SpatialVision: Bringing Popping-Out RViz to Life with AirPods

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ROSCon2023
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Search and Rescue robots
[Okada+, IROS2010]

Bridge inspection drones
[Mizutani+, IROS2013]

Tracked vehicle simulation
[Okada+, ICRA2020]

Overlaid fiducial markers
[Okada+, ICRA2021]
Today’s topic: Stereoscopic system SpatialVision

* Standard display
Stereoscopic System (SS) is useful

Surgical robots often employ SS
[Nam+, 2012]

SS expedited UGV’s movement through tight spaces
[Chen+, 2010]

SS reduced collision with surroundings
[Luo+, 2021]

Would also be useful in design
But SS can be bulky & costly

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<th>Head tracking</th>
<th>Display</th>
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<td>MoCap</td>
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<td>VSLAM</td>
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<td>Face track camera</td>
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<td>IMU</td>
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<td>None</td>
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SpatialVision aims **low complexity & cost**

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Hardware: AirPods + iPhone + PC

**iPhone**
- forwards head pose to PC

**AirPods**
- tracks head with built-in IMU

**PC (RViz)**
- aligns Rviz’s camera angle with head pose

→ Feels 3D due to the motion parallax
Software: iOS app + ROS 1/2

- **Built-in IMU**
  (AirPods Pro Gen 2, etc. originally for spatial audio)

- **Access to AirPods IMU via API** (Core Motion. iOS 14 or later)

- **Camera pose binding to a Tf frame**
  (FrameAligned mode)

What if **iOS app** that streams AirPods IMU to **Tf**?
AirSense: App streaming iPhone & AirPods sensors to ROS

- iOS15 or later
- ROS1/2 (requires rosbridge)
- AirPods IMU
- iPhone IMU
- Face track by front cam

Useful as a standalone app (MagSafe attachable IMU that can stream via WiFi or mobile)
Tf handles pose between PC & user

- **Known**: iPhone IMU
- **Known** (fixed): iPhone IMU
- **Unknown**: Offset of IMUs
- **Unknown**: Mount offset of AirPods
- **Known**: AirPods IMU
Calibrate “Unknown”s in 10 seconds

- Estimate unknown offsets by matching head track with the iPhone’s front cam
- No camera required once calibrated → works out of FOV or in a public place
- ROS1 Noetic or ROS2 Humble
Stars / Issues / PRs are welcome!

- [yoshito-okada/AirSense](https://github.com/yoshito-okada/AirSense)
- [yoshito-okada/spatial_vision](https://github.com/yoshito-okada/spatial_vision)

* Code will be committed once a paper has been published
ユーザとRVizの視点をTfで同期
ユーザとRVizの視点をTfで同期