Laboratory for Instrumentation and Measurement		
Group No:	EEL2-3	L1: in charge of the report
Date:		Assistant A2: Assistant A3:
Professor:		
Introduction to Measurement Automation (Part 1)		

Report History – Please leave all original papers in the report

Report 1		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ *1. Correction* ➔ Term.....	
1. Correction		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ 2*. Correction* ➔ Term.....	Last chance!!
2. Correction		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ ***not passed*** ➔ back to L1.....	

Final decision:

☐ o.k.

☐ not passed Prof. .....

Objectives

- Understand the concept of measurement automation
- Gain experience in the graphical programming based on LabVIEW
- Understand the characteristics and limitations of ultrasonic sensors

Preparation

During the lab session we will capture sensor data, display it on the screen and save it to a file. In order to allow you to program the controller you must be familiar with the basics of the programming environment LabVIEW.

1. Make yourself familiar with the basic idea of LabVIEW by reading the following one pager: http://en.wikipedia.org/wiki/LabVIEW

2. Read and watch the LabVIEW Environment Basics including a 3min video

3. Find more video tutorials on LabVIEW at NI Academic

LabVIEW shortcuts

<Ctrl>+E	Change between front panel and block diagram
<Ctrl>+Z	Undo
<Ctrl>+R	Run program
<Ctrl>+S	Save
<Ctrl>+B	Remove all broken wires
<Ctrl>+H	Activate context help

Ultrasonic Radar Station

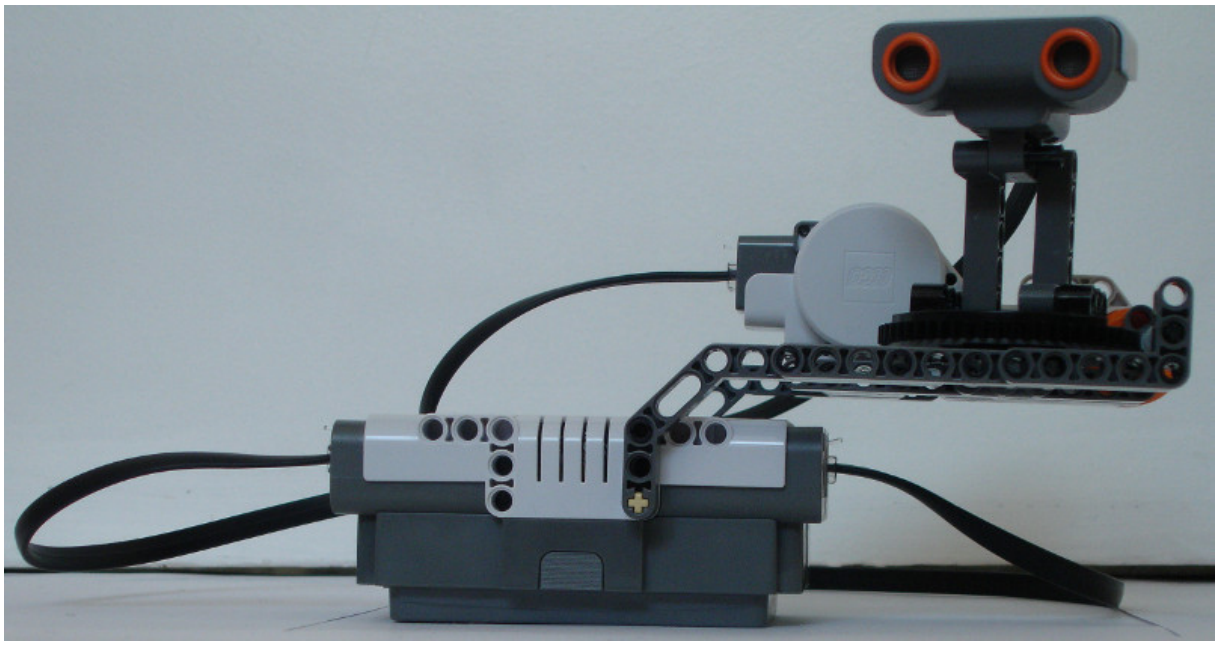
Radar has originally been the abbreviation for radio aircraft detection and ranging and has been changed into the more general term of radio detection and ranging. It is widely used not only for aircrafts but also for ships.

Fig.: U.S. Navy air traffic controller watches his radar scope

Radar is based on the time of flight measurement. The same principle can be applied to the indoor navigation of mobile robots.

