LONG RANGE FINDER MONOCULAR

Andrea Carroll and Ki Park

Abstract:

The purpose of this instrument is to find the distance of an object 14 meters to 805 meters.

Five experiments were tested to either prove or disprove the following:

1. Black objects get closer measurements to the accepted value than white objects
2. Bigger the object, the easier it is for the monocular to measure the distance
3. The manual provided the information that the monocular is able to measure from the distance of 20 meters to 1500 meters.

Introduction

A laser range finder monocular is a great and fairly accurate tool for measuring distance both far away and close. The laser range finder has been used for everything from a recreational sport of golf to the precise measurement of experiments at balloon fest. A laser range finder is really easy to measure far away distances without having to use something like a tape measurer. Whenever you have a place that you can focus on that is fairly straight away you can get almost the exact measurement.

When you are trying to measure something really far away you always have to remember that though the laser range finder does make everything a little bigger it is still far away. So if you are trying to measure something like a small ball a long distance away there is a good chance that you won't be able to read the exact distance of that ball. You might instead be able to get the distance of a tree or slope near it.

The fact is that a laser range finder works by sending out infrared laser beams. Which are sent out and then bounce off the certain object you want to read and then comes back into the laser range finder. Where it can calculate the distance by how much time it took for the laser beam to go there and come back The laser that it uses is not harmful to people because it used an infrared laser.

In the manual that came with the laser range finder we were able to see that it said certain things that we thought might be correct.

Things like that a certain color would be read better when being read far away than another. In this case a black object could be read better than a white object the same distance away. This brought up questions about balloon fest and how we could improve the reading of a balloon's height. Some ideas were that a black balloon would be better than a white balloon when being red by the laser range finder.

Another is that the laser range finder can read up to 1,500 meters away and as close as 20 meters. When we first heard this it sounded correct. Then we started to really think about it and started to wonder if it really could measure that far.

So from all inquiries we came up with three hypotheses:

1. When measuring a certain distance black will read closer to the actual number than white will.
2. The laser range finder monocular will read as close as 20 meters and as far away as 1,500 meters.
3. The larger the object the more accurate the reading will be.

Experimental

The procedures for this experiment were different ideas which we thought of in order to get the different data and measurements.

The hypothesis was that the Long Range Monocular will be able to read an object that is as close as 20 meters and as far as 1500 meters. Those two variables – 20 meters and 1500 meters, were given from the instruction manual. The effect of color was also tested to see whether or not the color of an object (dark or light) had any effect in the measurement and the effect of size was also tested to see whether or not the largeness of an object resulted in better measurements. In order to verify that those variables were correct, the different experiments were performed. The outcomes that were expected was that dark colored objects would get a more accurate measurement, larger objects will be easily read and closest to the accepted value and that the Long Range Monocular will be able to read objects as close as 20 meters and as far as 1500 meters due to the instruction manual having to provide the information. That was what a expected from the experiments.

Five different experiments were performed with the following: white and black poster boards, holding white and black balloons, flying the balloons in the air, using a wall at Virginia Peterson and using a white suburban on Linne Road. Each experiment tested different things. White and Black poster boards and balloons were used to test whether or not color had any effect on the measurements.

The following experiments are what have been tested:

1. Two tests were done: one where a white poster board was held 483meters away and one where a black poster board was held 483 meters
2. Two test in total one where we held a white balloon on a string extended over head 508 meters away from the laser range finder and one where we held a white balloon on a string extended over head 508 meters away from the laser range finder.
3. This test was to see if it would pick the balloon up in the air we had a string that was 10 meters long and the person holding the string was 20 meters away from the person with the monocular.
4. This test was to see how close the laser range finder could be used. What we did was we measured out 20 meters away from a wall and then went in every meter to see if you could get a reading from the laser range finder.
5. This test was to see how far away the laser range finder could be used. What we did was we took a car and drove it a certain distance away and used the laser range finder to see where it was the first place the laser range finder could pick up the car.

Diagram of Long Range Monocular

On the figure above you can see that it is labeled in three different places. These three different places are the most important to knowing how to use the laser range finder monocular. On the figure you see that it is labeled by the number 1,2, and 3.

#1 – eye piece which is used to look through when you are trying to locate and read the distance that you have chosen.

