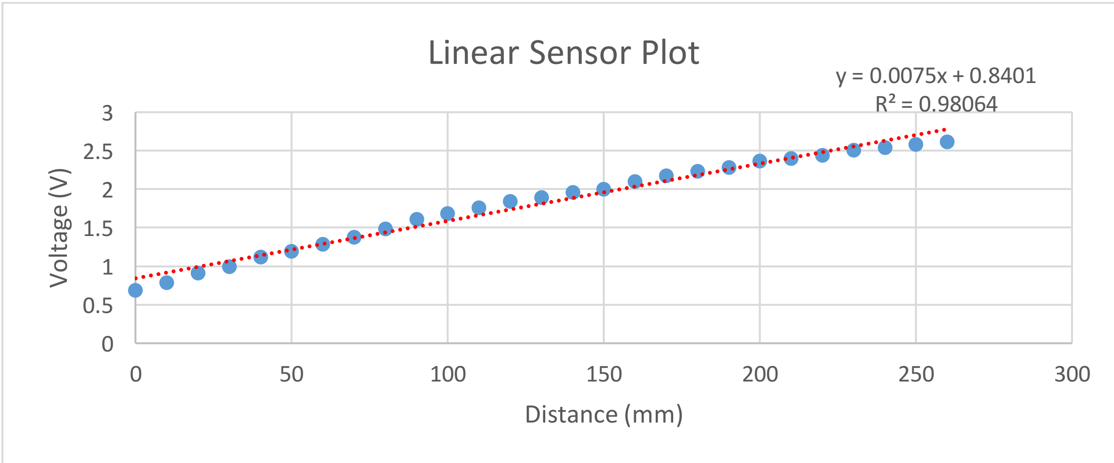
The procedure was to wire the LED, photocell, and resistor to the Arduino. A simple Arduino script was used to sample the photocell's voltage divider once every second. The ADC value from the serial output of the Arduino was recorded for every 1 centimeter from 0 cm to 26 cm.

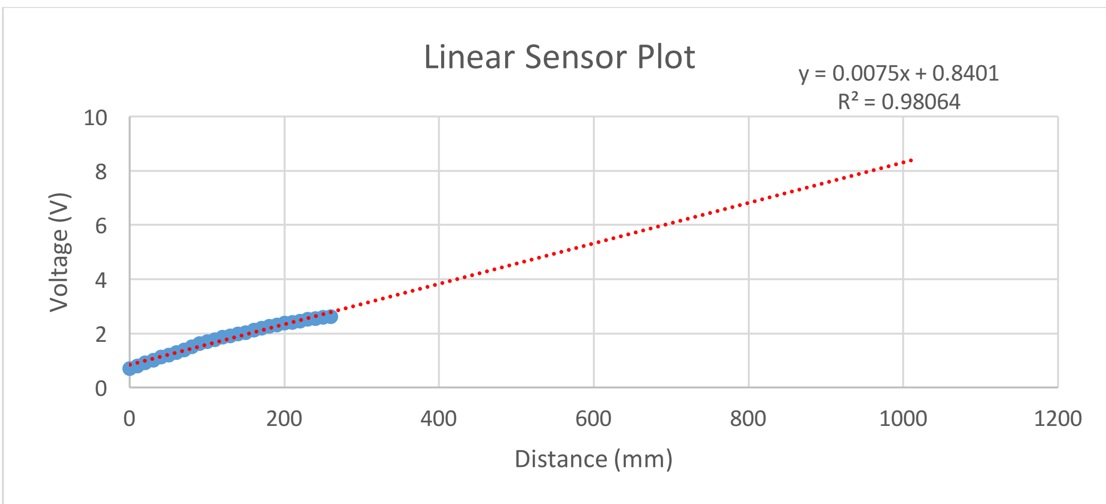
The results of the experiment were recorded in an excel sheet. Since the Arduino uses a 12 bit ADC, the output of the serial reading range from 0 to 1023. The equation [(measurement)/1023 * 5] was used to map the ADC value to a voltage. The results are shown below.

