SMART LAB ACTIVITY GUIDE

WEARABLE DEVICE

DESIGN CHALLENGE

Create a device that provides information to someone with a visual impairment about his/her environment.

DIFFICULTY LEVEL

Beginner – no prior experience necessary

MATERIALS

LEGO MINDSTORMS EV3

Tape, string, cardboard, paper, scissors, markers, and rubber bands

INDONESIAN HIGH SCHOOL CORE COMPETENCIES

Statistical analysis (Mathematics – Mandatory, Year X, 2.9 – 2.11)

Sensory systems (Biology - Year XI, 3.12)

SMART LAB DISCIPLINES

Science	Math	Art	Technology & Engineering
Senses	Statistical analysis	Art in design	User-centered device design

STUDENT OUTCOMES

- **User-centered design:** how to design for other people and keep users' needs, wants and limitations in mind.
- **Feedback:** how to receive, give and incorporate feedback
- **Experimentation:** how to plan an experiment, collect and analyze data, then apply results.

DETAILED OBJECTIVE

Write a program that:

- Collects information from a sensor(s)
- Provides feedback to a user with a visual impairment about his/her environment
- Uses a loop to repeat the program

EXAMPLE SESSION – 90 MINUTES

Introduction: 5 minutes
Put students into small groups (preferably groups of two)
Explain how each sensor works in the kit
Explain challenge and detailed objectives

Brainstorm: 10 minutes

Have students brainstorm a design in their groups

When brainstorming, have students consider:

1. What will their device detect?
2. What sensor will they use?
3. What feedback will their device give its user?
4. How will someone wear the device?

Have groups share design ideas. Examples:

1. A device that uses the ultrasonic sensor to detect when objects are near. When an object is near the motor will move to provide feedback to the user.
2. A device that detects an object's color and says the color out loud to the user.

Data Collection: 10 minutes

Have students use the on-brick data logging or Experiment feature in the EV3 software to collect and analyze data using the sensor(s) that they have chosen.

Share Data: 10 minutes
Have students share - what data they collected, how they collected the data, and problems that they encountered when using the sensors.
Use their explanation to give examples of the sensor error that they might encounter when collecting data:

- The light and ultrasonic sensors are best at measuring close objects than objects farther away.
- The light and ultrasonic sensor work best when pointed perpendicular to an object.
- The color sensor works best on LEGO bricks

Program: 15 minutes
Explain switch, wait and loop blocks
Have students program their device

Build, Test and Refine: 15 minutes
Have students build their wearable device by using the materials provided
Encourage students to iterate by testing and refining their device.
To test, have students with (or simulated) visual impairments use the device and give feedback. Students can use this feedback to refine their design.

Present: 10 minutes
Have students present their designs

Share: 15 minutes
Groups should take videos of their design being used and post the video and a short description of their wearable device to the website. The description should include an explanation of how the device works (the sensors used & feedback mechanism) and how the device would help someone with a visual impairment.

POSSIBLE MODIFICATIONS

This activity can be modified to specifically relate to a particular science subject.

Biology: have students study the senses and in the presentation or a written document include details of how the design mimics a sense in order to collect information about the environment. Explain also how the feedback mechanism gives information to the user through one of his/her senses.

Chemistry: study the chemistry behind the senses (chemical receptors and transmitters). Then, have students incorporate this information when presenting their design.

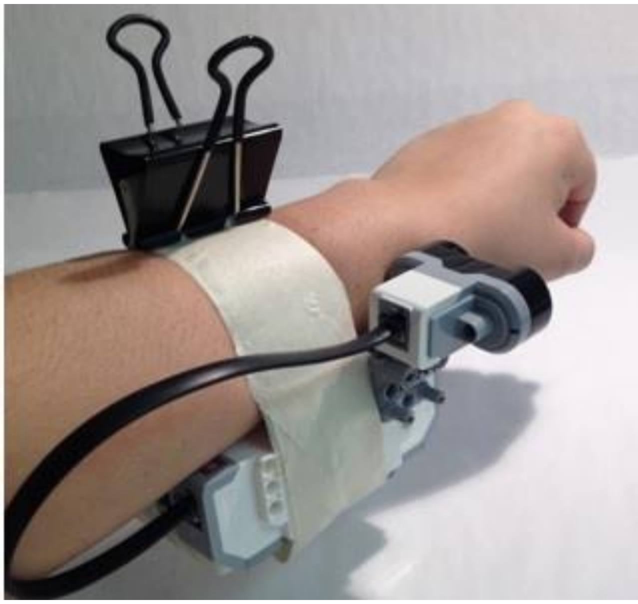
Physics: explain the details of how each sensor works. Have students research a device that uses a sensor and present or write about how it works.

Math: collect and analyze sensor data with statistics. Tutorials on analyzing data through the software experiment feature can be found on the welcome page of the EV3 software. Data can also be downloaded for analysis (for example to Microsoft Excel) by going to Tools->Export Datasets.

