# Design of a Calibration Test Setup for a 3-axis Accelerometer

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## ABSTRACT


Triaxial accelerometers are frequently used, mass produced components. Since they are a result of mass production, differences may occur. In order to eliminate these differences an accurate calibration is crucial. In this project, calibration methods are investigated in terms of complexity, cost and efficiency. In the light of these researches, design of a proper setup has been developed. Proposed setup is able to provide a correct solution in terms of measuring desired parameters such as sensitivity, transverse sensitivity (cross-talk), resonance frequency (bandwidth) and phase-shift.


## PROJECT DETAILS

- The sensor under test(SUT) is attached to an object with precise mass along with a reference sensor. The unified system is in free fall situation.
- The system is excited by an impact hammer. Outputs from the reference sensor, SUT and the impact hammer are compared.
- Using an impact hammer gives the opportunity to measure the input given to the system which decreases the uncertainty of the overall test.
- In order to get an accurate measure of acceleration, the system should be protected from any outside factors that might intervene with the pendulum motion of the mass. Moreover, it is crucial that the force is applied to the same central location of the mass each time.

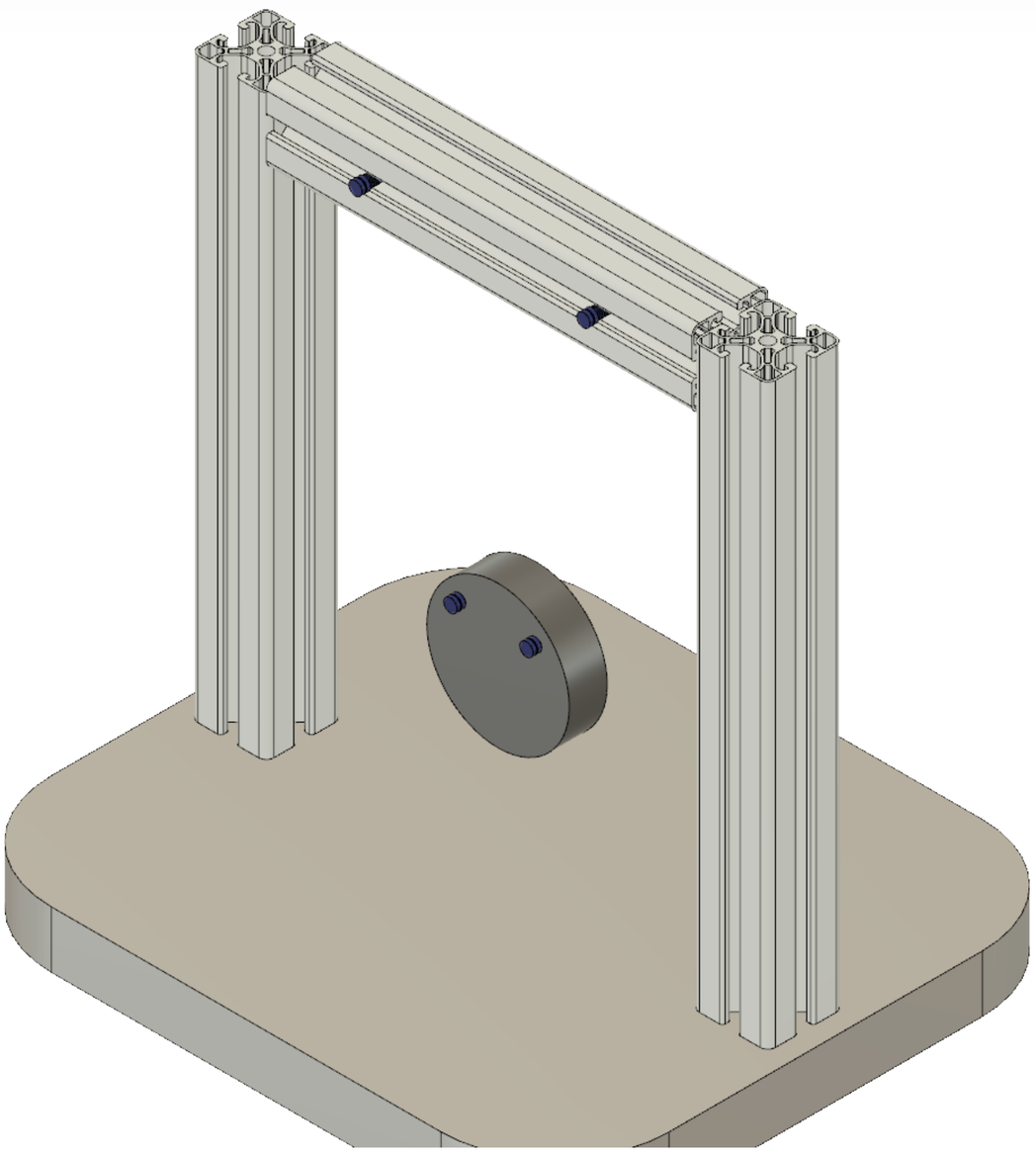

*Figure 1: Design of the physical setup*

## SOFTWARE

LABVIEW software has been used for developments and simulations of the experiment.