Goal

Build an ultrasonic radar station that is able to scan its environment and make a radar plot!

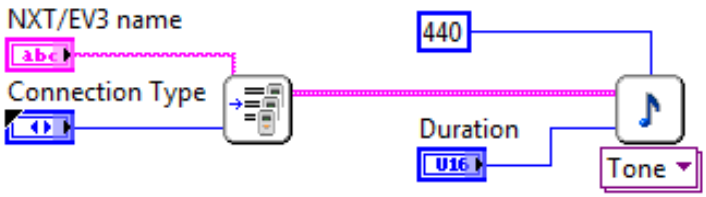


Setup

1. Build up a mechanism similar to the example given below that is able to rotate the ultrasonic sensor head. Do not use the servomotor.

2. Connect the electrical drive to output A of the EV3.
3. Connect the ultrasonic sensor to input 4 of the EV3.
4. Connect the EV3 to the computer's USB port.
5. Turn on the EV3 by pressing the dark grey center button and wait for the welcome tone.
6. Double click on the LabVIEW icon to launch LabVIEW 2016.
7. Open "helloWorld.vi".
8. Click the run arrow (upper left corner). The EV3 will make a sound according to the "helloWorld.vi".

Task 1: Understanding helloWorld.vi

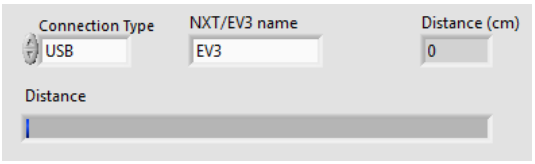


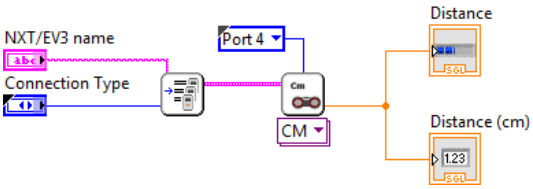
Answer the following questions:

1. What is the difference between the 2 blocks in a line and the 2 blocks on the left? For hints, activate the context help by pressing "Help" or <Ctrl>+H.
2. Find out what information is transferred by the data flows.
3. Find out the block names and explain how the program is working.

Task 2: Capturing a Measurement

1. Save the file helloWorld as task2.vi.
2. Open the functions palette by a right-click onto the white space of the block diagram window.
3. Open the MINDSTORMS Robotics → I/O palette and fix this subpanel by pressing the thumbtack (upper left corner).
4. Make yourself familiar with the available functions.
5. Find the function to read in a measurement of a sensor, integrate it into your block diagram and choose the correct option from the dropdown menu.

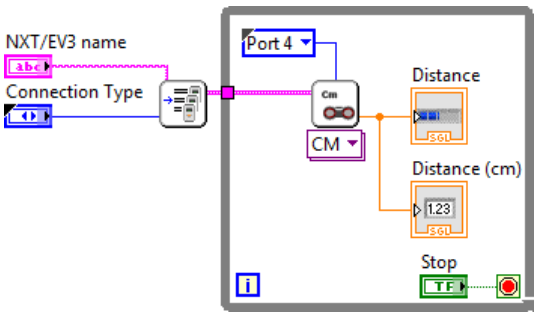




6. Find the measurement value output of the block you have integrated into your diagram, right-click this output and create an indicator.
7. Switch to the front panel and arrange the new indicator. Change its size so that you can easily read the value from a larger distance.
8. Test your program
9. Add a horizontal graduated bar to the front panel, connect it in the block diagram and configure the slider so that its upper limit is 255.
10. Test your program.
11. Save the file.

Task 3: While Loop

To investigate the performance of the ultrasonic sensor it is not appropriate to restart the program for a single shot measurement. A while loop allows to repeat the measurement until it is stopped by the user.



