MagShield: Towards Better Robustness in Sparse Inertial Motion Capture Under Magnetic Disturbances

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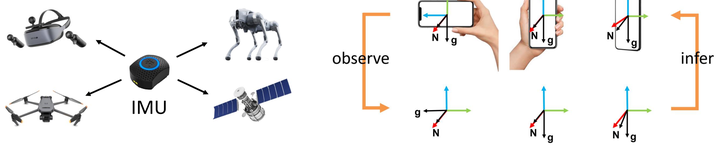
Preliminary

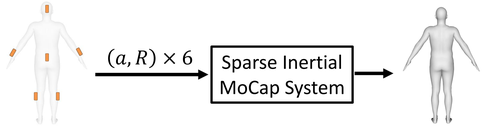
What Is IMU? A sensor that measures acceleration and orientation.
How Does It Senses Orientation? It estimates global orientation from locally measured angular velocity, gravity, and north direction via fusion algorithms.



How magnetic disturbances affect IMU? IMUs can be misled by “fake north”. Since pitch and roll can be inferred from gravity, only yaw error remains.

Introduction

Sparse Inertial MoCap aims to reconstruct human motion using only 6 IMUs.



Latest Works
PNP(SIGGRAPH 2024)
DynaIP(CVPR 2024)
ASIP(NeurIPS 2024)

Research Gap: All of the existing methods overlook the magnetic interference on IMUs—leaving the systems unrobust in real-world environments.

Our Contribution: We Propose MagShield, an IMU orientation estimation module that address magnetic interference in sparse inertial MoCap systems.

Project Page

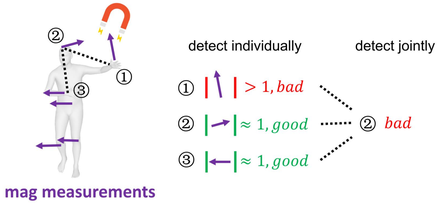
Code

Method

Guiding Question: What’s the core difference between independent IMUs and body-mounted IMUs?

Insight 1: Spatial Prior

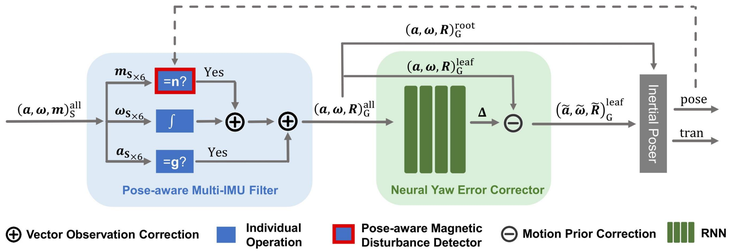
- Explanation: Body-mounted IMUs are physically close to one another, allowing them to share their "sensing" of the surrounding magnetic field.
- Our Approach: Aggregate magnetic field measurements with neighboring IMUs to decide whether to use the magnetic field for orientation estimation.



Insight 2: Human Motion Prior

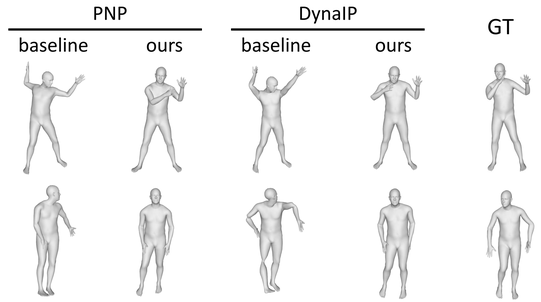
- Explanation: Yaw error can cause IMU readings to violate the constraints of human motion prior, making the (relative) yaw error of the IMUs predictable.
- Our Approach: Employ a neural network to predict the yaw error.

Full Pipeline

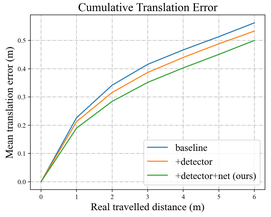


Results

Comparison With Baseline IMU Fusion Algorithm (ESKF)



Method	SIP Err	Ang Err	Pos Err	Mesh Err
PNP				
baseline	26.63	24.65	8.99	10.86
+detector	25.67	23.20	8.56	10.26
+detector+net (ours)	**24.19**	**20.23**	**8.17**	**9.74**
DynaIP				
baseline	31.55	28.79	9.10	11.17
+detector	30.79	27.26	8.64	10.67
+detector+net (ours)	**28.68**	**22.12**	**8.05**	**9.84**



Comparison With Commercial IMU Fusion Algorithm (Noitom)