Video: Pointing Gestures for Proximity Interaction

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***Abstract*—We propose 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 system has two requirements: first, the robot must be able to reconstruct its own motion, e.g. by means of visual odometry; second, the user must wear a wristband or smartwatch with an inertial measurement unit. Crucially, the robot does not need to perceive the user in any way. The resulting system is widely applicable, robust, and intuitive to use.**

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

Additional Materials

The video in a better quality and additional information on the project are available at:
http://people.idsia.ch/~gromov/pointing-gestures

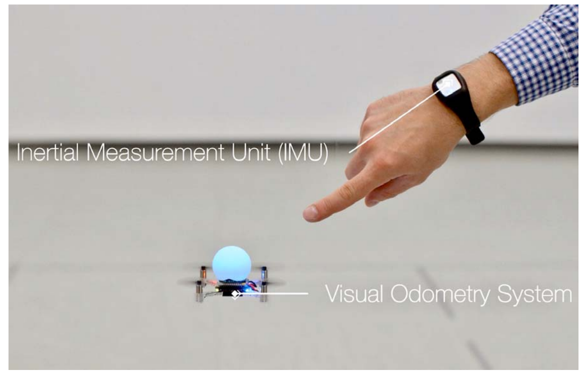

Fig. 1. Components of the proposed interface: a wristband with IMU worn by the user and the quadrotor equipped with a visual odometry system.

I. Description

Guiding agile robots, such as quadrotors, on complex trajectories with a joystick is a challenging task that requires a lot of skill and attention: in fact, the joystick interface introduces a layer of indirection, known as the *mental rotation* problem, that requires extensive training [1]. We demonstrate an alternative interface based on pointing gestures, that allows the user to operate in its own, egocentric, frame of reference. We use the 3D-orientation of the arm, acquired by a wrist-worn Inertial Measurement Unit (IMU) (Figure 1), to reconstruct a pointing ray: it originates at the users eyes and passes through the tip of the pointing finger. To find the pointed location, we intersect the ray with the ground plane.

This location is relative to the user, but it has to be expressed in the robot frame before the robot can move there. In a previous video [2], we assumed the relative pose of the user with respect to the robot was partly known. In this work we lift such assumption, and rely on a recently published method for *relative localization* [3]: at the beginning of the interaction, for a few seconds, the user points and follows the robot while the robot moves along a predefined trajectory; then, the system aligns the pointing rays to the corresponding robot positions to estimate the relative pose. Once a satisfactory alignment is found, the bracelet vibrates, the drone wobbles and changes the color of its light to green. From this moment, the user controls the robot, which follows the pointed location in real time. To disengage, the user holds the robot at the same place for a few seconds: then, the robot turns its light back to blue and the bracelet vibrates. At this point, touching the ground will land the drone.

Even though pointing is an inherently imprecise way to pinpoint positions, the real-time feedback provided by the robot's own position allows the user to achieve very accurate control.

We also adapted our approach to slow-moving ground robots: we substitute the robots own motion with the motion of a laser dot projected on the ground by a robot-mounted pan-tilt unit. This implementation also allows the user to draw a complex trajectory, which is then followed by the robot at its own pace.

We tested the system during several public events to assess its usability. Our experience shows that even people who never piloted a drone in their life get accustomed to the system in a matter of minutes: with minimal effort, users can maneuver the robot to nearby locations in an efficient and accurate way.

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References

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