#2 – is the “Mode” button. This button is used to change the setting of how you are going to read the distance you want to read. It can change the distance into yards, meter, and when determining speed kilometers per hour and meters per hour. When you first click the mode button an M should appear which means the laser range finder will read in meters. If you hit the mode button again it will change to reading MPH or miles per hour. When you click the mode button again you get KMH or kilometers per hour. On the fourth click you get the crosshairs which can be chosen to help you zero in on what you are measuring. The fifth click on the mode button you get a square which can be chosen to help you zero in on what you are measuring. The sixth click you get Y or yards which is one of the ways to measure the distance. On the sixth click you get M or meters again. Then you get everything lit up which shows you all the options of the laser range finder. Then

on the eighth click you get rec 1 which you can hit the #3 button to see your last recorded measurement. Then you get cl which means clear and if you push #3 button you can erase all your previous data.

#3- is the “Action” button which is used many different ways. One way is when you have the correct measurement on the screen, changing around with the #2 button; you can record your data. When holding down the action button a lightening bolt will appear on the upper left of the screen which means it is reading the distance then in the middle of the screen will appear your distance.

Results

The objective was to prove that that the Long Range Monocular will be able to read an object that is as close as 20 meters and as far as 1500 meters and support the information that was given to us in the manual book. Also another objectives is to see whether dark colored objects will have more accurate measurements compared to light colored objects.

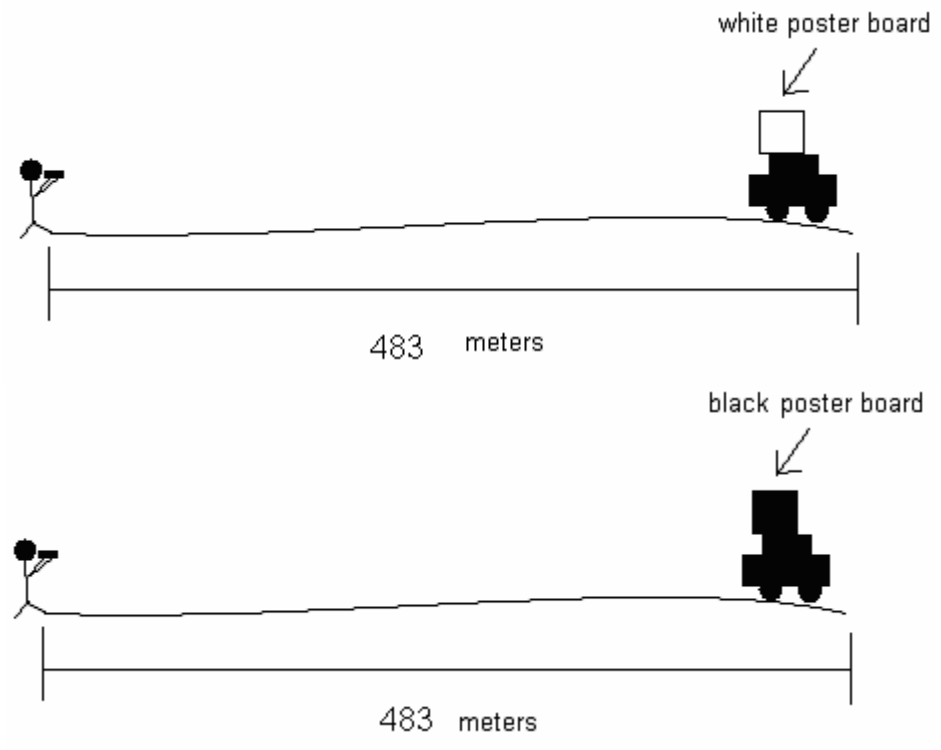
Five different experiments were performed with the following: white and black poster boards, holding white and black balloons, flying the balloons in the air, using a wall at Virginia Peterson and using a white suburban on Linne Road.

The first experiment consisted of two poster boards of white and black. On a street, we measured 0.3 mile and then 0.2 using a car. On Google, it provided the information that 0.3 mile equaled to approximately 483meters and 0.2 mile equaled to approximately 322 meters. On one end, one person held the poster boards and on the other, one person used the Long Range Monocular to measure the distances for the black poster boards and the white poster boards. The street was not evenly lined and was elevated at different parts.

