CHAPTER V
CONCLUSION

This thesis investigates measuring the magnitude and orientation of magnetic fields on the quantum diamond sensor with magnetic field calculations. The calculation involves distinguishing field characteristics from ODMR signals executed using three different instruments controlled by a Pulse Blaster unit and mapping unknown magnetic field vectors oriented in the direction of the North Pole.

The experimental setup aims to resolve adjacent Gaussian peaks characterized by their full width at half-maximum (FWHM), with the narrowest recorded FWHM being approximately 26 MHz in Figure 5.1. The calculation finds magnitude from 0 to 200 G in Figure 4.10 and distinguishes the ODMR signal with the smallest different angles at 2 degrees, like in Figure 4.5. The frequency sweeping program utilizes the built-in functionality of a microwave generator and integrates ODMR parameters for instrumental control and pulse duration respectively. The setup enables real-time magnetic field monitoring, capturing 200 data points every 5 seconds. However, several limitations were identified. First, a delay in frequency response from the microwave generator leads to discrepancies between the set and recorded values. Second, latency of the ODMR parameter detection process results in fewer detected data points than expected.

Magnetic field calculation and simulation program were developed to determine both the magnitude and orientation of magnetic fields from raw experimental data. Validating reference data indicates that the calculated results are consistent with expected values, demonstrating the system's ability to accurately resolve vector components of the magnetic field.

Importantly, the employing NV centers performs vector magnetometry by moving the magnet relative to a fixed sensor. The mapping procedure reconstructs the magnetic field vector components—B_{total}, B_x, B_y, and B_z—in the xy plane, allowing for visualization of magnetic field gradients and directions at three distinct levels of measurement resolution.

In addition, system improvement remains possible. The system lacks automation in processes such as magnet positioning and selection of intercepts of calculated results, resulting in time-consuming repetitions. Additionally, the use of a half-wave plate (HWP) to identify NV axes via polarization is possible for the system but labeling errors and uncontrolled constraints degrade calculation accuracy. Finally, the absence of calibration parameters requires that the system be manually calibrated prior to experimentation to ensure proper configuration of critical sweeping variables.

The proposed setup has potential applications in a variety of domains, including direct current (DC) magnetic field sensing, nuclear magnetic resonance (NMR), magnetic resonance imaging (MRI), and biological sensing. Moreover, the platform offers an accessible experimental framework for educational purposes in quantum sensing and introductory quantum mechanics laboratory instruction.