Distance (mm)	Voltage (V)	ADC Value
0	0.684261975	140
10	0.791788856	162
20	0.909090909	186
30	0.992179863	203
40	1.119257087	229
50	1.19257087	244
60	1.285434995	263
70	1.37829912	282
80	1.485826002	304
90	1.612903226	330
100	1.686217009	345
110	1.759530792	360
120	1.842619746	377
130	1.896383187	388
140	1.964809384	402
150	2.003910068	410
160	2.101661779	430
170	2.179863148	446
180	2.238514174	458
190	2.287390029	468
200	2.365591398	484
210	2.399804497	491
220	2.443792766	500
230	2.507331378	513
240	2.541544477	520
250	2.585532747	529
260	2.61485826	535

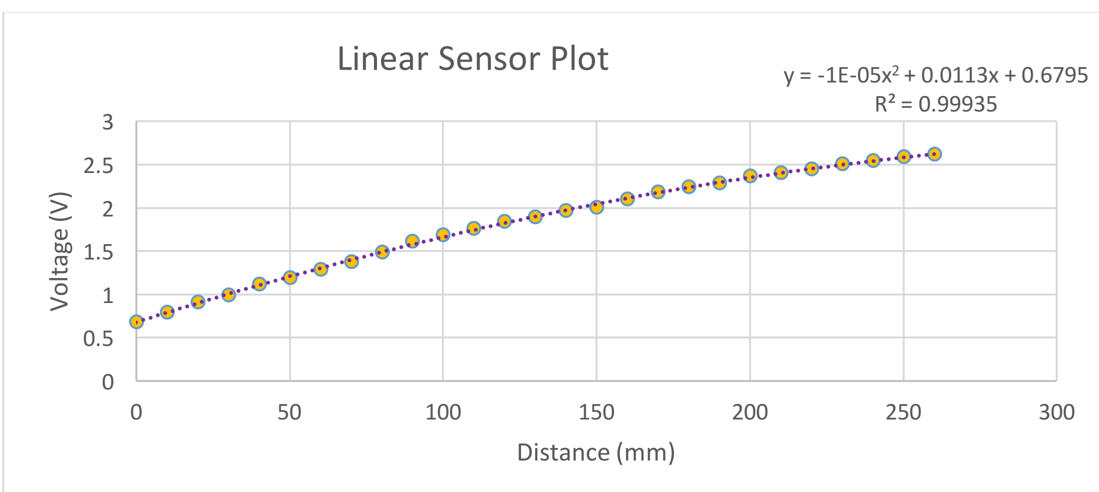
The results were plotted on a scatter plot for Distance (millimeters) vs Voltage (volts). Three regressions were used to analyze the data: linear, polynomial (degree 2), and logarithmic. The equation of the regression line as well as the R squared value are shown on the linear regression plots below. Also, a forecast of 750 mm was plotted to see if the regression would be an accurate representation of a greater distance.

