1. Reflection-based acoustic tracking

1. Monitor reflection: orientation $\phi_1$ and position $xyz_1$
2. Wall reflection: orientation $\phi_2$ and position $xyz_2$

Track Head Position via Headset Microphones

4. Method overview: tracking

1. Pair-wise cross-correlation $R_{x,y,z}(\tau)$ in $x$ and $z$ dimension
2. $x$-dimension: synthesize time-of-arrival $\tau_x$ from $R_{x,y,z}(\tau)$
3. Convert time-of-arrivals $\tau_{x,y,z}$ to incidence probability $p(\Theta)$
4. Map Cartesian probability $p(\mathbf{r})$ to spherical probability $p(\Theta, \phi)$

6. Experiments: tracking

- Observed horizontal head orientation $\theta$
- Observed vertical head orientation $\phi$

7. Experiments: mapping

- Observed horizontal head orientation $\theta$
- Observed vertical head orientation $\phi$

8. Conclusions

We formulate:
- Steps towards reflection-based acoustic SLAM
- New techniques for reflection orientation & position sensing

We achieve:
- Head tracking with 2 microphones per ear at 50 Hz update rate
- Horizontal tracking error: 30° (acoustic)
- Environment mapping

Future work:
- Embed in noise cancellation headphones, 6 DOF, loop closing
- Explore applications outside the presented domain

9. References