Process Parameter Monitoring during Operation of an Injection Molding Machine via Bluetooth Device using Piezo- electric Sensor and Asynchronous Data Acquisition System

Mostafa Meraj Pasha

Advisor: Dr. Kye-Hwan Lee

Department of Manufacturing and Industrial Engineering

Abstract

Injection molding is one of the most popular techniques for global plastic production. With this automation technique, the plastic product can be manufactured at a low cost with a complex geometrical shape. A manufacturing process with high productivity of an injection molding machine depends on molding pressure and temperature inside the mold cavity. In this research, an experimental work is performed to determine a process monitoring system using asynchronous data acquisition, through the incorporation of piezo-ceramic sensors to acquire pressure of the injection molding system. This system will be designed in such a way that, a Bluetooth device can be connected with a sensor and can take live data reading of parameters from the running molding machine.

Introduction

For an injection molding system, both dimensional control and online defect detection are extremely important for producing precisely controlled product. Moreover, these online process parameters are the reliable indicator of shrinkage, warpage, thickness, and weight of the final product [1], [2].

Although determining process parameter is very significant inside mold , it is always challenging to collect these data as numerous unavoidable variations persist in the molding process [3].

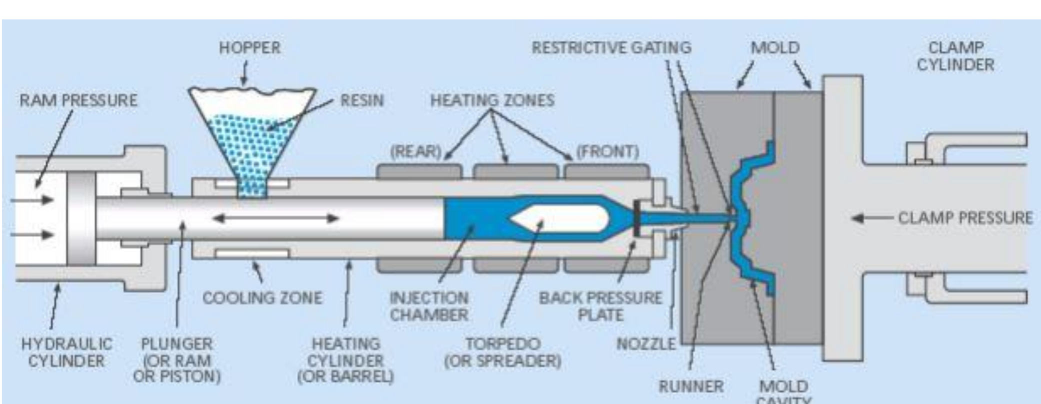

Figure 1: Schematic cross section of the injection molding system [4]

The aim of this research is to develop a prototype for solving certain industrial problem of injection molding process monitoring.

Background

Based on the literature review, it is observed that various type of sensors has been used to obtain mold cavity data but selecting the suitable sensor will have certain number of advantages. Additionally, installing wire through the mold to sensor is costly.

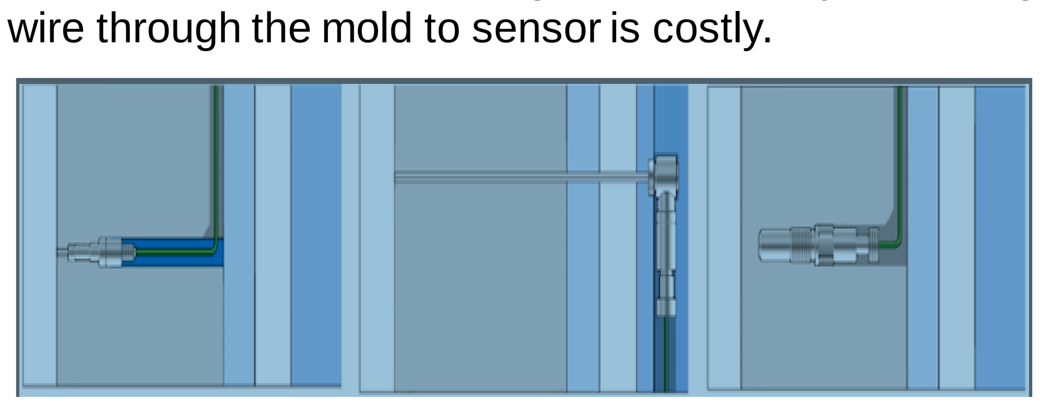

Figure 2: Direct, indirect and contact-free in-mold measurements[5]

Challenges

- ❑ Selecting the appropriate, cost effective sensor.
- ❑ Find out the convenient data acquisition process.

