***SDR Stem Camp Day One***

***Communicating via Light Bulbs – Morse Code***

***~2 Hours***

**Introduction**

In this activity, we will introduce the fundamental concepts of communication through electrical signals. The goal of this activity is to give the students a simple but realistic opportunity to create their own communication system that can be traced back to fundamentals of SDR’s. The students will send pulses of electricity to the lightbulb to send information to other students in the camp.

What is Morse Code? Morse Code is a method used in telecommunication to encode alphabet characters to a distinct signal made up of “dots” and “dashes” (Reference *Morse\_Code\_Table.jpeg* to assist during the activity). The Morse Code was once at the forefront of communication as it allowed people to communicate over long distances more efficiently than previously.

**Materials**

The materials needed for this activity include:

1. Contact key
2. Light bulb
3. Light socket
4. D4 Battery holder
5. 1.5V D4 Battery
6. Three alligator clip wires

Instructors should create groups of 3-5 students to complete this activity. Groups are preferred over completing the activity individually to encourage collaboration and the sharing of ideas together between students.

**Assembly**

Assemble the materials as shown in the figure below:

Diagram

Description automatically generated

Figure 1: Assembly Diagram

1. Connect the wires to the bulb holder, battery holder, and contact key as shown above.
2. Place your battery into the battery holder.
3. Screw the lightbulb into the lightbulb holder and press the contact key. You should see the light bulb turn on while you press the key.

**Background**

At this point, students should have tested their materials by seeing the light bulb turn on when they press the contact key. If there are any problems up to this point, have the instructor look over the materials assembly and ensure all clips are secured. If that does not fix the issue try replacing one component at a time starting with the bulb, then battery, then wires.

In today’s world, telegraphs are no longer used for long range communication thanks to advances in technology. However, at one point in time the telegraph was the gold standard for fast long-range communication using electrical signals. Telegraphs played an important role in sharing information during World War 1 that allowed tactical changes and intelligence information to be relayed quickly to the necessary parties.

**Demonstration**

Utilizing the *Morse\_Code\_Table*, students should take turns in the group and follow these next steps:

1. Send a very simple “S.O.S” message to the rest of the group. This will allow everyone to become familiar with the speed of each person “dots” and “dashes”. A dot should have a much shorter light signal when compared to a dash (i.e. the light should be on for a shorter amount of time for a dot compared to a dash).
2. Write down a short sentence or phrase you plan on trying to relay to the rest of your group through morse code with the light bulb but be sure no one else on your team can see the phrase once you’ve written it down.
3. Using the *Morse\_Code\_Table,* send your sentence to the group, The rest of your group should be watching the light bulb and writing down each letter that they believe you are trying to send.

After your team member is done relaying his/her message, the group must work together to figure out that message. Whichever team from the entire camp deciphers the message first will be the winners. If time allows, the winning team should come up with their own few sentences and try to relay that message to the rest of the students in the camp. The students will be competing against the instructor(s) to see who can decipher the message first. If the students decipher the message first, they will get a small prize (this is up to the instructor what it will be, or if there will be a prize).

**Discussion**

Now, instructors should discuss the activity with the students and aim to make connections between the activity concepts and more general signal and communication concepts. This discussion should hopefully be driven half by the instructor and half by the students.

Below are some of the key talking points to be mentioned by the instructor.

1. Explain how the telegraph using Morse Code is related to signal processing in SDR’s. Instead of reading and translating a light signal, an SDR will take in an RF signal and must translate it into something meaning it can be used elsewhere in a system.
2. Give a very brief explanation about what RF is and how it differs from light. The instructor can make this quick and simple by referencing radio stations.
3. Explain what “noise” is in an RF environment and ask the students for what the version of “noise” could be in this activity. There are no wrong answers as this is just used to get the students to make the connections in their mind from this activity to an RF environment.
4. Explain the connection between the assembly parts and the activity, and the parts of an RF system. For example, in this activity the students’ eyes are working as the receiving node in an RF system, and the students working to decipher the message is an example of signal processing algorithms implemented in RF systems.

**References**

https://www.unitedsci.com/media/activity-guides/MCE001\_Morse\_Code\_Kit\_Preview.pdf