Figure 1

POSTER BOARD

Experiment diagram.



Distance: 483 meters

Black Poster board	White Poster board
477 meters	473 meters
478 meters	470 meters
477 meters	471 meters
473 meters	473 meters
479 meters	472 meters

Distance: 322 meters

Black Poster board	White Poster board
307 meters	307 meters
311 meters	304 meters
312 meters	305 meters
305 meters	304 meters
309 meters	308 meters

In figure one, you can see that the accepted distances are different from the observed. The black poster board measurements outcome came out to be greater than the white poster board outcomes. Also, it tended to be closer to the accepted distances. The data that was collected shows that the darker an object is, the more closer the observed value is to the accepted value.

Resolution: $\pm$ 1.0 meter

Accuracy:

Sample calculation

$$\frac{477 + 478 + 477 + 473 + 479}{5} = 476.8 \text{ meters}$$

$$|476.8 \text{ meters} - 483 \text{ meters}| = 6.2 \text{ meters}$$

$$\frac{6.2 \text{ meters}}{483 \text{ meters}} \times 100\% = 1.2\%$$

Distance - 483meters

Black Poster: 1.2 % off or 98.8% accurate
White Poster: 2.3% off or 97.9% accurate

Distance - 322 meters

Black Poster: 4.1% off or 95.9% accurate
White Poster: 5.1% off or 94.9% accurate

Precision:

Distance - 483meters

Black Poster: ± 6 meters
White Poster: ± 3 meters

Distance - 322 meters

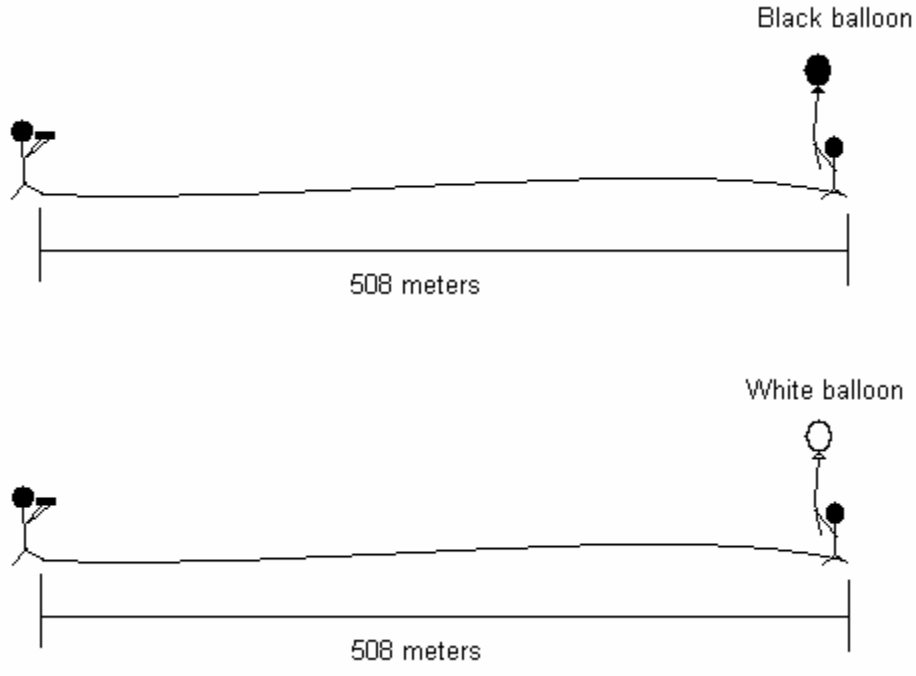
Black Poster: ± 7 meters
White Poster: ± 4 meters

The second experiment consisted of holding white and black balloons. This time, we measured to test which color was more precise to the observed value of the balloons. On one end, one person held the balloons and on the other, one person used the Long Range Monocular to measure the distances. First, we measured the distance to four balloons held by one person and got 508 meters. Then we measured the distance using only one white/black balloon.

Figure 2

HELD BALLOONS

Experiment diagram.



