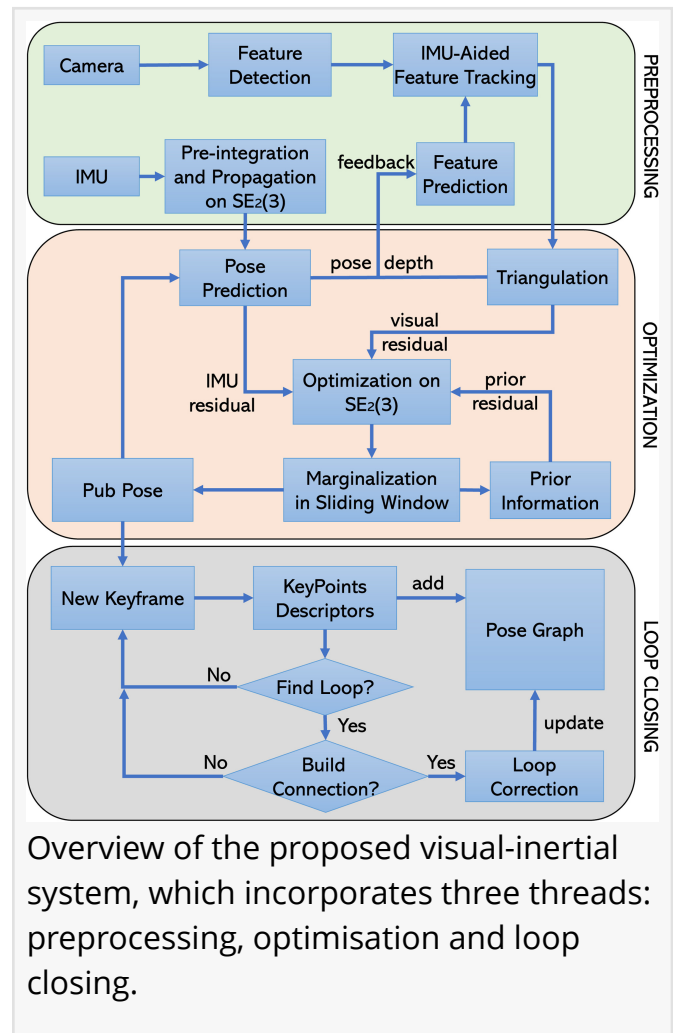


Robot self-dynamics help SLAM stay on course

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/EINPresswire.com/ -- A research team has developed a simultaneous localization and mapping (SLAM) system that helps robots remain oriented when their own rapid movement makes camera images difficult to interpret. The framework combines visual information with data from an inertial measurement unit (IMU), using the robot's self-dynamics to predict feature motion, represent coupled motion states, and correct accumulated navigation drift. Tests showed stronger tracking during rapid movement, vibration, dim scenes, and large illumination changes, while maintaining real-time operation. By turning the robot's motion from a source of disruption into useful guidance, the approach could support steadier navigation for drones, autonomous vehicles, mobile robots, and augmented-reality systems operating in demanding environments.

[Reliable robotic navigation](#) depends on estimating position and motion while building a map of unfamiliar surroundings. Cameras offer detailed environmental information but can lose visual features in textureless areas, motion blur, abrupt rotations, or changing light. Visual-inertial odometry (VIO) addresses some of these weaknesses by combining cameras with inertial sensing, yet many existing frameworks still process orientation, velocity, and position separately and do not explicitly account for rapid rotation, body vibration, or other self-generated dynamics. Their feature trackers may also begin searching from poor initial positions when images shift sharply between frames. Because of these challenges, deeper investigation is needed into navigation systems that jointly model visual change, inertial uncertainty, and robot self-motion.



Researchers at the National Key Laboratory of Machine Perception, Shenzhen Graduate School, Peking University; the Shenzhen Institute of Artificial Intelligence and Robotics for Society; and The Chinese University of Hong Kong-Shenzhen published the study online on May 12, 2026, in

CAAI Transactions on Intelligence Technology. The work presents a monocular Visual-inertial odometry (VIO) framework that incorporates robot self-dynamics into visual feature tracking, inertial measurement unit (IMU) preintegration, state optimization, and loop closing, linking these functions through coordinated preprocessing, optimization, and correction threads and evaluating them through module tests, ablation studies, and public-dataset comparisons.

The system first integrates IMU readings to predict where a visual feature should appear in the next camera frame, giving the tracker a more accurate starting point during sudden motion. It uses different prediction strategies depending on whether the feature's depth has already been estimated. The tracker then adjusts for affine deformation of image patches, brightness changes, and reasonable departures from the predicted path. In the backend, the researchers represent orientation, velocity, and position together using the extended special Euclidean group $SE(3)$, rather than optimizing them as separate quantities. This preserves their physical relationships during preintegration, uncertainty propagation, and state updating. A decoupled loop-closing module identifies revisited locations and reduces long-term drift without relying on the odometry module's original feature associations. On an 11-sequence public micro aerial vehicle dataset, the average feature-tracking success rate rose from 73.95% for the image-only Kanade–Lucas–Tomasi (KLT) tracker to 79.53%. The full system reduced average trajectory root-mean-square error (RMSE) from 0.197 meters for the baseline to 0.103 meters, and four-degree-of-freedom (DoF) loop correction lowered it further to 0.059 meters. Processing averaged 74.58 milliseconds per frame, remaining below the study's 100-millisecond real-time threshold.

The authors said the results show that a robot's own motion can be treated as valuable information rather than simply as interference. By using inertial predictions to guide visual tracking and keeping rotation, velocity, and position mathematically connected, they said the framework is better able to withstand blurred images, rapid turns, vibration, and sudden lighting changes. They added that separating loop closing from the main odometry pipeline makes the correction method easier to transfer to other visual or visual-inertial systems without rebuilding their internal feature-tracking structure.

The framework may be particularly valuable for compact platforms that must navigate with limited sensing and computing resources while moving quickly through unstable visual environments. Potential applications include aerial robots flying through confined spaces, autonomous vehicles handling vibration and sharp turns, service robots moving through crowded indoor settings, and augmented-reality devices maintaining alignment during rapid camera motion. Because the tracker, $SE(3)$ -based inertial model, and loop-closing module can be integrated separately, developers could adopt only the components suited to their systems. Further evaluation in larger real-world environments will be needed to test performance with diverse moving objects, longer missions, different sensor qualities, and stricter onboard computing limits.

References

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