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Autonomous aerial vehicles: guidance, control, signal and image processing platform

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Summary

The use of unmanned systems is gaining momentum in civil applications after successful use by the armed forces around the globe. Autonomous aerial vehicles are important for providing assistance in monitoring highways, power grid lines, borders, and surveillance of critical infrastructures. It is envisioned that cargo shipping will be completely handled by UAVs by the 2025. Civil use of unmanned autonomous systems brings serious challenges. The need for cost effectiveness, reliability, operation simplicity, safety, and cooperation with human and with other agents are among these challenges. Aerial vehicles operating in the civilian aerospace is the ultimate goal which requires these systems to achieve the reliability of manned aircraft while maintaining their cost effectiveness. In this presentation the development of an autonomous fixed and rotary wing aerial vehicle will be discussed. The architecture of the system from the mission requirements to low level autopilot control laws will be discussed. Trajectory tracking and path following guidance and control algorithms commonly used and their implementation using of the shelf low cost components will be presented. Autonomous takeoff landing is a key feature that was implemented onboard the vehicle to complete its degree of autonomy. This is implemented based on accurate air-data system designed and fused with sonar measurements, INS/GPS measurements, and vector field method guidance laws. The outcomes of the proposed research is that the AUS-UAV platform named MAZARI is capable of autonomous takeoff and landing based on a prescheduled flight path using waypoint navigation and sensor fusion of the inertial navigation system (INS) and global positioning system (GPS). Several technologies need to be mastered when developing a UAV. The navi-

gation task and the need to fuse sensory information to estimate the location of the vehicle is critical to successful autonomous vehicle. Currently extended Kalman filtering is used as fusion algorithm for position and poses estimation. Then path planning, trajectory generation and trajectory guidance alternative strategies is presented. One of the important UAV mission is target surveillance using an onboard vision system. AUS-UAV Mazari is using a gimbaled camera for target monitoring and target tracking using basic digital image processing and techniques. Successful moving target geo-location algorithms were developed and results will be presented. Future plan is to develop a cooperation strategy between several vehicles in the air and on the ground. Use of vision system to aid the vehicle in localization using ground features is also under consideration.

Keywords: Autonomous aerial vehicles, guidance, control, signal, image processing