# Deployment of autonomous IoT drones for precision farming in an automated manner

Kaya Kuru[1], Darren Ansel[1], David Jones[1], Benjamin Watkinson[1], John Michael Pinder[1], Claire Tinker-Mill[1]

[1] *School of Engineering and Computing, University of Central Lancashire, Preston PR1 2HE, U.K.*

*Kkuru@uclan.ac.uk*

**Abstract**

Precision farming (PF), as described by European Commission, is a management approach that focuses on (near real-time) observation, measurement, and responses to variability in crops, fields and animals; it can help increase crop yields and animal performance, reduce costs, including labour costs, and optimise process inputs; all of these can help increase profitability; at the same time, PF can increase work safety and reduce the environmental impacts of agriculture and farming practices, thus contributing to the sustainability of agricultural production [1]. Vehicles are becoming increasingly automated by taking on more and more tasks [2], [3] under improving intelligent control systems equipped with enhancing low-power monitoring sensor technologies [4] and Artificial Intelligence (AI) techniques [5], [6], [7]. Autonomous Unmanned Aerial Vehicles (UAVs) (A-UAVs), as flying autonomous robots, with self-learning and self-decision-making abilities by executing non-trivial sequences of events with decimetre-level accuracy based on a set of rules, control loops and constraints using dynamic flight plans involving autonomous take-off and landing are taking their indispensable parts with little or no human in the loop [8], [9], [10], [11] to accomplish various automated tasks [12], [13], [14], [15], [16], [17], [18]. PF is one of the most promising applications showing the benefits of using drones [19] where a lack of human element in the farming industry is becoming evident [20]. For instance, remote monitoring using Internet of Things (IoT) UAVs is safe, cost-effective and could be easily and frequently repeated, providing prompt information about livestock's population size and their instant location and health-related issues [21], [22], [23]. The University of Central Lancashire (UCLan) has been developing intelligent IoT drones to execute numerous tasks in various disciplines (https://www.uclan.ac.uk/business/archive/lidz) for a decade within the concept of Automation of Everything (AoE) and Internet of Everything (IoE) [24], [25] using several supervised and unsupervised AI techniques [26], [27], [28]. This research demonstrates how highly integrated technologies with drones can help the farming industry overcome challenging issues. Intelligent UAVs can overtake some of the labour-intensive tasks to execute PF. The integration of UAVs embedded with IoT and sensor-driven technologies into farming [28] can improve productivity with substantial cost savings. IoT technologies instilled with AI techniques can lead to automated ways of performing daily routines in large farms. Within this perspective, in this event, several examples of PF-based IoT drones, developed by UCLan, are demonstrated.

**Keywords**: Precision Farming (PF); Precision Livestock Farming (PLF); livestock health monitoring; livestock management; autonomous unmanned aerial vehicles (UAV); thermal imagery; active RFID, Internet of Things (IoT), Internet of Everything (IoE)

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