

# Estimating geomagnetic field detection sensitivity of pigeons and passerine migrants using deep machine learning

Vedachalam Narayanaswamy and Bala Naga Jyothi Vandavasi\*

National Institute of Ocean Technology, Ministry of Earth Sciences, Government of India, Chennai 600 100, India

The capability of homing pigeons and passerine migrants to derive navigation-related information from the geomagnetic field (GMF), enabling them to navigate from unfamiliar sites, is a subject of research. Despite the vast trajectory information available from field experiments, the true accuracy of their map and compass sense are seldom reported. The recent developments in bird geo-tagging, precision world magnetic model and deep machine-learning capabilities enable us to understand the mechanisms underlying their innate abilities in true navigation. In this article, we machine-learned the GMF anomaly in a 10 km<sup>2</sup> region and analysed the flight path efficiency for a 10-km GMF-anomaly-guided trajectory using the developed deep-learning-based artificial intelligence (AI) algorithm. From the simulated flight path and comparing the computed efficiencies with the field-reported results, it is observed that the sensitivity of the GMF gradient detection sensory system in pigeons and passerine migrants in familiar and unfamiliar regions are in the range of 1–3 nT and 0.5–2.5 nT respectively. Identified results shall help implement AI-based solutions for understanding spatiotemporal bird migration and enacting environmental conservation policies.

to reach the preferred environmental conditions was proved, which evoked interest in finding biogenic magnetite, including olfactory epithelium of trout fish, the abdomen of bees, upper beak skin of pigeons and the antennae of ants, based on which lots of behavioural, histological, and neurophysiologic studies are being conducted hitherto<sup>3</sup>.

## Progress in bird navigation research

Before and in the early 90s, most of the studies on pigeons were conducted to understand their response to spatial GMF variations by releasing them in regions of magnetic anomalies, where they showed marked deviations from the home direction and increased disorientation, which were observed with binoculars, that too limited to the beginning of the homing flight. In 1920, the US Geological Survey launched the Bird Banding Laboratory, which made efforts to provide unique markers for identified birds, enabling them to track their travel routes. Since 1947, various field experiments have been conducted to understand bird navigation. Keeton and Walcott demonstrated that homing pigeons possess magnetic sensors.