Vertical farming automation SoA summary

The most prevalent one is surely the application of Internet of Things (IoT) to the growing environment: even in commercial solution (for example container farming), IoT is almost a requirement and it is used to a certain degree. The easiest application is the monitoring of critical crop parameters (for example water pH and conductivity to monitor the amount of nutrients in the water, air humidity, air temperature, light intensity and frequency,…): all the data is gathered from the different sensors, processed (often with cloud computing services) and then delivered to a human operator (through PC or smartphone), which can intervene. A much more powerful, convenient and automated solution (and therefore more widespread) is to use IoT not only for monitoring but also for controlling the growth of the plants: often each controlled parameter is given a value range (in form of two threshold) and a way to influence it (for example the HVAC control for air temperature or the nutrient water pump for pH and conductivity). The system gathers all the data, processes it, tries to keep the assigned parameters in the given range and reports all the results to the user; in case it incurs in to a problem which is not able to solve, it notifies the operator. This hybrid of IoT and threshold control is the most used technique in commercial solution. A more refined approach (usually implemented in a research setting) is to use IoT to gather and process (with cloud computing and AI) big data (different types of cultivation and settings) to improve the production (for example tweaking the thresholds or recognizing a faulty sensor).

The second technology that is developing fast in indoor farming is AI: the IoT and threshold control is very susceptible to sensor failure and miscalibration, so an AI could help identifying and solve this problems without the intervention of a human operator. Another use for AI is to improve the growth process by analyzing the parameters and the results (as already stated before in conjunction with IoT). Finally, AI is also used as a recognition tool: instance of using it to detect the growth stage of a plant, the quality of it, and even its the health condition (for example by detecting mold or fungi) are present in literature. These type of solution are rarely used in a commercial setting but it seems that the innovation goes in this direction.

It is known that robots are used more and more in traditional agriculture and so they have been applied also to vertical farming: however they are mostly used as ‘mobile sensors’ (for example a drone that has a routine of checking the condition of each pod or a rail mounted one with a recognition camera) and don’t handle the crops as much as in traditional agriculture (so seeding and picking). This is due to the high cost of them compared to the yield of an indoor farm, the fragility of the cultivated plants (the preferred types of crops for indoor farming are leafy greens), and the more restricted space available in these settings. However examples of these kind of solutions are vastly present in literature.

Lastly other much less prevalent technologies are present, for example the development of a digital twins of the farm to improve production, and nanotechnology (microsensors) to improve data acquisition or to improve the distribution of nutrients; however researches that include these topics are much rarer.