SOUND AT THE SPEED OF LIGHT

M7-21 ENGINEERING

OUESTION

- Is a homemade laser communicator effective at transmitting long range and short range audio transmissions through a red laser beam?

Abstract

- There are many ways to transmit audio available in the market at this time, yet none are able to do all of the following: transmit for a very long distance, provide ample privacy, deliver high quality, and be inexpensive to use. There might now be a solution…lasers are a wonderful way to transmit audio at rapid speeds to long distances and short with privacy allocated to and kept in mind, all while being cost effective. To discover more about the technology I decided to use the scientific method to explore the possibilities and the question: Is a cheap homemade laser effective at transmitting audio for long distances? I hypothesized that indeed the laser would be able to transmit audio for a distance of over 125 meters or more without significant or none at all loss of quality. To test how far the laser would actually transmit the audio, first I actually built the transmitting and receiving end, then I started transmitting audio at preset intervals of distance and checked off if the audio was received or not in a data chart. The results were quite a surprise, as not only was the low power everyday laser pointer able to transmit audio for 125 meters, it transmitted for up to 130 meters. This was possible because the laser beam did not lose focus till that distance. The possibilities for this project are endless, from being modular and being able to transmit in huge stadiums to data transfer, the future is limitless.

Hypothesis

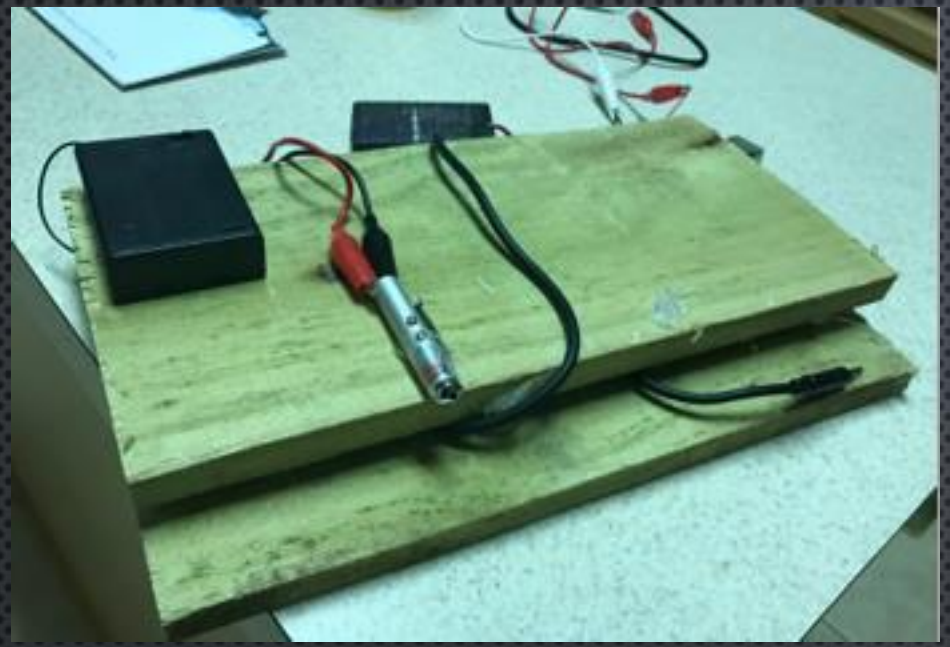
- Even if the distance between the transmitter and receiver increases, the signal should stay strong for 100 meters or more, and the max expected range is 175 meters.