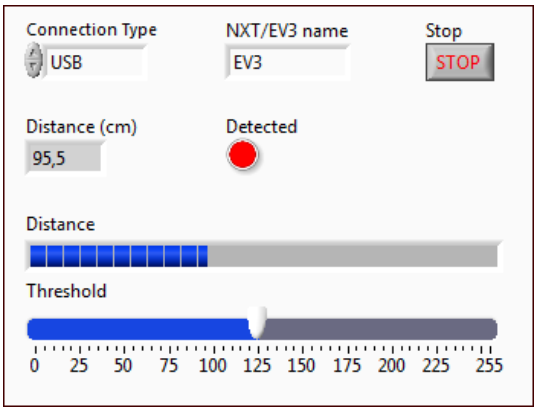
1. Save the file task2.vi as task3.vi.
2. Open the functions palette by right-clicking the block diagram.
3. Open programming palette → structures palette → while loop.
4. Drag the while loop around the measurement block and its indicators. This ensures that the action is repeated as long as the while condition is true.
5. Add a stop button by right-click on the red bullet (→ stop condition) of the while loop and choose the context menu option create control.
6. Switch to the front panel and arrange the stop button and size it appropriately.
7. Save the program and test it.

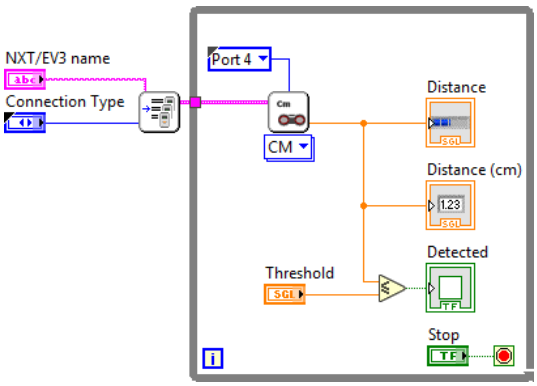
Task 4: Alarm threshold

Often the presence of an object must be detected. Therefore, the measurement value is compared with a threshold. If the measured value is below the threshold, an alarm signal occurs.

Save the file task3.vi as task4.vi and enhance the program so that a red signal is turned on if the measured distance is lower than a threshold. The front panel must offer the possibility to adjust the threshold. In addition to the required control and indicator a function of the comparison palette (see programming palette) is required.

Save the file before you test it.

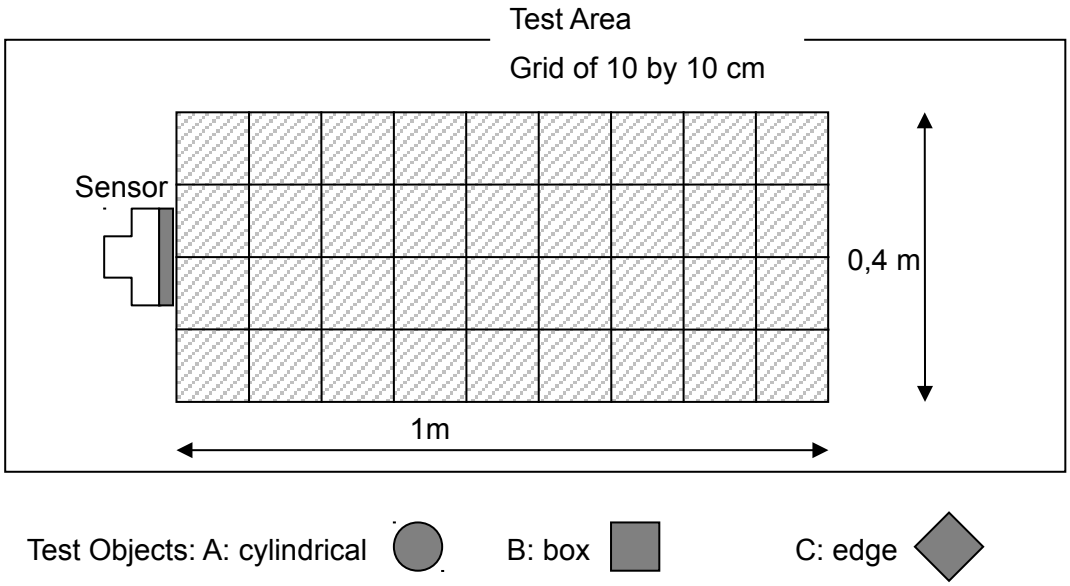




Task 5: Characteristics of ultrasonic sensors

Find out the extent of the detection zone of the ultrasonic sensor. Place the sensor on the table so that it is not detecting anything. Then place a test object systematically in different positions on a 10 by 10 cm grid in front of the sensor (see fig. below) and write down the positions where the object can be detected.

Use a circular object (cup) and a rectangular object (box) in 2 different orientations as shown below.



Transfer the results on grid paper and explain the results and set up rules how to ensure a reliable detection of an object by an ultrasonic sensor.