

# Remote Monitoring and Management of In-vessel Composting

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## Abstract

Home and community composting, which are essential components of every bio-waste management strategy, are gradually succeeded by in-vessel composting which allows a more efficient and hustle-free process, especially in the urban environment. Following this development, several Information Communication Technology (ICT) applications came to fill the gap of remote monitoring and management of in-vessel composters to further automate the process and render composting units truly autonomous (Autonomous Composting Units - ACUs). Previous work (Nikoloudakis et al., 2016; Nikoloudakis et al., 2018) emphasized on the cloud-side of such Internet of Things (IoT) applications, presenting the organization and data management strategy for the remote control of the composting process. Here we focus on ACU-side, proposing a framework that can allow faster deployment of multiple ACUs into a cloud IoT application with little effort. Our approach recognizes that heavy industrial automation units as ACUs are mostly controlled using typical industrial grade PLCs and private communication protocols instead of using popular IoT microcontrollers and open-source technologies. Hence, with our work we attempt to integrate such close-source technologies into the world of Industrial IoT, warping them into an open-source envelope. To this end, bridging of the two worlds is accomplished using an ad-hoc Machine-to-Machine (M2M) protocol. The flow of the control data is based on the bidirectional communication of the industrial PLCs with the open-source environment using the SNAP7 Protocol (SNAP7). This M2M communication is developed over Ethernet networks following the Client-Server paradigm, thus also isolating and securing the industrial system from the Internet world. Open-source technologies like Node.js, MQTT, Grafana, and Influx DB are also used in our development to accomplish a fully monitored environment and a seamless integration of the industrial world with IoT. Taking into consideration the potential of non-accessible ACUs, message transmission takes place via mobile links. To this end, a 4G router using an IoT Sim Card is installed in the ACU's electronics enclosure as well. The system was

implemented in the ACUs developed during the Project “ACU - Autonomous Composting Units” on a composter with capacity 3 m<sup>3</sup>. Preliminary results show the efficiency of our approach. The great advantage of this configuration is the bidirectional communication with ACUs that allows the end user to monitor and control all the Inputs/Outputs of PLCs from a friendly UI. All sensors and actuators connected to the ACU can be monitored and controlled via the developed responsive web application, while historical data are stored in the data base and are visualized through analytical reports.

**Keywords:** IoT, Autonomous Composting Units, SNAP7, PLC, Machine-to-Machine, Node.js

### **References**

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