IC231 Spring 2022 – Lab 8 – Pressure sensor

Srikanth Sugavanam, Erwin Fuhrer, ssrikanth@iitmandi.ac.in, erwin@iitmandi.ac.in

In this lab you will learn how to interface a digital pressure sensor to Raspberry Pi and to conduct different types of differential pressure measurements

Learning outcomes

In this lab, you will learn how to operate on e

- How to use an I^{2}C sensor with Raspberry Pi.
- How to derive the measurement value using the transfer function from the manual
- How to identify the type of the pressure sensor by a measurement.
- How to apply a pressure sensor to measure pressure differences.
- How to apply the pressure sensor to measure flow velocity.

Instructions

To successfully conduct the lab you need to know a little background information about I2C communication and Raspberry Pi. The information how to prepare the Raspberry Pi for I2C sensor communication you will find here: https://www.electronicwings.com/raspberry-pi/raspberry-pi-i2c. Raspberry Pi. You need to follow all the steps in this tutorial up to the detection of the sensor

Tasks:

1. Connect the sensor using breadboard to the Raspberry Pi. Ensure that you use the right pin connections and that you use the required pull-up resistors. Configure the raspberry Pi according to the instruction given in the link above. Show that the sensor is detectable and verify the Sensor address that you obtain with the address given in the manual.

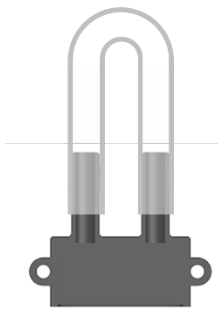

Figure 1: Pressure sensor setup for Task 2/3

2. Conduct a null measurements to analyse the noise of the sensor when there is no signal (pressure difference) expected. Prepare the sensor using the silicone tube as seen in figure 1. Download the sensor driver file and the python file from Moodle. Execute the code and

analyse the output of the raw data. Modify the code such that you acquire 500 sample points, save and plot the results of the raw data.

3. The raw data is available in form of an integer value derived from a 16-bit integer. Convert the acquired data into a pressure value. Use the Sensor manual for proper conversion. Repeat the previous experiments and take 500 sample point. Plot the converted data. Calculate the effective noise value (RMS value)
4. Open one valve of the pressure sensor and repeat measurement 3 again. Does the noise increase? Compute the RMS value and compare to the result from Task 2. What could be the reason?

Figure 2: Pressure sensor setup for Task 4/5

5. For this experiment we want to analyse the type of pressure sensor. Close the silicone tube at the end by pressing it with the finger. While recording the pressure data squeeze the tube, hold it for two seconds and release the finger. Analyze the results and determine the type of sensor based on your observations. Analyze your observations in the report.

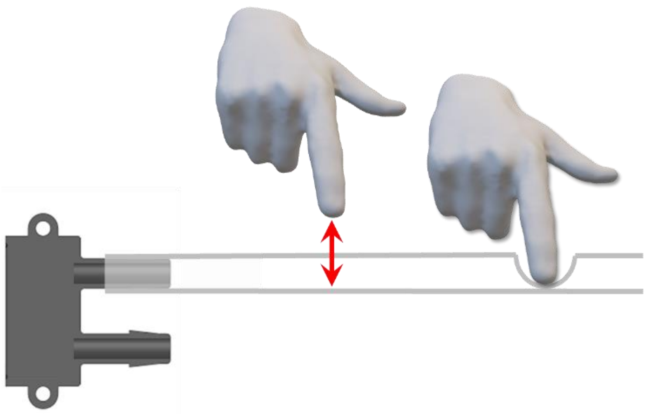

Figure 3: Pressure sensor setup for Task 5.
The silicone tube at the end needs to be permanent closed.

6. In the lecture we have learned that the atmospheric pressure increases by 12 Pa/m The goal of the next measurement is to measure the pressure difference of air between point A and point B as shown in figure 4. Thus connect the metallic tube to the open silicone tube. Conduct a measurement and evaluate the findings. Analyze your results in the report using the method that have been taught in the class.