Methodology

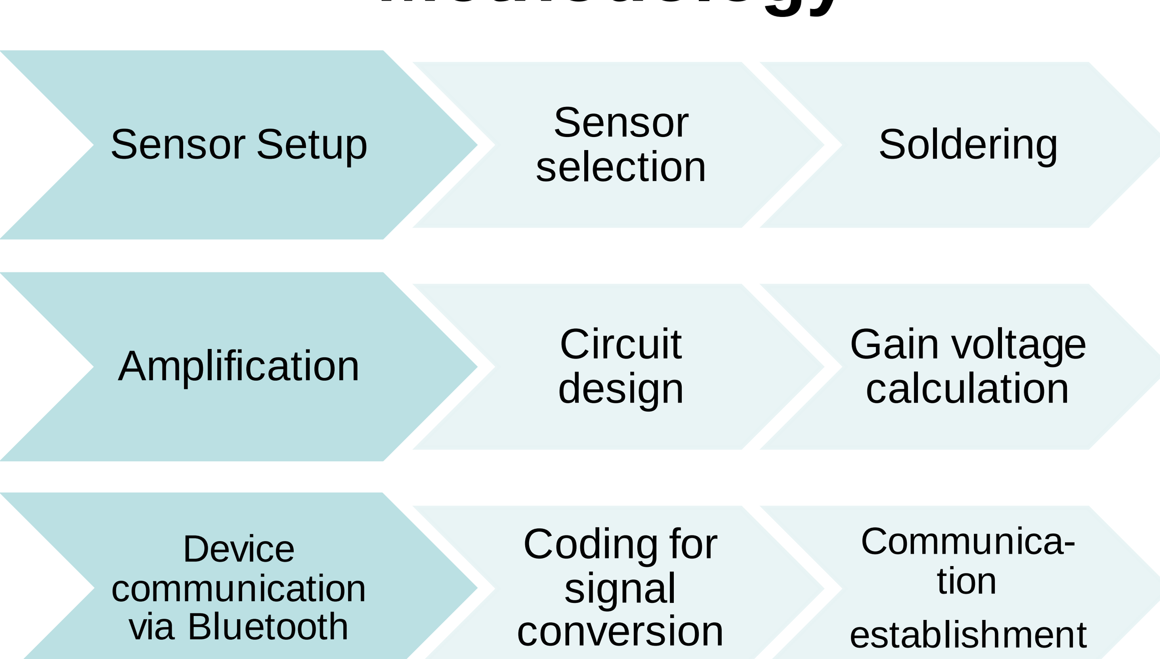

Figure 3: Working flow chart

Step 1:Sensor setup

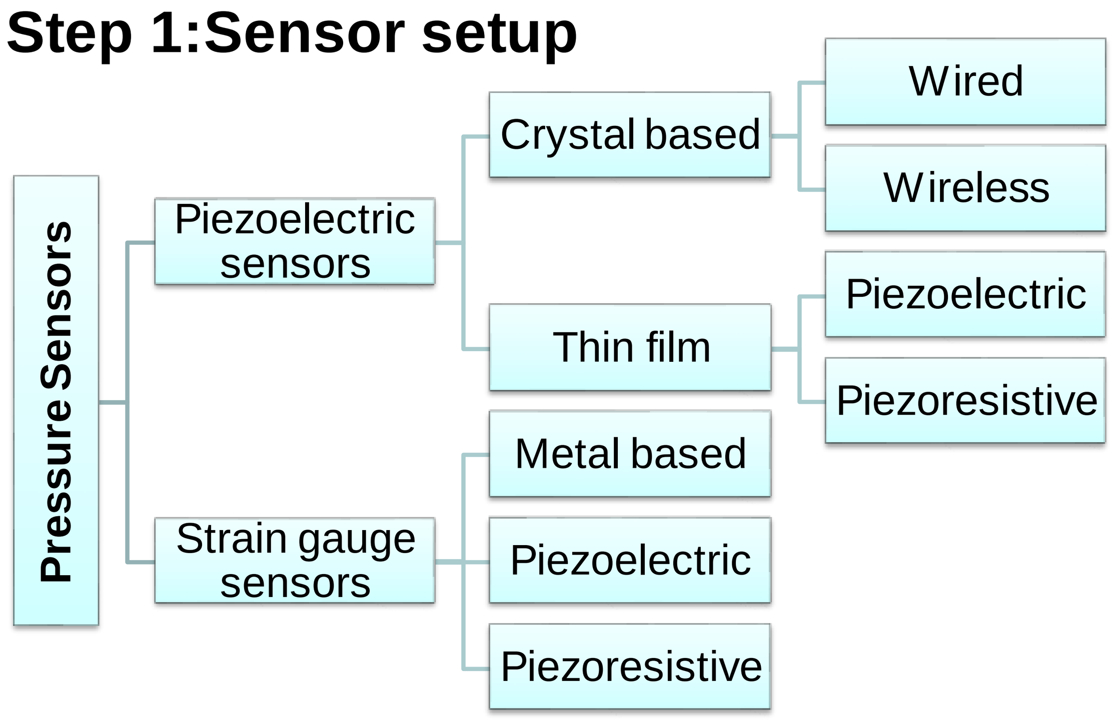

Figure 4: Classification of Pressure Sensor [5]

Why Piezo Disk?

- ➢ Can be installed in tapped holes beneath the surface of the mold cavity.
- ➢ Requiring much less modifications to the mold structure which makes the sensing less invasive physically and more advantageous economically.
- ➢ Higher number of sensors can be installed what leads to more accurate pressure profile.

Specification

Sensor: Piezo disk of 6x0.6mm.

Reason: To make the installation easier.