- To start the process some information from the user must be entered. These informations are serial number of the sensor under test, reference sensitivity and the information about which axis is under test. Afterwards, system gets triggered when the impact hammer force input exceeds the desired force value.
- On the user interface section, software plots the acceleration and force data in real time and prints all the data gathered into excel file for further analysis.
- **Sensitivity :** Obtained by multiplying reference sensitivity with the ratio of output and reference voltage.
- **Cross-Talk :** Obtained by dividing the voltage output of transverse axes to the calculated reference sensor acceleration.
- **Bandwidth :** By using FFT and computing the signal in power spectrum, resonance frequency is obtained by calculating the frequency that gives maximum amplitude.
- **Phase-shift :** After computing signals in frequency domain, phases of two signals are differentiated and plotted. Than, curve fitting has applied to the obtained plot in order to calculate the phase-shift.

## DESIGN

The model is produced in the Sabancı University machine shop facility.

- Drafts of the technical designs are sketched for each part of the general assembly setup, using Autodesk Fusion 360.
- Aluminum is set to be used as the core material of the setup, making the general structure compact and light-weighted. The proposed prototype has two profile aluminum columns and a circular table that hold the system together.
- A precise mass will be hanged from a bridge that connects the two columns. The mass hanged through a stationary fishline that is mounted to the bridge so that it satisfies the conditions of a true free-fall setting.

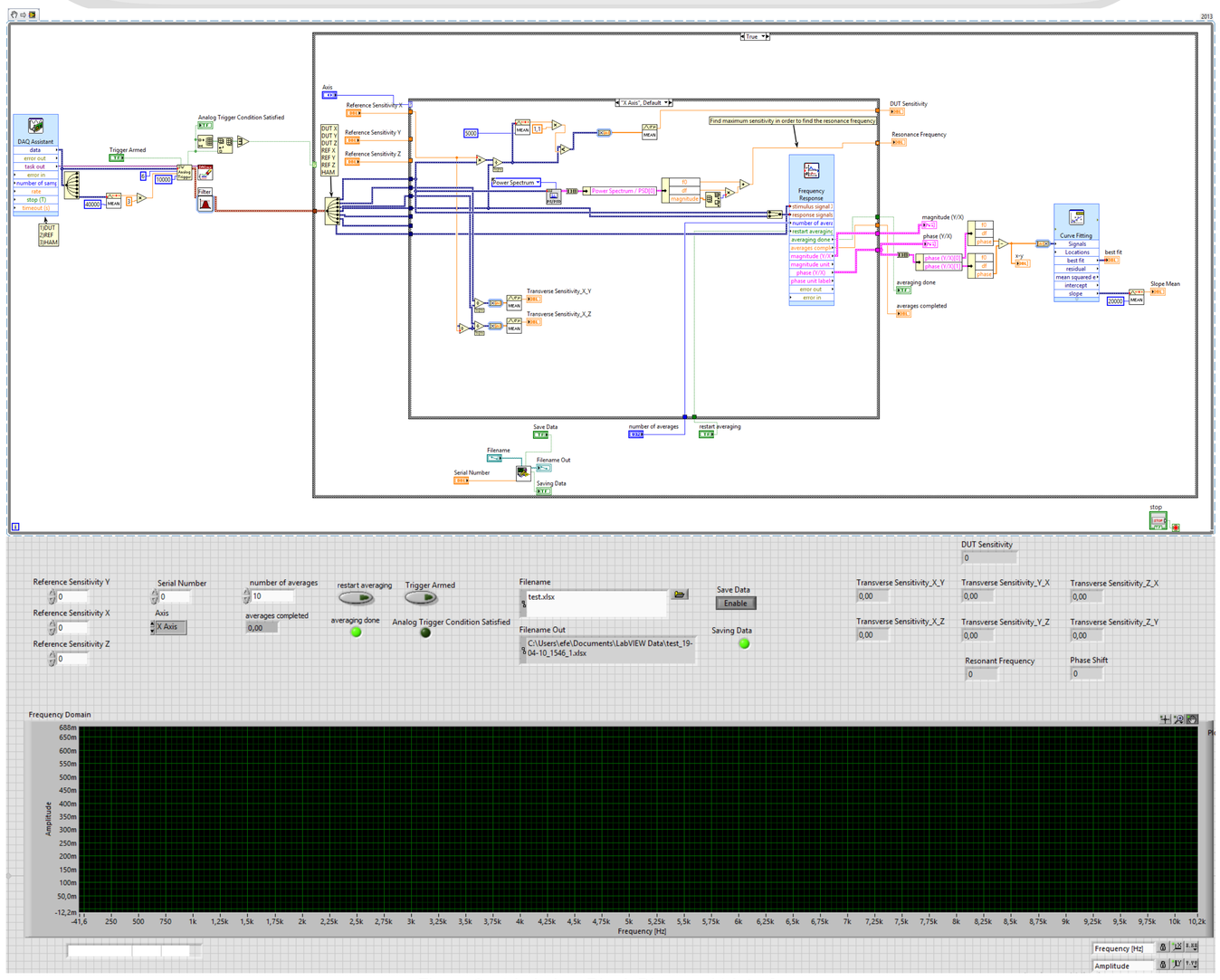


*Figure 2: a) Labview Block Diagram b) Interface*

## CONCLUSION

In spite of the numerous calibration methods, the proposed solution is the most practical and achievable solution for the given circumstances. To maintain a solution that is within a sensible budget, an additional reference sensor that acquires reference data without relying on high precision control is used. Calibration is achievable by comparing these reference and sensor under test data and making the necessary adjustments. The accelerometers are tested under pendulum motion to obtain the necessary test data. The test data are, then, transmitted through data acquisition device and analyzed in the LabView software. Pendulum-impact hammer test offers low cost, simple and accurate method for measuring the sensitivity and the cross-talk.

## REFERENCES


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