Drone-based RF Monitoring System for Agriculture Applications

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In recent years, unmanned aerial vehicles (UAVs) have become an increasingly popular and viable commodity in the day-to-day operations of numerous industries. Their applications encompass everything from military and scientific to commercial and recreational, examples of which include: search and rescue operations, surveillance, landmine detection, package delivery, videography and many others. In the United States, UAVs are commonly used in agricultural applications; in order to maximize the yield, a farmer must consistently and accurately monitor the crops to detect potential problems with field uniformity, water pooling, and plant health early on. This consistency is the key reason why UAVs are a much more affordable option than the currently available alternatives such as manned aircraft surveillance, satellite imagery and manned scouting.

One of the most important factors in precision agriculture is to maintain a uniform soil moisture level throughout the field. This requires a data-acquisition system that is efficient, accurate and, at the same time, affordable for the farmer. Our approach to performing soil moisture measurements is to use a team of low-cost, commercially available quadcopters that are capable of shaping their collective radiation pattern simply by changing their relative positions in space. The state of the art agricultural drones use passive, high frequency sensors to approximate the soil moisture, while the team of quadcopters will be equipped with low frequency radars capable of penetrating the canopy and the ground underneath to get the most accurate readings. The swarm of drones could also be given the ability to autonomously distribute the workload among its members in order to finish scanning large fields more efficiently. The system will use a combination of empirical and analytical scattering models in order to approximate the local dielectric constant of the soil (Y. Oh, K. Sarabandi, and F. T. Ulaby, IEEE Transactions, Vol. 40, NO. 6, June 2002). Based on this information, the volumetric soil moisture can be extracted. The drone-based monitoring system will offer farmers a dependable and affordable alternative in precision agriculture.