Lab 4: Localization

To use the **ultrasonic** and **light** sensors for accurately navigating the robot to a known (initial) orientation and position on the field.

Demonstration Procedure

As shown in **Figure 1**, the robot is placed along the 45° line (thick dotted) inside the bottom-left tile of the 4x4 field grid. The **brown-colored** walls represent wooden walls used for the **ultrasonic localization**. Please note that the robot could be placed in **ANY ORIENTATION** and **POSITION** along this 45° line. For example, **Figure 2** shows another orientation and position of the robot's starting position compared to that in **Figure 1**.

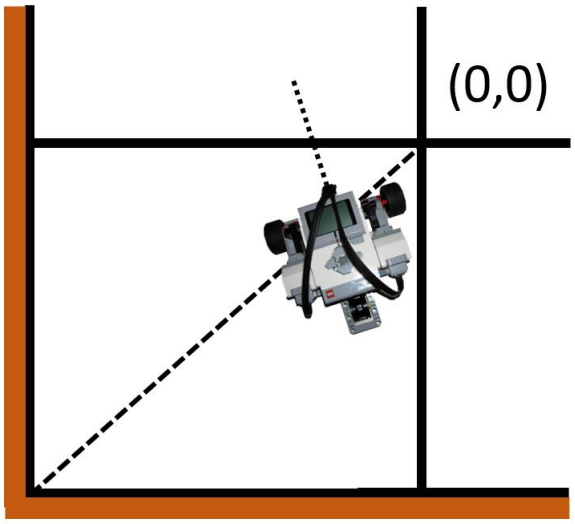

Figure 1. Robot's Starting Orientation A

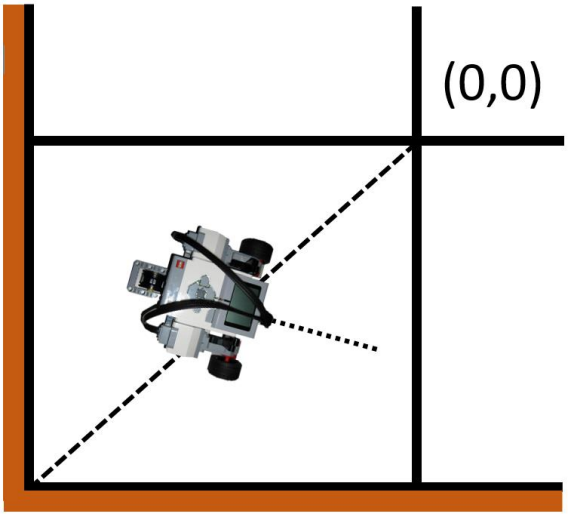

Figure 2. Robot's Starting Orientation B

Upon completing the **ultrasonic localization**, the robot should orient to its estimated 0° axis and the TA will measure the *orientation error* with respect to its true 0° axis (check **FAQ 1, 2**). Note that you should have a stopping criterion to ensure that the robot stays still while the *error angle* is being measured (e.g. *Button.waitForAnyPress()* can be used to separate the two procedures).

After the measurement is complete, the robot should then move to the (0, 0) point as shown in **Figure 1** and **Figure 2**. Once **light localization** is performed at this point, two error quantities are measured by the TA: the *Euclidean distance error* between the robot's actual position and the (0, 0) point, and the *orientation error* with respect to the 0° axis. Hence, these three error quantities are used for grading the Lab 3 demonstration as discussed below.

Part 1: Ultrasonic Localization (10 points)

- **10 points** are given for *orienting* the robot on its 0° axis within an error tolerance of **±10°**. A penalty of **-2 points per ±5°** is imposed. Hence, the following table is used:
  - **± [0, 10] °** → **10 points**
  - **± (10, 15] °** → **8 points**
  - **± (15, 20] °** → **6 points**
  - **± (20, 25] °** → **4 points**
  - **± (25, 30] °** → **2 points**
  - **± (30, ∞) °** → **0 points**

Part 2: Light Localization (20 points)

- **10 points** are given for orienting the robot along its 0° axis at point (0, 0) within an error tolerance of **±10°**. A penalty of **-2 points per 5°** is imposed. Hence, the following table is used:
  - **± [0, 10] °** → **10 points**
  - **± (10, 15] °** → **8 points**
  - **± (15, 20] °** → **6 points**
  - **± (20, 25] °** → **4 points**
  - **± (25, 30] °** → **2 points**
  - **± (30, ∞) °** → **0 points**
- **10 points** are given for reaching point (0, 0) within an error tolerance of **1 cm** using a *Euclidean distance*. A penalty of **-1 point per cm** is imposed. Hence, the following table is used:
  - **[0, 1] cm** → **10 points**
  - **(1, 2] cm** → **9 points**
  - **(2, 3] cm** → **8 points**
  - **(3, 4] cm** → **7 points**
  - **(4, 5] cm** → **6 points**
  - **(5, 6] cm** → **5 points**
  - **(6, 7] cm** → **4 points**
  - **(7, 8] cm** → **3 points**
  - **(8, 9] cm** → **2 points**
  - **(9, 10] cm** → **1 points**
  - **(10,∞) cm** → **0 points**

Frequently Asked Questions (FAQ)

1. Do I need to implement my robot's localization routines using the same 0° axis shown in **Figure 1** and **Figure 2** (that is, along +y axis)?
   No, you do not need to. Once you set your 0° axis (+x, +y, or any other) to the demoing TA, all the robot's angle/orientations are measured with respect to your convention.

2. Do I need to move to another position within the **ultrasonic localization** procedure?
   No, you should only rotate about your starting position. Once the *orientation error* in part 1 is measured, the robot should then move to the (0, 0) point for **light localization**.