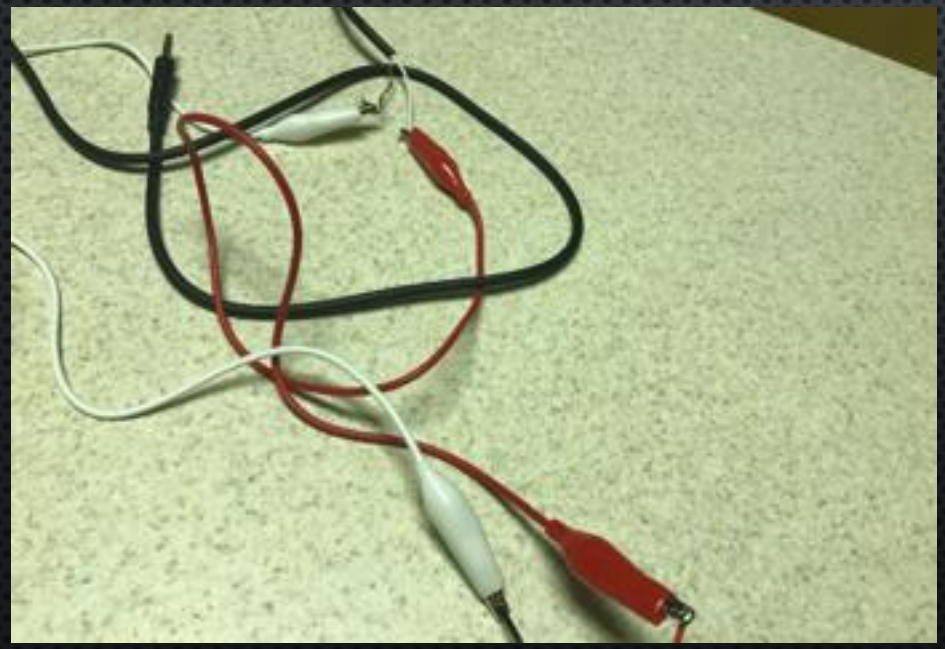
PROCEDURE

- Half of this project is based on a student made device called the audio output transformer that I will be building, which will then be tested. To start out, all the wires and components must be prepped for connection to the other connections and components for this device. You must cut off one of the male ends of the wire and strip the 3.5mm HOSA mono audio cable gently using the "12 AWG solid" hole with the wire stripper, I will be careful and wear gloves for this. Repeat this process two times as this will be the basis of your audio input, and audio output. Another step for preparing the components for connection requires inserting 3 AA batteries into the battery holder, making sure to leave the slip into the "off" position. The components are all set and ready once the two preparatory steps are taken, and I am ready for assembly. To get started, I will first connect the laser to the battery pack, providing power to the laser, the basis of the project. To accomplish this, I will connect an alligator clip wire to the spring inside the laser (positive) and another alligator clip wire to the casing of the laser, to ground the connection. Next, I will take the wire connected to the spring and attach that to the red wire which represents the power of the audio output transformer. Furthermore, I will take the white wire on the audio output transformer also a power attachment, and attach it to the black (negative) lead on the battery pack. Moving on, I will connect the alligator clip previously connected to the grounding on the laser and attach it to the red wire on the battery pack, which represents positive, which completes the circuit between the laser and the battery pack, though it is important to note that the circuit is not completed. Before I will go any further, since the basic circuit is complete, I will turn the battery pack on to make sure the laser works and that there is no fault in the connection before moving on. If the laser works, it will be time to connect the mono 3.5mm HOSA cable for the audio input. To do so, I will take the stripped end of the 3.5mm wire and connect two alligator clip wires to the 2 wires the stripped cable exposes. Once the wires are connected take the two alligator clips and attach them to the green and blue wires on the audio output transformer which represent data, to allow the data to be transferred through the transformer into the laser. To further elaborate, the laser and battery pack would be already connected, and when the audio output transformer receives that signal it transforms it into an electrical current and sends it through the laser, allowing the data to be transmitted. Coming back to track, the 2 wires that connected the mono HOSA cable to the audio output transformer completes the transmitting end of the device, and now all I would have left to do is build the receiving end, which consists of a solar cell and a 3.5mm HOSA audio cable. The solar cell contains two multipurpose lead wires coming out of it and, they can be used for pretty much anything, so I'll connect two alligator clips to the exposed ends. On the other side of the alligator clips I will connect the 3.5mm wire and the transmitter and receiver can now be deemed complete, and tested to find out the range of the laser audio transmitter.
- The process of testing the laser audio transmitter can be deemed pretty straightforward, simple, and efficient, as it can get and show me the results simply. The first step of which is actually travelling to field C in a local park near my house, deemed Red Bug Lake Park. The time of arrival at the location can be estimated around 7:30 pm and all testing will take place between 7:35 pm and 8:00 pm on the same day, to maintain similar lighting conditions and weather. Also, this timing is ideal to get the best performance from the laser pointer. When I arrive I will follow a specific set of instructions to make sure results are optimal.
- *Step 1: Prepare the laser on the tripod by aligning the tripod at 90^0 perpendicular to the ground.*
- *Step 2: Put down measuring tape on the ground with the 0-meter measurement at the transmitter end tripod.*
- *Step 3: Travel a set distance away from the transmitting tripod (for example, 5 meters) and set down the receiving end tripod.*
- *Step 4: Travel back to the transmitting end and play audio on iPhone.*
- *Step 5: Travel to the receiving end and verify that the audio is being transmitted from the laser, if it is than mark that it transmits at that set distance, if it does not than mark down on the data table that the transmitter does not transmit at the set distance.*
- *Step 6: Repeat the trial 5 more times and record the results.*
- *Step 7: Repeat at set intervals until the data set is complete.*
- *Step 8: Create and analyze graphs based on data collected.*