Observed distance: 508 meters

Black Balloon	While Balloon
508 meters	506 meters
509 meters	508 meters
508 meters	503 meters
508 meters	506 meters

In figure two, you can see that the observed measurements for the black balloon were closer to the observed value than the white balloon. Again, the data that was collected shows that the darker an object is, the closer to the observed value is to the measured value.

Resolution: ± 1.0 meter

Accuracy:

Sample calculation

$$\frac{508 + 509 + 508 + 508}{4} = 508.25 \text{ meters}$$

$$| 508 \text{ meters} - 508.25 \text{ meters} | = 0.25 \text{ meters}$$

$$\frac{0.25 \text{ meters}}{508 \text{ meters}} \times 100\% = 0.05\%$$

Distance - 508 meters

Black Balloon: 0.05% off or 99.95% accurate

White Balloon: 0.44% off or 99.56% accurate

Precision:

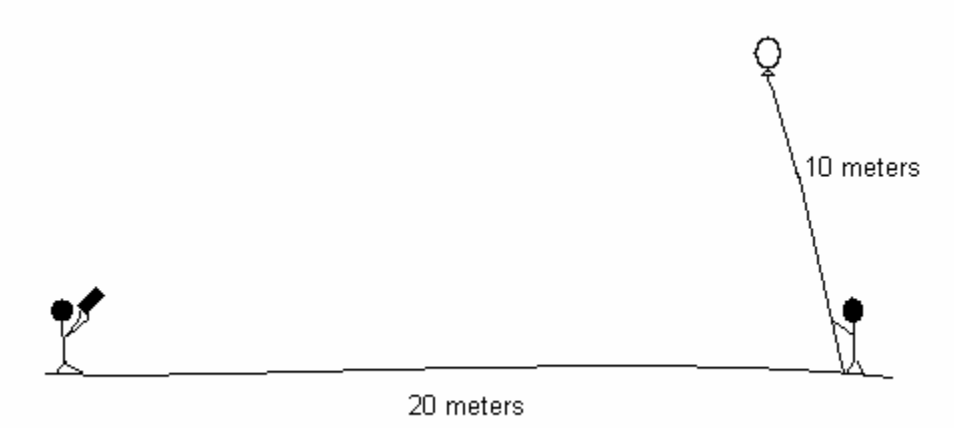
Distance – 508 meters

Black Balloon: ± 1 meter

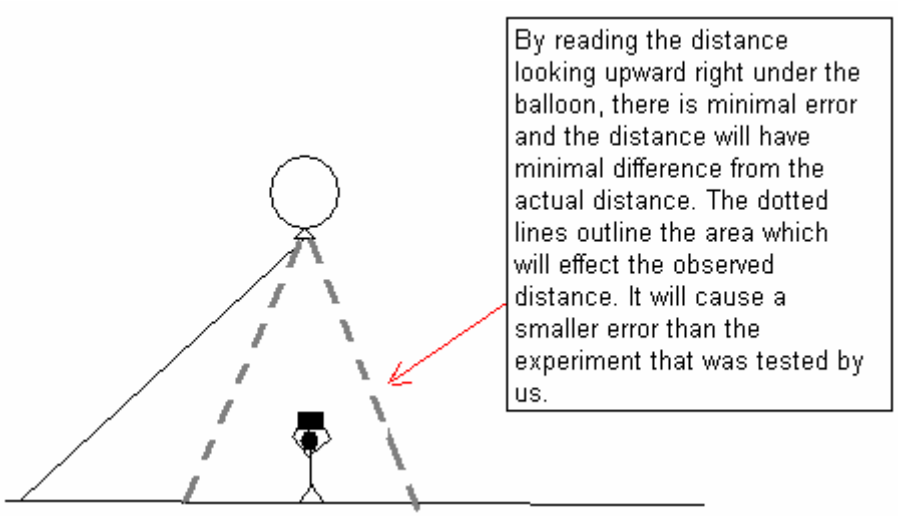
White Balloon: ± 5 meters

The third experiment consisted of holding the balloons in the air. We used 10 meters of ribbon to tie onto the balloon. Therefore the vector from the ground to the balloon was 10 meters. The distance at which the observer with the Long Range Monocular was at was 20 meters away. We took pictures of the experiment so that the angle of the balloon could be measured and then be able to calculate the distance from the monocular to the balloon.

