

SAILSHAPE

SMART SAILING THROUGH SENSE AND SHAPE

RFID-BASED SAIL SHAPE RECONSTRUCTION AND PERFORMANCE GUIDANCE SYSTEM



ABSTRACT

SAILSHAPE is a real-time system that measures and reconstructs the 3D shape and dynamics of a sailing boat's sail using passive RFID tags distributed over the sail surface. By triangulating tag positions with a network of antennas and fusing inertial and boat data, SAILSHAPE detects luffing (*flutter*), quantifies shape deformation, and provides the skipper with actionable cues to optimize trim and course for maximum aerodynamic efficiency.

SYSTEM OVERVIEW

1 RFID TAGS ON SAIL

Passive UHF RFID stickers are placed on key points of the sail (luff, leech, head, clew and intermediate zones) forming a virtual mesh.

2 MULTI-ANTENNA RECEPTION

Antennas installed on the mast and deck continuously interrogate tags. Phase and RSSI measurements are used to estimate 3D position.

3 SENSOR FUSION

RFID-derived positions are fused with IMU, compass and boat speed data to compensate motion and obtain a stable sail reference frame.

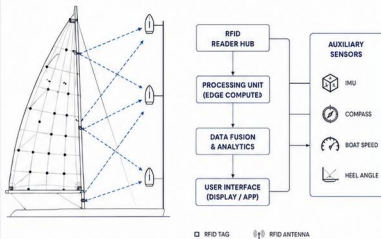
4 SHAPE RECONSTRUCTION

A surface model of the sail is computed in real time from the point cloud using a constrained mesh fitting algorithm.

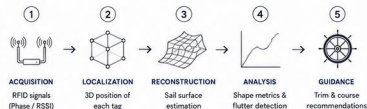
5 ANALYTICS & GUIDANCE

The system extracts aerodynamic indicators and detects luffing (*flutter*). A decision engine generates trim and course-correction cues.

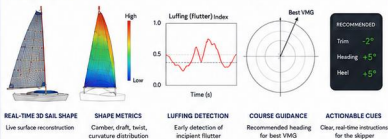
ARCHITECTURE OVERVIEW



PROCESSING PIPELINE



KEY OUTPUTS



TECHNICAL HIGHLIGHTS

- ✓ Passive RFID UHF for lightweight, maintenance-free sensing
- ✓ Multi-antenna phase/RSSI localization for robust 3D tracking
- ✓ Sensor fusion with IMU, compass and speed for accuracy in dynamic conditions
- ✓ Real-time mesh reconstruction with outlier rejection and smoothing
- ✓ Luffing (*flutter*) detection based on leech oscillation and shape variability
- ✓ Low power, designed for harsh marine environments

MEASURED IMPACT

- 📈 5-12% improvement in VMG (upwind performance) in sea trials
- 🕒 Early luffing detection 2-4 seconds before it is visually noticeable
- 🚢 More stable sail shape and reduced drag due to flutter events
- 🏆 Proven in offshore and inshore racing conditions