JKU

JOHANNES KEPLER
UNIVERSITY LINZ

INFLUENCES ON THE DETECTION PROBABILITY OF FERROMAGNETIC OBJECTS

Lukas Heindler
lukas.heindler@jku.at
2021/11/01
Johannes Kepler University Linz

JOHANNES KEPLER UNIVERSITY LINZ

IARIA

Resumé

- Lukas Heindler
- Bachelor Program Electronics and Information Technology at JKU
- Working at Institute for Measurement Technology
- Research topics at IMT: Sensors for material characterization, signal processing, magnetic imaging, optics based sensors

Table of Contents

MOTIVATION

Motivation

- High Speed detection of <u>non</u> magnetized ferromagnetic objects
- What if there is a residual remanence?

POTENTIAL MEASUREMENT PRINCIPLES

Requirements

- Detect concealed ferromagnetic objects
- High Speed, large air gap, high temperature range, adaptive threshold
- Problems: distance to resolution, external EM disturbances, temperature

Possibilities

- Anisotropic magneto resistive (AMR) sensor
- Capacitive sensors
- AC excitation
- Hall effect sensor

Theory of Sensor Operation

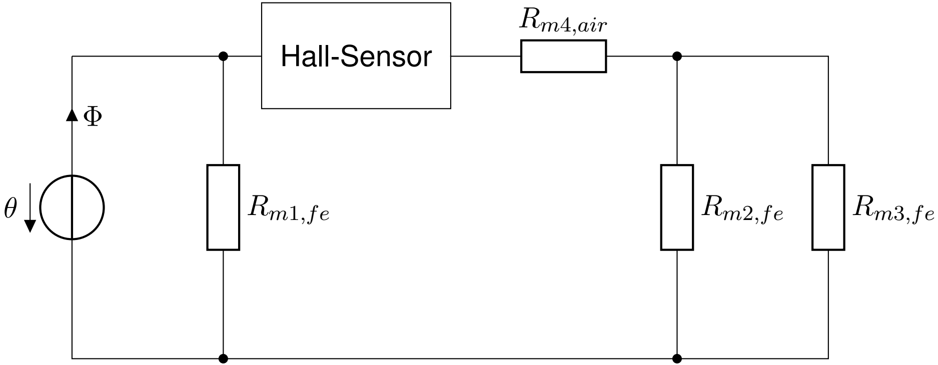


Figure: An equivalent magnetic circuit diagram.

SCHEMATIC AND THE SENSOR SYSTEM

Schematic

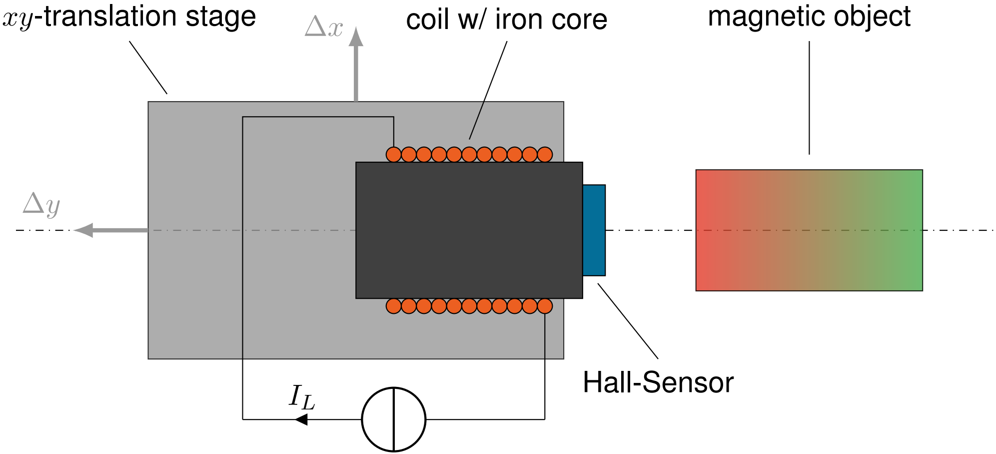
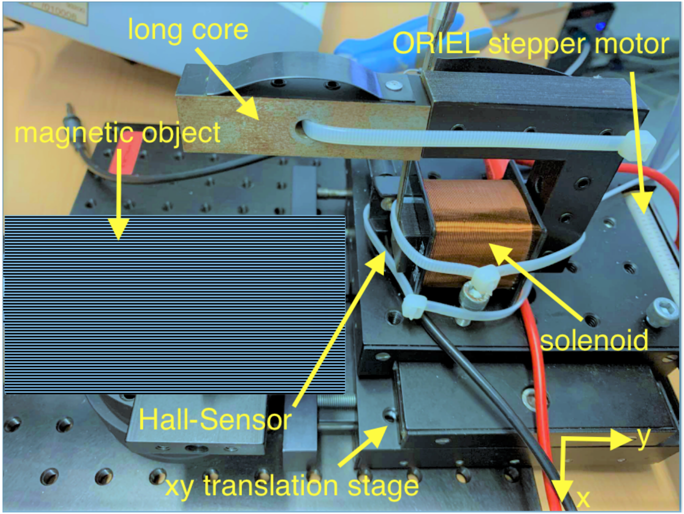
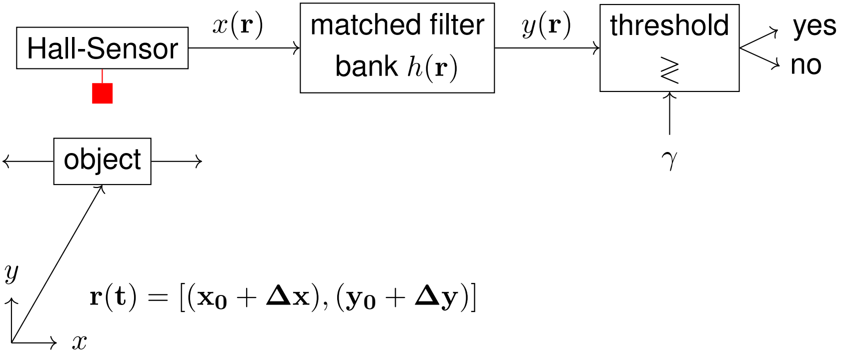


