# Distinguishing Bacterial Motion Quantitatively: A Diagnostic Method for Intestinal Disease

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Gastrointestinal illnesses afflict more than 100 million people in the U.S. alone and are often indicated by gut microbiota motility. Typically, swarming bacteria are indicators of infection while swimming bacteria are more innocuous. Current diagnostic methods for intestinal diseases are lengthy, expensive, non-specific, or lead to serious complications. This study proposes a novel way to diagnose Inflammatory Bowel Disease (IBD) through quantitatively distinguishing bacterial motion. Current methods of discerning bacterial motility involve only qualitative description without consideration of potential medical applications; no quantitative models to differentiate bacterial motility exist. In this study, a novel interdisciplinary diagnostic tool was developed that distinguishes swarming and swimming SM3 bacteria quantitatively for the first time. Photolithography was used to create PDMS sheets and microgears for studying both motilities. Software captured images for Particle Image Velocimetry (PIV) analysis for the calculation of Vortex, Nematic, and Polar Order Parameters, which were fed into a developed machine learning algorithm; accuracy was analyzed to ascertain the importance of each variable in motility distinction. VOPs were used to generate a Vicsek model for differentiating swimming and swarming, which demonstrated the importance of cell-cell alignment force in motility distinction — the model yielded high and low VOP values for swarming and swimming respectively. Studies of motility on intestinal tissue supported modeling trends from prior PIV analysis on agar. This novel tool can be tested in a variety of intestinal diseases to provide a preliminary diagnosis, operating more economically, efficiently, specifically, and safely than conventional procedure.

**Awards Won:**

First Award of $5,000

Robert Horvitz Prize for Fundamental Research

Patent and Trademark Office Society: Second Award of $500

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