MATERIALS

- 7 alligator clip wires, 1 encapsulated solar cell, 1 audio output transformer, 1 laser, (2) 3.5mm mono audio cables, 1 red class 2 laser, 1 plastic casing, 1 3AA battery holder with on off switch, 1 amplifier, 1 speaker, 1 measuring tape, 1 protractor, 3 AA batteries, producing 4.1 volts, tripods to mount devices, and iPhone.





Analysis

- During the experimental process I observed certain trends between the intervals and concluded that the laser beam's ability to transmit audio maxes out at around 250 meters from the point of transmission (the place where the laser is). The laser holds up at the intervals of 10 meters, 20 meters, 30 meters, 40 meters, 50 meters, 60m, 70m, 80m,90m,100m,110m,120m, and 130m. After which the quality of the laser dropped significantly due to the fact that it lost focus, making the audio barely readable, if at all at 140 meters and higher. Even though the fact of the matter is that the laser transmitted audio for only 130 meters it still proved my hypothesis right, and there are many further applications for this type of technology.
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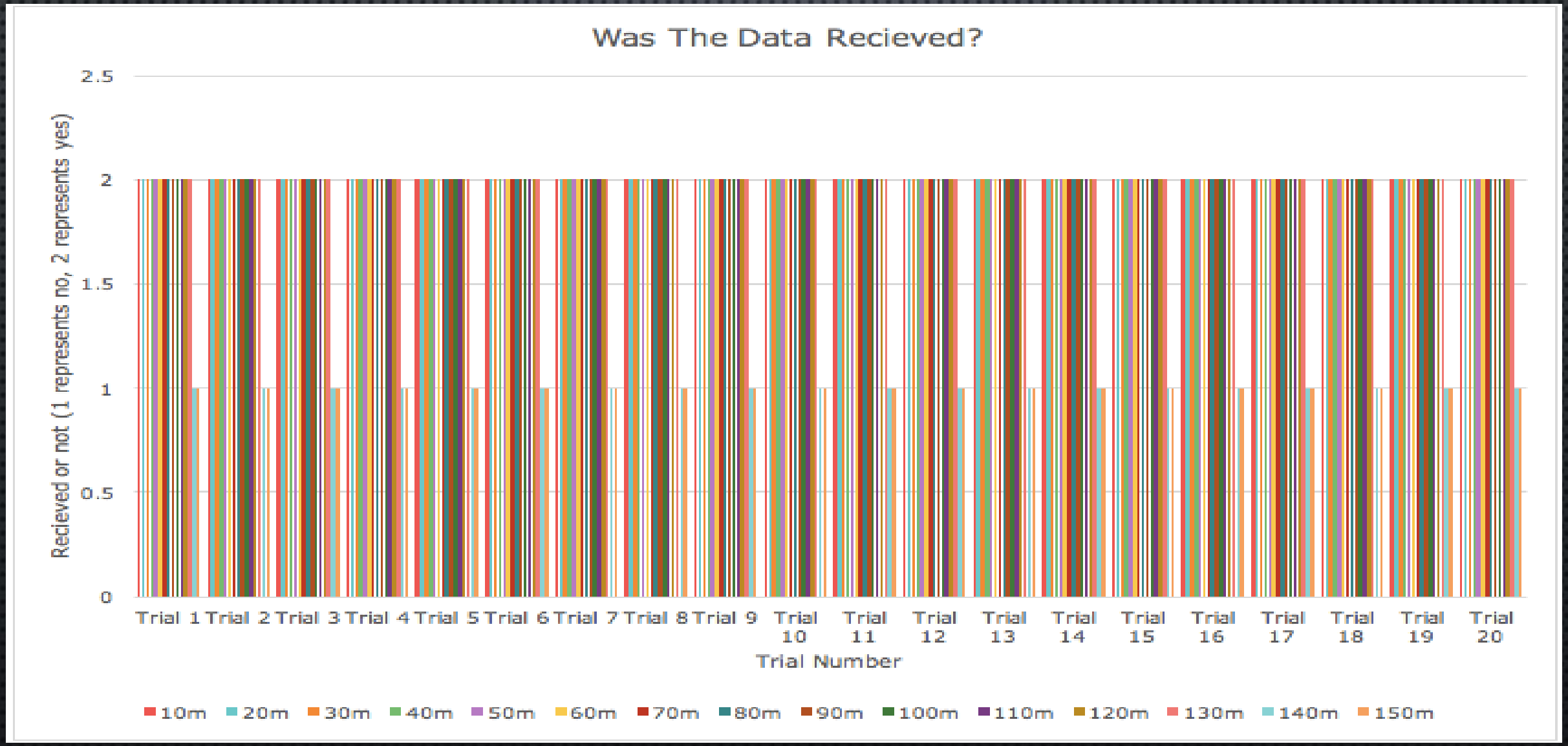
DATA CHART