POSSIBLE EXTENSIONS

Ask students: How could they use their device to get a range of feedback? For example, the sensor beeps with increasing frequency as the object gets nearer. Hint: use the sensor blocks (in the yellow tab) and the data operations blocks (red tab) to scale sensor data to a sound value. See the Musical Instrument Activity Guide for more information.

EXAMPLE SOLUTIONS



The above device uses an ultrasonic sensor. The user points it in a direction, and the device will beep if an object is close. This device will prevent the visually impaired user from bumping into objects.

Additional Solutions:

1. The device could use the light sensor’s ambient light feature to detect the light level of his/her environment. This device could then notify the user if they are entering a dark room.

2. The device could use the motor’s rotation sensor to measure a space. A wheel could be attached to a motor and when rolled, the EV3 beeps every 2 cm.

REFERENCE

Units and Ranges

Ultrasonic sensor: measures distance in centimeters (0 - 255 cm)

Light sensor: measures ambient or reflective light with arbitrary intensity units (0 – 100), and detects color

Gyroscope: measures angle of rotation (positive and negative) in degrees and rate of change in degrees per second

Motor: measures angle of rotation (positive and negative) in degrees

Touch sensor: measures/compares states (pressed, released, bumped)

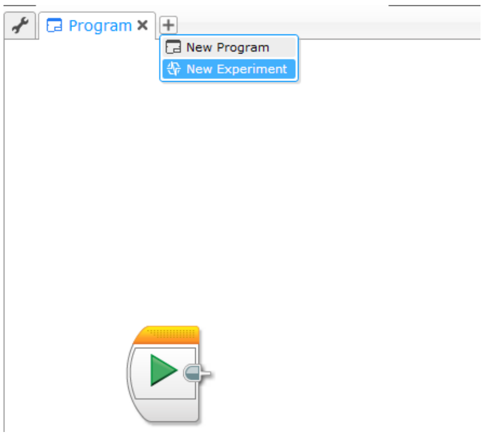
EV3 sound frequency range: 250 Hz – 10,000 Hz

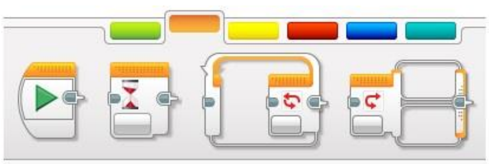
Connecting to the EV3

The motor plugs into ports A, B, C, or D on the EV3 brick

The other sensors plug into ports 1, 2, 3 or 4 on the EV3 brick

Program Support

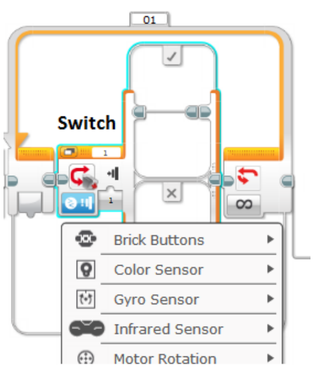


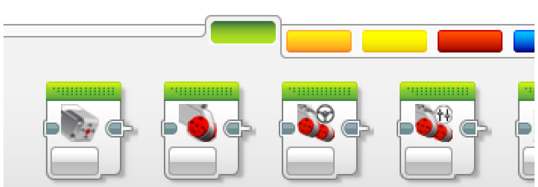


Flow control tab: Consider using a **wait for** or **switch** block to control the maximum and minimum tone range.

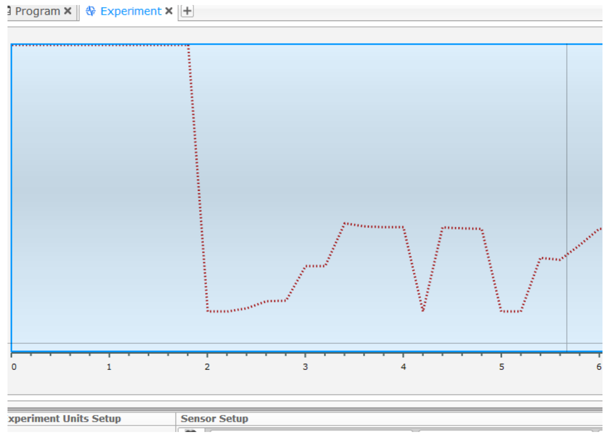
Switch block: program chooses between cases based on input

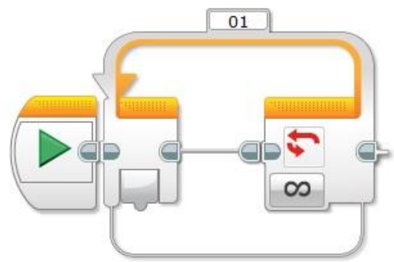
Wait for block: program waits until condition is met





Action tab: contains the motor blocks





Loop: blocks inside are repeated