Figure 3
BALLOON FLYING IN AIR
Experiment diagram.



This experiment would have been better if the measurements were taken under the balloon rather than at an angle away from the balloon. By being under the balloon, it limits the measurement error more so than how we had done this experiment. This will be a way to measure the distance during Balloon Fest.



Distances that were measured by the Long Range Monocular to the balloon:

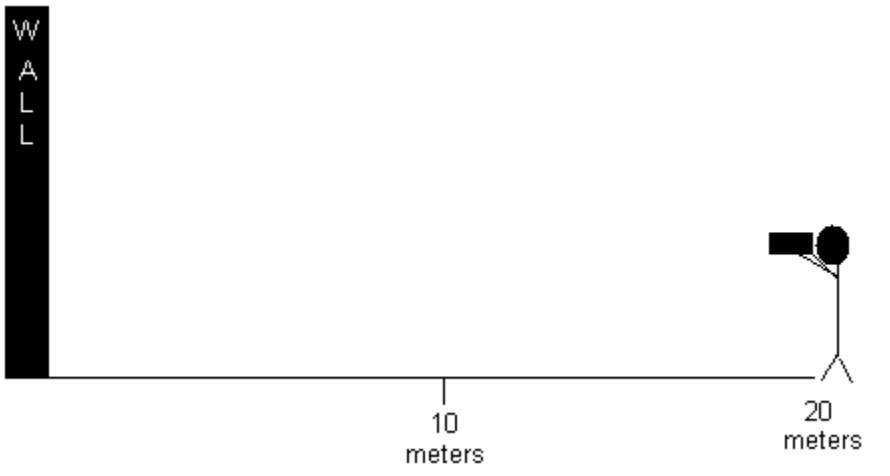
Black Balloon	White Balloon
20 meters	23 meters
18 meters	21 meters
17 meters	20 meters

The fourth experiment was performed using a wall at Virginia Peterson Elementary School. We measured 20 meters away from the wall to see how close the Long Range Monocular could measure an object.

Figure 4

WALL AT VIRGINIA PETERSON ELEMENTARY SCHOOL

Experiment diagram.



ACCEPTED DISTANCE	OBSERVED DISTANCE
20 meters	20 meters
19 meters	18 meters
18 meters	18 meters
17 meters	17 meters
16 meters	17 meters
15 meters	15 meters
14 meters	N/A

Accuracy:

Sample Calculation

$$|20 - 20| = 0 \text{ meter}$$

$$\frac{0 \text{ meter}}{20} \times 100\% = 0$$

20 meters: 100% accuracy
19 meters: 95% accuracy
18 meters: 100% accuracy
17 meters: 100% accuracy
16 meters: 95% accuracy
15 meters: 100% accuracy
14 meters: not available.

Precision: $\pm$ 1 meter

In Figure 4, it is shown that the Long Range Monocular is able to measure only up to 15 meters. At 14 meters, the Long Range Monocular could not measure the distance due to the closeness of the wall. Here, the data shows that the closest distance the Long Range Monocular could measure was 15 meters. The instruction manual provided us that the instrument could only measure to 20 meters. Our data did not support that given information. We found out that the larger an object is, the more closer it was to the correct measurement with a $\pm$ 1.0 meter resolution.

The fifth experiment was measuring how far away the Long Range Monocular could measure an object. In this case, a white suburban was used as the object to be measured. The vehicle measure the accepted distance while the observed distance was measured with the Long Range Monocular. The street was fairly straight but uneven at places. In figure 5, you can see that the Long Range Monocular was not able to measure the distance of 0.5 mile (805 meters) and beyond. Here, the data shows that the farthest distance the Long Range Monocular could measure was 779 meters. The instruction manual provided us that the instrument could measure up to 1500 meters. Our data did not support that given information.

Figure 5
WHITE SUBURBAN ON LINNE ROAD

Experiment diagram.