Soldering flux : Acid Soldering flux.

Reason: Nickel electroplating piezo disk.

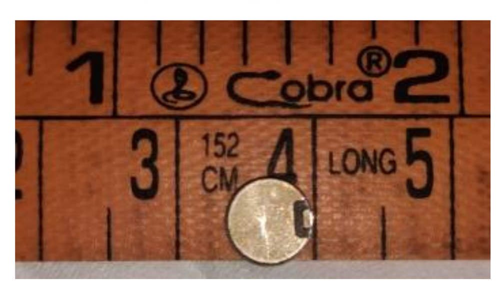

Figure 5: Dimension of piezo disk

Step 2: Amplification

As the output of piezo disk is in milli-volt range around (150~250 mv), a single operational amplifier (TL081) is used to amplify the voltage of piezo disk.

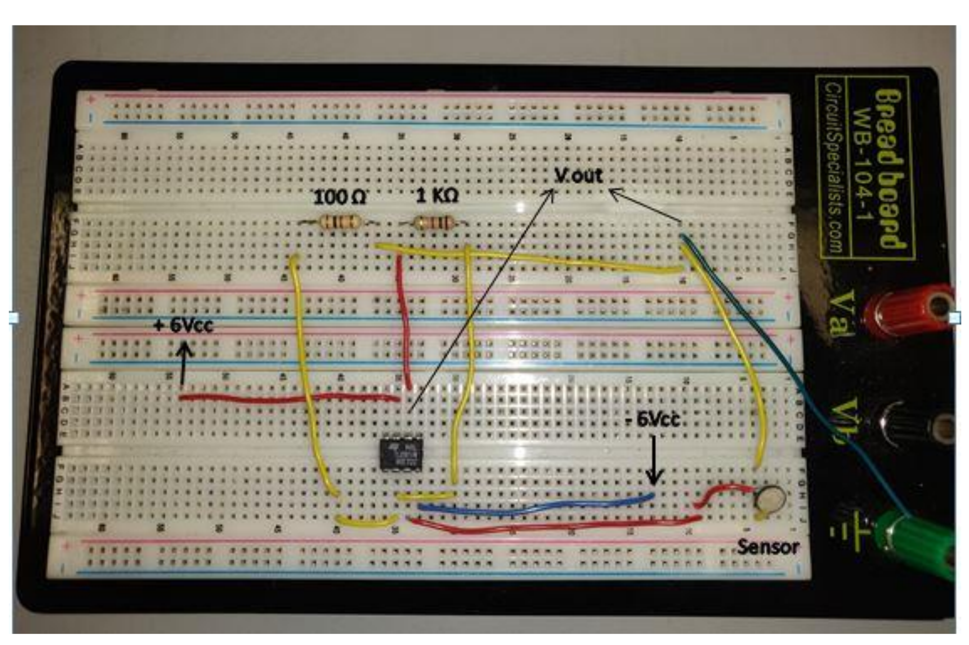

Figure 6:Designed Circuit for Amplification

Step 3: Device Communication:

Development Kit model: SimpleLink™ MSP432P401R high-precision ADC LaunchPad™ Development Kit, with low energy enable dual mode Bluetooth CC2650 module.

