Demo: Pointing Gestures for Proximity Interaction

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***Abstract*—We demonstrate a system to control robots in the users proximity with pointing gestures—a natural device that people use all the time to communicate with each other. Our setup consists of a miniature quadrotor Crazyflie 2.0, a wearable inertial measurement unit MetaWearR+ mounted on the user's wrist, and a laptop as the ground control station. The video of this demo is available at https://youtu.be/yafy-HZMk_U [1].**

***Index Terms*—pointing gestures; natural user interface; proximity interaction.**

Introduction: Joystick is a popular interface used for controlling robots both in research and commercial applications. However, it is known to introduce a layer of indirection associated with the *mental rotation* problem [2]. We demonstrate an alternative solution based on pointing gestures, that allows the operator to naturally control robots in an egocentric frame.

Approach: We use the 3D-orientation of the arm, acquired with the IMU, to reconstruct a pointing ray: it originates at the user's eyes and passes through the tip of the pointing finger. At the beginning of the interaction, for a few seconds, the user is required to point and follow the robot while the robot moves along a predefined trajectory; the system aligns the pointing rays to the corresponding robot positions and estimates the relative pose [3] between the user and the robot. Then, the user can control the drone in real time, as it moves to follow the intersection between the pointing ray and the floor. Even though pointing is an inherently imprecise way to pinpoint positions, the real-time feedback provided by the robot allows the user to achieve very accurate control.

Demo components: 1) Mbientlab MetaWearR+ wearable sensor with on-board IMU and Bluetooth LE wireless module worn by the user on the wrist of a pointing arm; 2) miniature quadrotor Bitcraze Crazyflie 2.0 with an LED-light and a visual odometry board, total weight 35–40g, size: 9×9×3cm, connected to the host PC via 2.4GHz proprietary radio link (Nordic nRF24LU1+); 3) host PC running Robot Operating System (ROS); 4) wireless joypad for safety purposes.

Demo Sequence: 1) The quadrotor is placed at an arbitrary location, 1.5m from any obstacles; 2) The user, standing at any nearby location, presses the button on the bracelet: the drone takes off, switches its light to blue and starts following an equilateral-triangle trajectory with edge length 1m; 3) The user follows the drone by pointing with a straight arm for a 5–7s: then, the drone wobbles, changes its color to blinking green, and the bracelet vibrates: now, it is the user to control the drone; 4) The user points at the floor where they want the drone to hover at and the drone immediately follows there; the user can maneuver the drone on complex trajectories this way; 5) When the user wants to disengage from the drone, they keep it at the same location for 3s: then, the drone switches its light back to blue and stops following the pointed location; 6) To land the drone, the user kneels and touches the ground.

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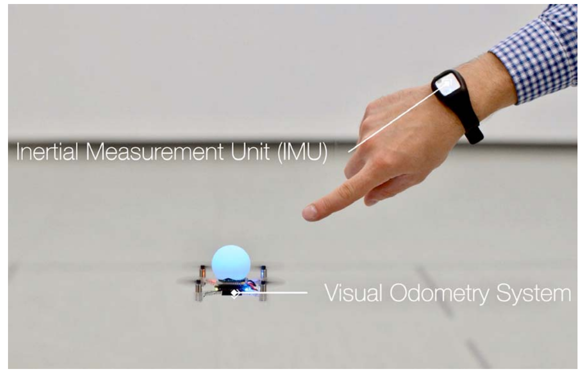

Fig. 1. Components of the proposed interface: a wristband with IMU worn by the user and the quadrotor equipped with a visual odometry system.

Logistics: The minimal space required (W×L×H) is 3×3×3m, but a slightly larger space in at least the length dimension is preferable; the drone flies at a fixed height of about 50 cm. For the best performance of the visual odometry, the area should be well illuminated; most floors are suitable in our experience, unless they are very homogeneous in color or reflective. If allowed, the demo can be shown on the main stage with prior testing.

The total time necessary to show the demo ranges from 1 minute to 5 minutes (including an explanation of the approach). A similar setup has been extensively tested during several public events and proved to be robust; we can hot-swap between several identical drones in case of malfunctions. Our experience shows that even people who never piloted a drone in their life get accustomed to the system in one or two trials.

References

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