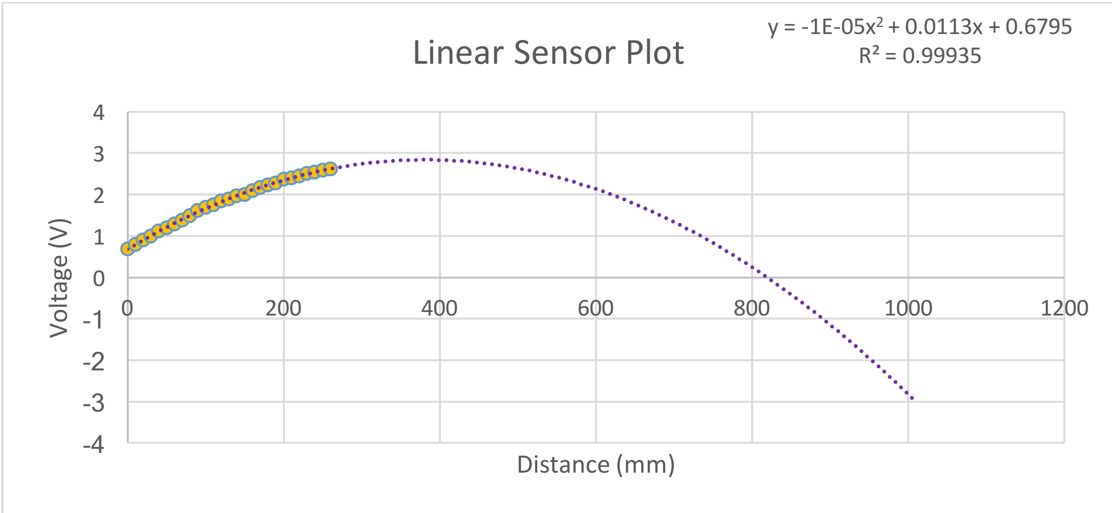
Linear Regression



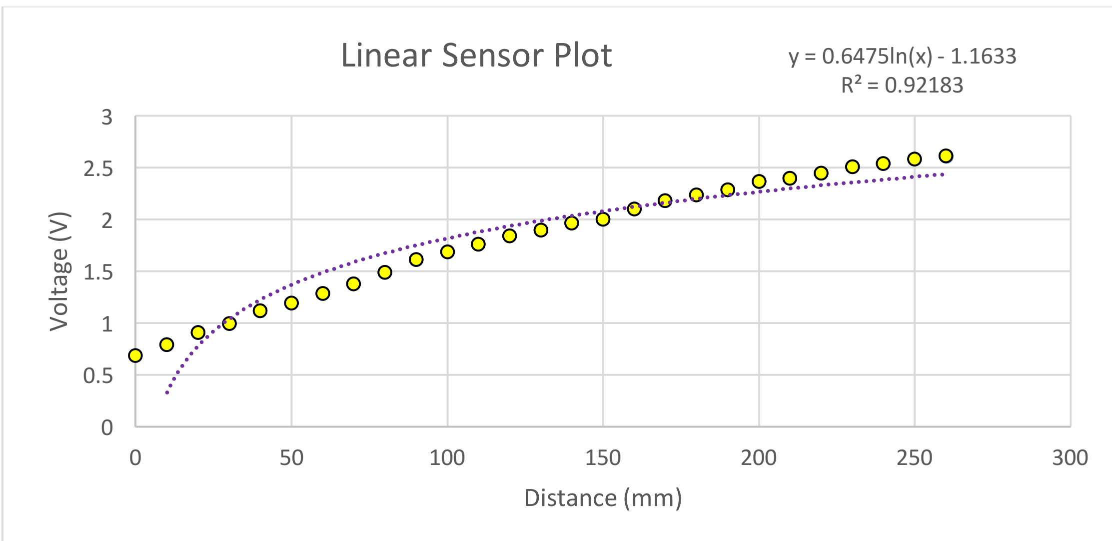


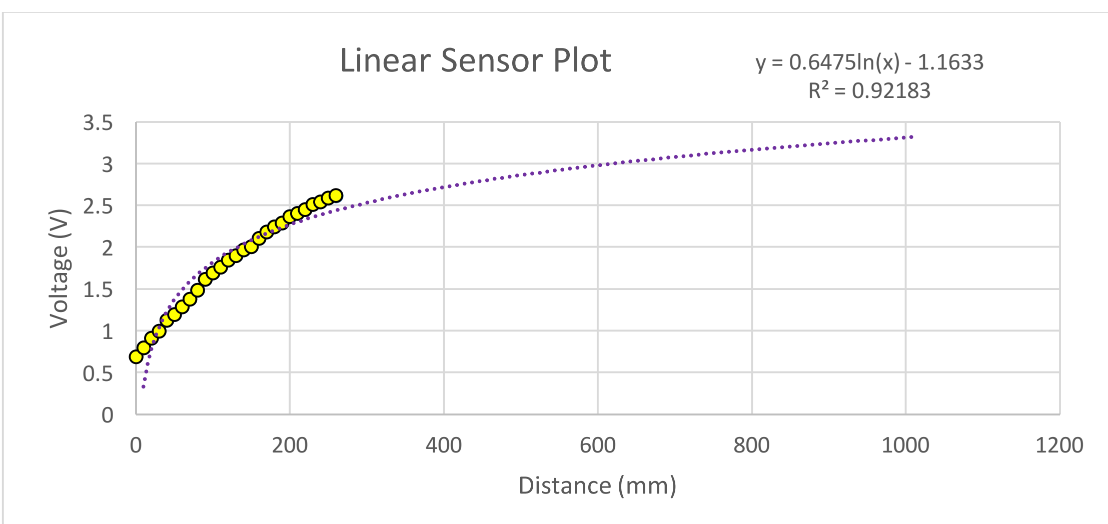
Polynomial (degree 2) Regression





Logarithmic Regression





Analysis

The linear regression was a good fit with a 0.9806 R-squared value, the linear regression plot would continue to infinity. A linear regression would be accurate for small distances.

The polynomial regression had the best R-squared value of 0.9993, the forecast plot goes to negative infinity.

The logarithmic regression had the worst R-squared value with 0.9218, but its forecast would theoretically be the most accurate.

Conclusion

The photocell accurately changed resistance based on the rod's distance from the LED. The polynomial regression was the best fit line, but more test data needs to be taken where the light fades so that the regression line can be more accurate. The existing sensor gave great results for optical distance sensing. For future design, a completely black rod could be used to avoid wrapping the tube and a tighter seal on the sliding tube and outer tube could yield better results. Depending on different sized tubes and different rod lengths, the equation of voltage vs distance could change, but there is a clear relation with the existing sensor that is built.