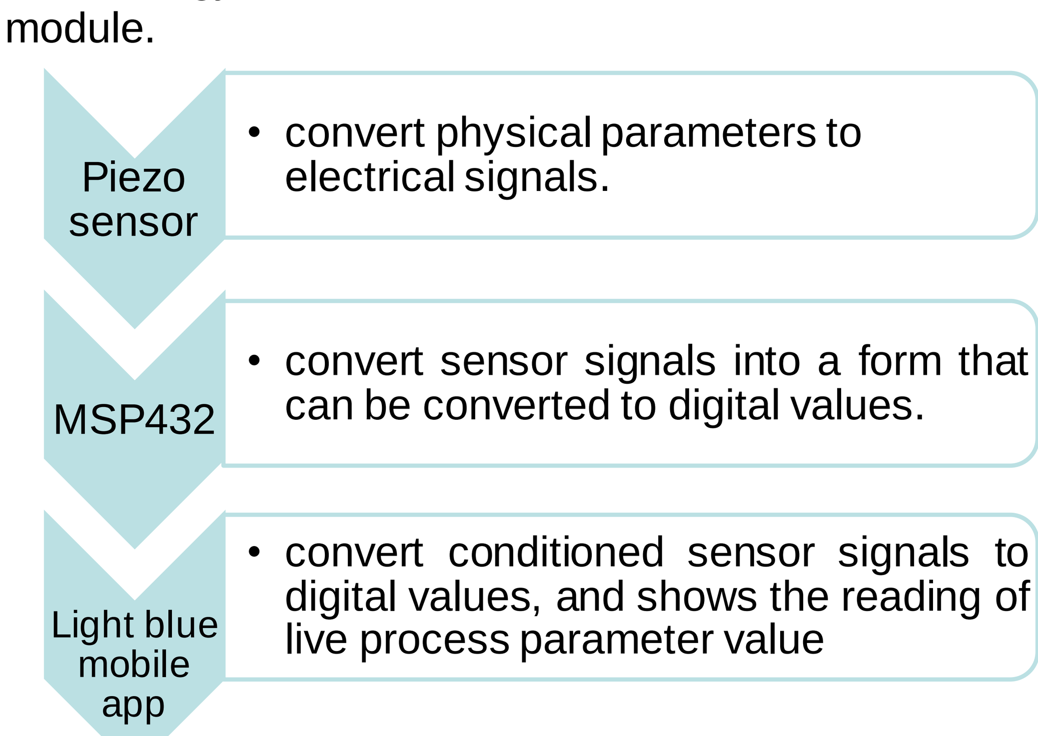

Figure 7:Data acquisition process flow-chart

Software for coding:

Code Composer Studio (Version 9.2.0), an integrated development environment to develop applications for Texas Instruments embedded processors is used for controlling this data acquisition process.

Result and Discussion

Figure 8 and 9 show that the prototype can successfully read the data from the sensor. The value of 2.63 is voltage value generated by the piezo disk by applying manual pressure on it.