Figure: Working principle of the measurement setup

Built Measurement System

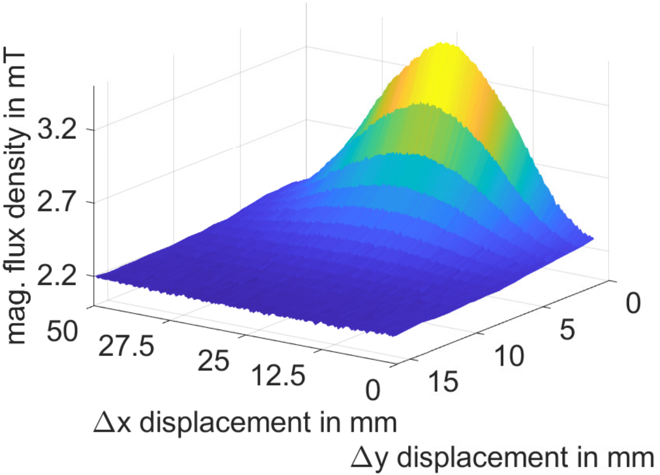


Signal Processing

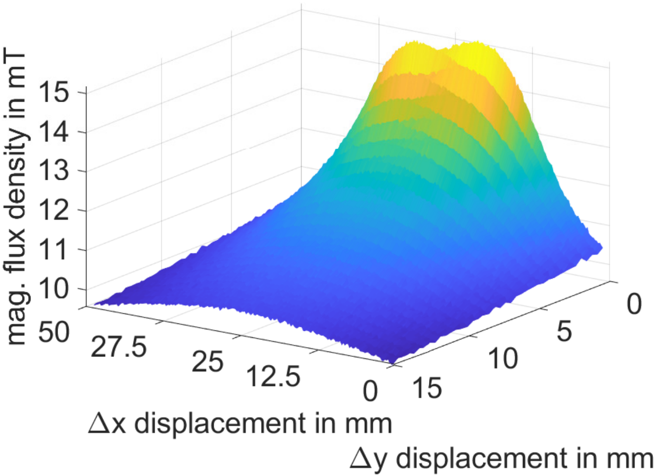


RESULTS

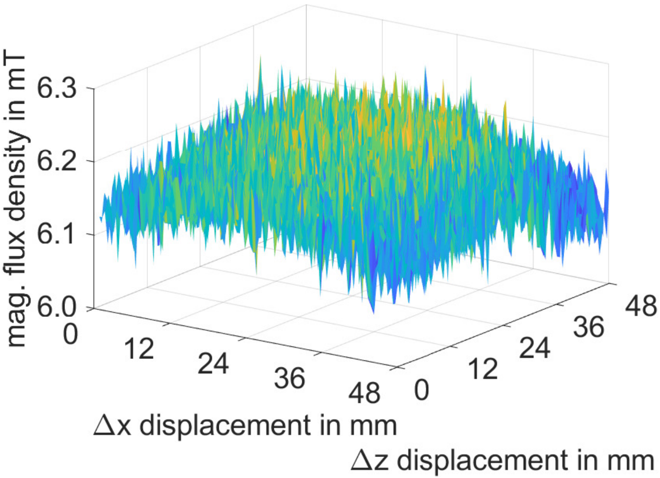
Results with short core



Results with long core

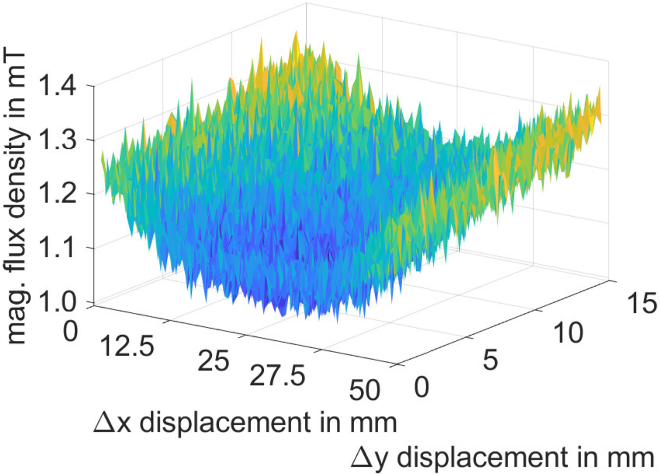


z-Axis

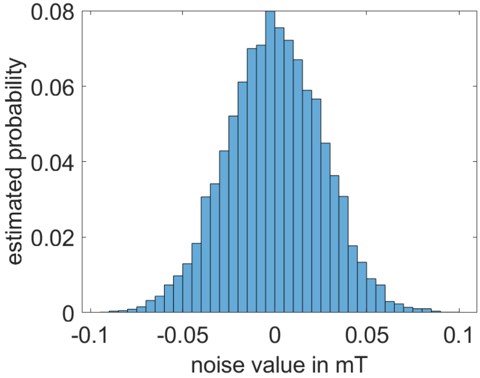


mag. flux density in mT
6.3
6.2
6.1
6.0
0
12
24
36
48
0
12
24
36
48
Δx displacement in mm
Δz displacement in mm

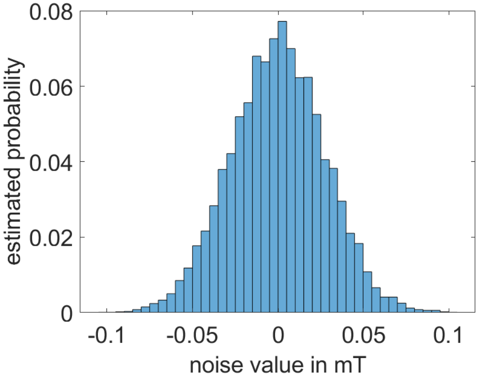
Reverse Current



Noise and SNR



(a) xz-plane



(b) xy-plane

Figure: Histograms of the stochastic values of the xz- and the xy-plane.

CONCLUSION

Discussion and Outlook

- Increase Sensibility
- Simulation for better core
- Electrical and Magnetic interferences

References

[1] E. Schrüfer, L. Reindl, and B. Zagar, Elektrische Messtechnik, Hanser Verlag, 2018.

[2] P. Ripka, Magnetic Sensors and Magnetometers, Artech House Inc., 2000.

[3] J. P. Bastos, Electromagnetic Modelling by Finite Element Methods, Dekker, 2003.