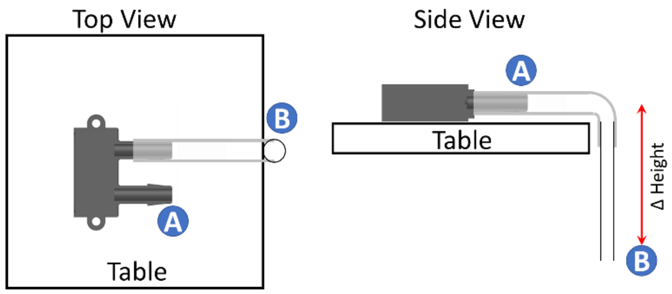

Figure 4: Setup for measurement of height difference

7. Prepare the measurement setup as shown in figure 5. The 6 mm silicon hose has an outer diameter (OD) of 6 mm and an inner diameter (ID) of 4 mm. Take a recording when you open the syringe such that a volume flow is establish of $1\frac{mm^3}{s}$. Repeat the experiment by closing the syringe with the same speed. What pressure difference would you expect if you assume a measurement as discussed with the Venturi-Meter and what do you observe? How can you explain the difference? (Details about the push-in connector you will find here: https://www.festo.com/media/pim/987/D15000100122987.PDF, page 38).

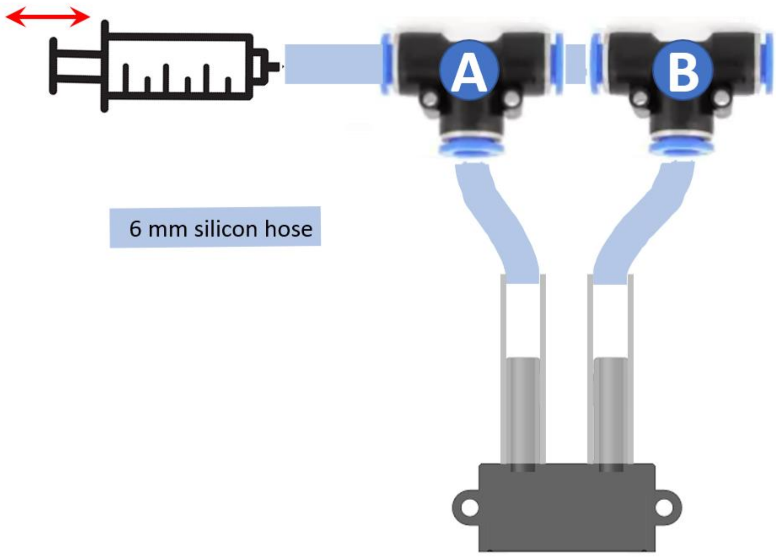

Figure 5: Setup for analysing Bernoulli equation and Flow resistance

8. Modify the experimental setup of figure 5 by adding the 25 cm silicone tube (OD: 4 mm, ID: 2.5 mm) between the two T-joints. Compute the theoretical fluid resistance of the added silicone tube using the equation $R_{ST} = \frac{8\mu L}{\pi R^4}$, where L is the length of the tube and R is the radius of the tube. The dynamic viscosity μ of air can be assumed with $\mu = 18.4 \cdot 10^{-6} Pa \cdot s$. With the fluid resistance you can calculate the expected pressure drop Δp when you have a volume flow of $\dot{V} = 2\frac{ml}{s}$. Conduct the experiment and compare theoretical and experimental values. Repeat the measurement with $\dot{V} = [1{,}5{,}10]\frac{ml}{s}$, and explore if the relation between pressure drop and volume flow rate is linear.

Tasks completion criteria:

1. Screenshot of sensor address in command line
2. Plot of the raw data
3. Plot of the converted data
4. Data recording and analysis of the result
5. Data recording and analysis of the result
6. Data recording and analysis of the result
7. Data recording and analysis of the result
8. Data recording and analysis of the result

List of all prereading material

- ➔ https://www.electronicwings.com/raspberry-pi/raspberry-pi-i2c
- ➔ https://omronfs.omron.com/en_US/ecb/products/pdf/en-D6F-PH_users_manual.pdf
- ➔ https://www.mouser.in/datasheet/2/307/Omron_D6F_PH_Datasheet-2515010.pdf
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