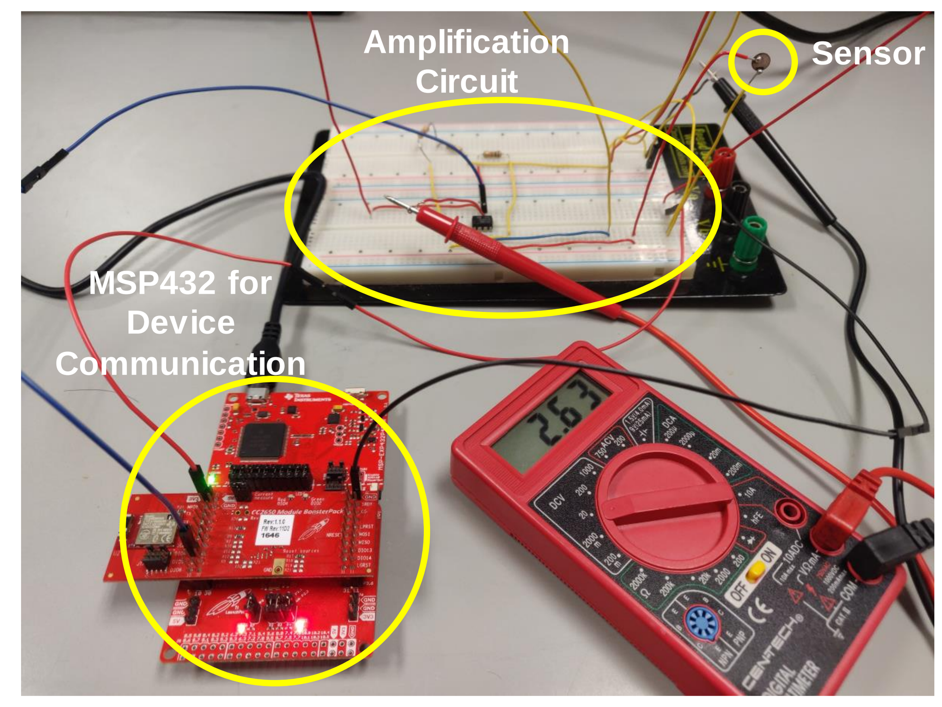

Figure 8: Final Prototype

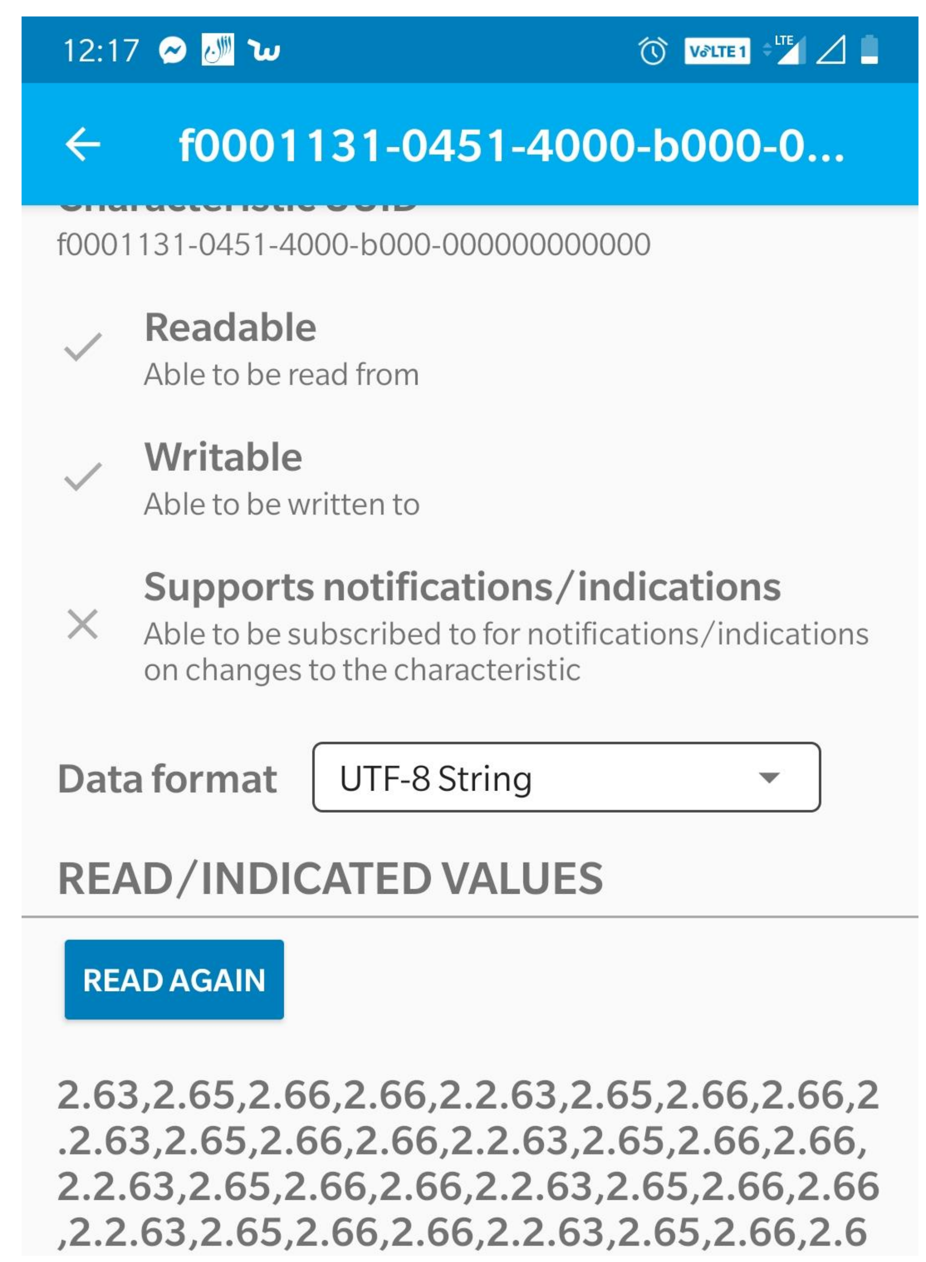

Figure 9: Data Acquisition from sensor in an android device via Bluetooth

Conclusion

As the prototype design is successful, the next phase of this research work is

- ❑ By mounting Sensors and circuits in the mold, simulate asynchronous communication.
- ❑ To create a database of process parameter for generating a reference model and control algorithms.

Acknowledgments

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