ENGINEERING EDUCATION
FOUNDATION OF AMERICA

EEFA STEM Taskforce Activity:
Lidar Survey

Activity Overview:

This activity will simulate how Lidar survey is collected. Lidar stands for light detection and ranging. It is a way to collect survey information without taking survey measurements from the ground in person. Lidar data is collected via plane or drone using a laser to bounce light off objects. The time it takes for the light to bounce off objects and return to the sensor is used to calculate the distance to that object. As the plane/drone flies over an area, it collects many data points to create a surveyed surface. This activity will simulate a plane/drone flying over a surface, taking one set of data points in a line. Lidar is taken vertically, while this activity simulates the process horizontally.

Material List (provided):

- Tabletop work area approx. 4′ x 4′
- Laser measuring device
- Wooden block to mount laser measuring device (approx. 4″ x 4″ x 2″)
- Wooden board (2″ x 2″ x 40″) to serve as reference track
- Wooden board (2″ x 4″ x 40″) to serve as a backdrop (if activity is not set up against a wall)
- Meter stick
- For the concluding “hidden landscape” option: A foam core sheet approx. 2′ x 3′ to block participants’ view, plus stands to hold this sheet in place
- A variety of cardboard boxes, approximately shoebox-sized
- Masking tape
- Supply of pre-printed graph paper, 4 squares/inch, with labeling
- Supply of preprinted data recording sheets
- Colored pens or pencils

Instructions:

(Steps 1-3 should be completed prior to activity session if possible)

1. Attach laser device to small wood block. Attach meter stick to reference track. (should be done already)

2. Set up the work station. Place Meter stick/reference track parallel to the backdrop wooden board or the wall. Tape boards down so reference track is consistant through the activity. Use tape to mark off the work area. The work area will be determined by the label on your graph paper.

3. Layout cardboard boxes within the work area. For older participants, provide boxes for them to arrange themselves. Make sure the boxes are set up within the work area.

4. Split participants into groups. There are enough materials for up to 5 groups. Give participants a timeline for the activity (20-30 mins). Go through the materials for the activity. Have groups determine roles for each participant. Encourage teamwork to manage materials and time!

5. Demonstrate how the laser works to the participants. Show them how the device reads the distance to the object it is reflecting off.

6. Show participants how to slide the laser along the reference track and record the location along the meter stick and the Lidar distance on the data recording sheet.

7. Participants should now begin the data recording, using the data recording sheet. Assist as needed.

8. Once the data is collected, participants can transfer their data to the graph paper. The data points can then be connected. Participants can then compare the graph to the shape of the boxes they surveyed. Assist as needed.

9. Older participants can sketch the shapes of the boxes on the graph paper to see the relationship between the data and the actual landscape.

10. Discuss how and why the data and the actual landscapes differ. Discuss the ways the data could be more accurate.

11. For older participants and if time allows, conduct a challenge activity. (If not, skip to step 12.) This requires the additional set up for the hidden landscape. Place foam core and stands between the reference track and the boxes. Rearrange the boxes so the “landscape” is different. The foam core acts as a tree cover so that participants cannot see the ground they are surveying. The foam core board should be placed just high enough that the laser doesn’t hit it. Explain how lidar can be collected, even through

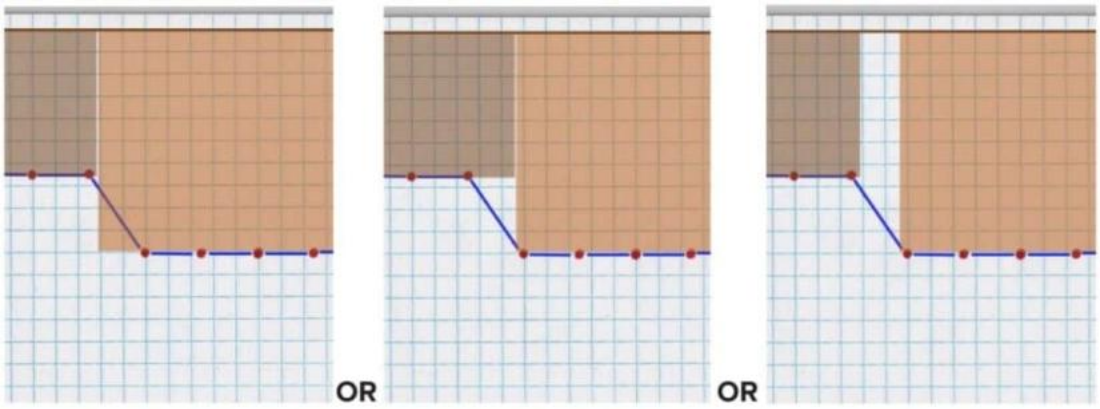
trees. (Some light gets reflected back from the tree cover, but some makes it down to the ground. Points are then reviewed for the elevation data with the most intensity to determine the ground elevation. See graph in the section below.) Provide clean data recording sheets and graph paper so participants can complete the challenge. Once the data is collected, have participants compare the hidden landscape to the data.

12. Wrap up activity by explaining how survey gets used in engineering, using your own personal experience. Ask participants to provide ways they think Lidar could be used.

Things to Keep in Mind:

- Instruct participants **NOT** to play with the lasers. **Do not** shine in eyes or around the classroom.
- HAVE FUN AND ENGAGE WITH PARTICIPANTS!!! 😊
- Know your audience – Use vocabulary based on participant age and ask questions that the participant will understand. Tailor the activity to the participant as needed. Participants can work alone or in groups.
- Explain the background of the experiment
- LiDAR is an active remote sensing system. An active system means that the system itself generates energy - in this case, light - to measure things on the ground. In a LiDAR system, light is emitted from a rapidly firing laser. You can imagine light quickly strobing (or pulsing) from a laser light source. This light travels to the ground and reflects off of things like buildings and tree branches. The reflected light energy then returns to the LiDAR sensor where it is recorded.
- A LiDAR system measures the time it takes for emitted light to travel to the ground and back, called the two-way travel time. That time is used to calculate distance traveled. Distance traveled is then converted to elevation. These measurements are made using the key components of a lidar system including a GPS that identifies the X,Y,Z location of the light energy and an Inertial Measurement Unit (IMU) that provides the orientation of the plane in the sky (roll, pitch, and yaw).

- More data points: One major problem arises when you measure two data points right next to each other that have different values. It is impossible to know what happened in between those two data points.
    - It could mean that the boxes were pushed to the left, pushed to the right, or even have a gap in between them…maybe even something else! The truth is that it is impossible to know. To find a possible answer, engineers increase the resolution—that is, they take measurements closer together. Have participants take closer measurements in these areas.



- Graph showing how Lidar can "see" through the trees.