[4] S. Taghvaeeyan, R. Rajamani, Magnetic Sensor-Based Large Distance Position Estimation With Disturbance Compensation, IEEE Sensors Journal Vol. 15, 2015.

[5] `https://www.phywe.de/`

[6] R. Piepgras, S. Michlmayr, J. Egger, B. Zagar, Potential und Einschränkungen der Messung magnetischer Mikrostrukturen mit einem Faraday-Magnetometer, in tm - Technisches Messen, Vol. 86, Nr. 10, Walter de Gruyter, pp. 577–585, 2019.

[7] R. Piepgras, S. Michlmayr, B. Zagar, Optical Analysis of Magnetic Microstructures, in SPIE: Proceedings of SPIE Volume 11144 - IMEKO Joint TC1 -TC2 International Symposium on Photonics and Education in Measurement Science 2019, Serie Proceedings of SPIE, Vol. 11144, 2019.

[8] J. G. Webster, The Measurement, Instrumentation and sensors Handbook, CRC Press LLC and Springer-Verlag, 1999.

[9] S. M. Kay, Fundamentals of Statistical Processing, Volume I: Estimation Theory, Prentice-Hall Signal Processing Series, 1993

[10] W. A. Gardner, Introduction to Random Processes with Applications to Signals and Systems, 2nd ed. McGraw-Hill, 1990

THANK YOU