	1 mile - 0.6 mile	0.5 mile	0.4 mile	0.3 mile
Accepted	1609.344 - 965.6064 meters	805 meters	644 meters	483 meters
Observed	unable to measure	778 meters 779 meters	650 meters 647 meters	489 meters 481 meters

Resolution: ± 1.0 meter

Accuracy:

Sample Calculations

Distance: 0.5 mile (805 meters)

$$\frac{778 + 779}{2} = 778.5 \text{ meters}$$

$$| 778.5 - 805 | = 26.172 \text{ meters}$$

$$\frac{26.172}{805} \times 100\ \% = 3.3\%$$

0.5 mile: 3.3% off or 96.7% accurate
0.4 mile: 0.7 % off or 99.3% accurate
0.3 mile: 0.5 % off or 99.5% accurate

Precision:
0.5 mile: ± 1 meter
0.4 mile: ± 3 meters
0.3 mile: ± 8 meters

The factors that could have caused the errors are that the Long Range Monocular wasn't held steady enough to focus on the object, the Long Range Monocular was not reading the correct object, and/or the weather could have had an effect on the laser beams reflecting off the object and returning to the monocular. If the Long Range Monocular isn't held steadily, there is a high chance that it will not read the targeted object. If there are other objects in the way, the Long Range Monocular will calculate that distance other than the marked object. Weather could have also had an effect on the measurements. Another factor is that an object might have not been able to be measurable by the Long Range Monocular because it was too small for the Long Range Monocular to target and send the laser beams.

A laser range finder is a great way to measure distance. It has been used from everything from golf to higher things like fire control of today's sophisticated weapons.

Through our experiment we had five tests to either prove or disprove our three hypotheses. We also found out how precise and accurately the data was and therefore how precise and accurate the laser range finder is.

When we were trying to prove and disprove our three hypothesis we found that in some cases the manual was correct and in others the manual was incorrect. From the five tests we did we tried to explore all the ways someone might get different readings from the same laser range finder.

The only improvement I might make to change how our data was collected was how to check if the laser range finder was correct or not. Since we were having to measure a great distance we couldn't very easily measured out to see how far it really could go so we used a car. Though the car we used was a very nice and well taken care of car there is always a degree of guessing when it comes to odometers in cars.

Conclusion

In conclusion our data was taken and though there were some things that were unavoidable we got the best data we could. The weather conditions were ideal it was sunny but slightly windy. One part of the problem we had was the fact that the two roads we tested on were uneven but fairly straight. When you live in Paso it is really hard to find a road that is straight and very unlikely that it doesn't have any slope. The unevenness of the roads would have effected the total distance measurement of the object away compared to the accepted distance measured with the car odometer.

During this whole experiment we were able to find answers to our hypothesis.

Hypothesis 1) We found out that the color black was better to use than white. We found that when dealing with black balloons/poster boards we got a more accurate recording of the data than we did with the white balloon.

Hypothesis 2) We found out that the manual was incorrect on the both the farthest distance and the shortest distance. When trying to find the longest distance we found out that we couldn't pick up a car over a half of a mile away. The first time the laser range finder came back with a number was when the car was 0.5 miles away. Also when figuring out how close it could read it was able to read up to 15 meters away not 20 meters.

Hypothesis 3) It is true that when you have a larger object you can get a better reading. This is because when the laser bounces off the larger object is has more of a change to go straight back into the laser range finder. We also found out that when you have a small object a far distance away it is also really hard to pick it up. You are more likely picking up a tree or slope or person near that object not he actual object.

When talking about precision and accuracy you are talking about two different things. Precision is when you have a group of numbers and how close the numbers are together. Accuracy is how close the reading is to the expected or correct distance. We found out that precision on fixed things that you know the exact distance was about $\pm$ 1 meter but on things that moved it turned out that it was a larger number. Then when you look at the accuracy the smallest time it is off is when it is 0% off when we measured how far away the wall is and we got the exact distance we were standing from the wall. The largest percentage of inaccuracy was when 5% off during one of the wall measures the laser range finder read 17 meters instead of 16 meters. So when you are looking at accuracy and precision it really changes with how long the distance is and how close the distance is. If something is 1 meter off when it is 500 meters away it really doesn't make that big of a difference but when you are measuring something close you can get a larger percent of precision.

Overall the laser range finder is a good way to find distance. You can find distance when it is far away but when it is close it will be farther off. It is a good way to find out if something is about 500 or 550 meters away but if you want to know the difference between 500 and 501 meters it would just be better to get out a tape measurer.