SUPPLEMENTARY MATERIAL / SUPPORTING INFORMATION

Magnetic Field Sensing Bolstered by Deep Learning on Scattering Images from Random and Conventional Laser Illumination

Emanuel P. Santos[1], Wenyu Du[2], Edwin D. Coronel[1], Alyson J. A. Carvalho[3], Zhijia Hu[3], Ernesto P. Raposo[4], Anderson S. L. Gomes[1]

[1]Departamento de Física, Universidade Federal de Pernambuco, 50670-901 Recife, PE, Brazil.
[2]National Key Laboratory of Opto-Electronic Information Acquisition and Protection Technology, Information Materials and Intelligent Sensing Laboratory of Anhui Province, Key Laboratory of Opto-Electronic Information Acquisition and Manipulation of Ministry of Education, School of Physics and Opto-electronics Engineering, Anhui University, Hefei, 230601, China.
[3]Universidade Estadual da Paraíba, Campina Grande, PB, Brazil.
[4]Laboratório de Física Teórica e Computacional, Departamento de Física, Universidade Federal de Pernambuco, 50670-901 Recife, PE, Brazil.

1. Calibration and calculation of experimental accuracy

The standard laboratory calibration was performed by observing the current passing through the coils, measured using a Minipa ET-2076A multimeter, and plotted as a function of the magnetic field recorded on a Teslameter (Phywe digital, serial No. 319900040863, sensitivity 10 μT, ranges 20-200-1000 mT) coupled with an axial Hall probe. For each magnetic field value, we took 50 consecutive electric current measurements and the graph is represented in Fig. S1. The experimental accuracy is then calculated as:

$$accuracy = \langle \left[\left(1 - \frac{\sigma_i}{\mu_i} \right) \times 100 \right] \rangle$$

Where σ_i is the standard deviation of the electric current related to magnetic field i and μ_i is the average intensity of the current related to magnetic field i.

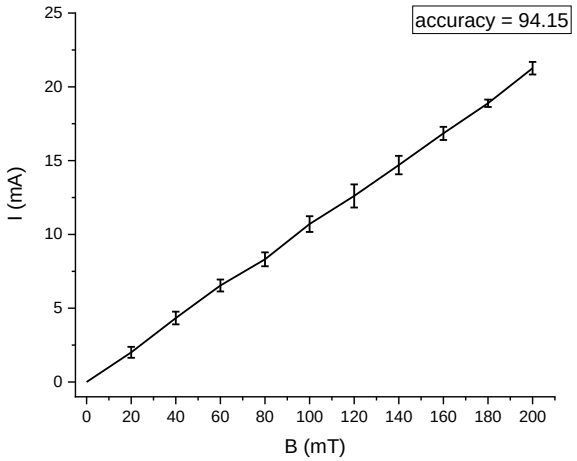

Figure S1. Calibration of the magnetic field using a multimeter coupled to the Phywe Stelltrafo mit Gleichrinter source for 20 consecutive measurements for each field value.

2. Entropy of the difference of two images

Considering two images, we calculate the value of Shannon's entropy (equation 4 of the main article). To understand the mechanism of entropy under the difference of images, in Figure S2 we show, initially (first line) the entropy of the difference of two identical images, resulting in the value zero, as expected. For an image generated by a conventional laser and another generated by a random laser (second line), the difference of these two generates an image whose entropy is 3.68. In the third line we have the entropy of the difference of the speckle with a blue background image and, in the last case (fourth line), we have for the speckle and a random image.

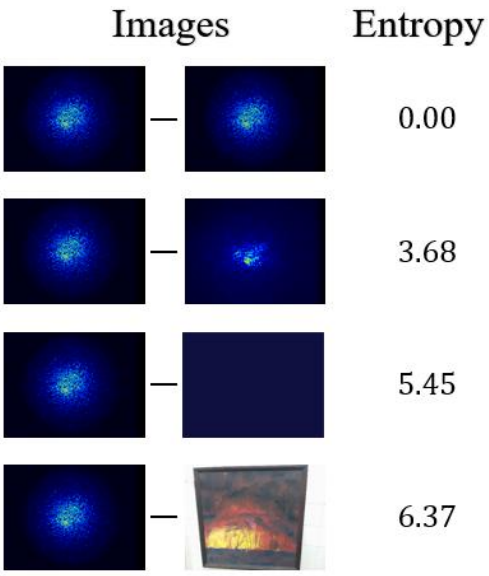

Figure S2. Entropy calculated on the image resulting from the subtraction of two images.

3. Graphical User Interface

An interesting proposal is to develop a graphical user interface (GUI) that can serve as a quick and easy access platform for the scientific community. Using the MHCNN model presented in the main article and the python language, we created a simple GUI (Figure S3) in which the user can upload an image and, based on the trained model, the interface shows what the magnetic field of that image is.

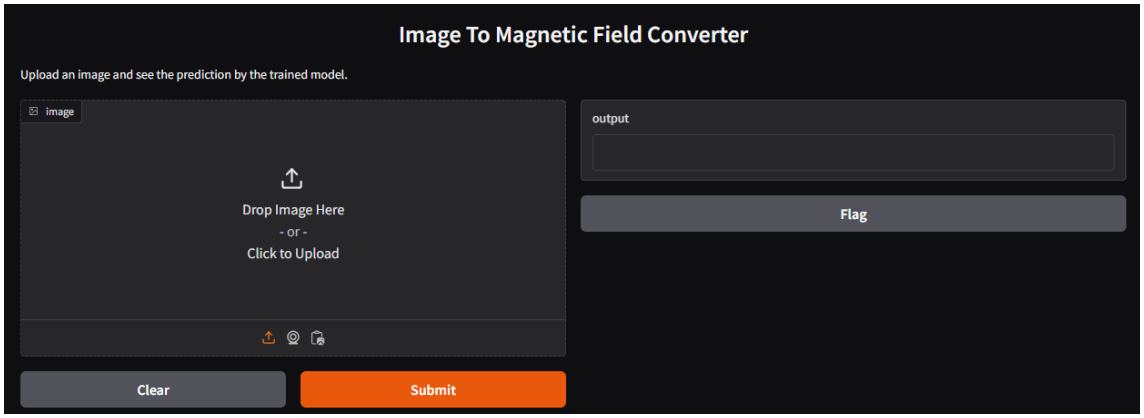

Figure S3. Graphical user interface (https://youtu.be/AUOiQjnVmVg).