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11	Trial 12	Trial 13	Trial 14	Trial 15	Trial 16	Trial 17	Trial 18	Trial 19	Trial 20
10m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
30m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
40m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
50m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
60m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
70m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
80m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
90m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
100m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
110m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
120m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
130m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
140m	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
150m	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

GRAPH


Was The Data Recieved?
Recieved or not (1 represents no, 2 represents yes)
2.5
2
1.5
1
0.5
0
Trial 1 Trial 2 Trial 3 Trial 4 Trial 5 Trial 6 Trial 7 Trial 8 Trial 9 Trial 10 Trial 11 Trial 12 Trial 13 Trial 14 Trial 15 Trial 16 Trial 17 Trial 18 Trial 19 Trial 20
Trial Number
10m 20m 30m 40m 50m 60m 70m 80m 90m 100m 110m 120m 130m 140m 150m

Conclusion

- The science fair is a great place to innovate, and find new or old ideas to test and prove validity and the application of. This year I decided to take on the project of transmitting audio data through the light of a laser beam and receiving it, testing out the distance at which this pointer device works, the results were pretty surprising. The experiment turned out flawlessly, and everything worked the way it was supposed to, unlike other science fair years I have had. There is one thing that I would definitely change, were I to replicate the experiment: the jig for testing the laser. Even though it was fairly compliment -able at keeping the beam consistent, at points it was very difficult to work with, and it did not fare well with water. Getting back to the statistics of this experiment I learned that, the laser beam can successfully transmit audio for up to 130 meters without significant, if all, drop in quality, making this a potentially revolutionary audio communication method and supporting my hypothesis. It was able to achieve such a distance due to the fact that the laser pointer I used was able to keep its focus for 130 meters and not any farther. If the laser was able to keep its focus, the solar panel could read the data and output it correctly. The possible applications for this device are endless, it could be used in stadiums where long distance audio transfer is quite expensive, and is not usually high quality. It could be used in military ground to air communications without the fear of being intercepted, as beams don't scatter. The laser device can even be easily be swapped out to gain more distance as the pointer used was relatively low powered.The technology can even be morphed to transfer data through lasers…the possibilities are endless.

WORKS CITED

- Lawrence Livermore National Laboratory "How Lasers Work." *How Lasers Work*. Lawrence Livermore National Laboratory, 14 Oct. 2014. Web. 15 Sept. 2016. <https://lasers.llnl.gov/education/how_lasers_work>
- Society For Science "Rules for All Projects." *Student Science*. Intel ISEF, Mar. 2016. Web. 15 Sept. 2016. <https://student.societyforscience.org/rules-all-projects>
- Welson, Fenley. "How a Laser Can Transfer 26 Terabits of Data per Second - Tested.com." *Tested*. Tested.com, 24 May 2011. Web. 15 Sept. 2016. <http://www.tested.com/tech/2364-how-a-laser-can-transfer-26-terabits-of-data-per-second/>
- Smith, Jacob. "Build a Laser Communication System." *Build a Laser Communication System*. EETech Inc., 22 May 2015. Web. 15 Sept. 2016. http://www.allaboutcircuits.com/projects/build-a-laser-communication-system/
- Field, Simon Quellen. "Simple Laser Communicator | Make:." *Make DIY Projects and Ideas for Makers*. Make, 04 Jan. 2015. Web. 15 Sept. 2016. http://makezine.com/projects/make-16/simple-laser-communicator/
- Watson,Craig. "Sound Systems: Mono vs. Stereo." *Sound Systems: Mono vs. Stereo*. MCSquared, 12 Apr. 2014. Web. 20 Sept. 2016. <http://www.mcsquared.com/mono-stereo.htm>.
- Coates, Eric. "Learnabout Electronics." *Transformers*. HONS Inc., 2 Oct. 2011. Web. 20 Sept. 2016. <http://www.learnabout-electronics.org/ac_theory/transformers.php>.