Indoor Farming's Profitability Can be Improved with Wireless Sensing & Control Kit

Concerns about global population growth, sustainability, and ecologically friendly farming are encouraging growers to adopt innovative technologies to improve overall efficiency. One of the more exciting of these innovations builds upon the Internet of Things (IoT) to enable remote, wireless, real-time sensing, monitoring, and control of indoor farming operations and conditions such as LED lighting, temperature, soil pH and moisture levels, and humidity.

However, these are complex functions and end users often struggle to combine sensors, actuators, wireless communications, LED lighting and control and mobile applications to gather the right data, analyze it quickly, generate the appropriate response, and *act upon it*. Even those who are technologically proficient to implement a system find that existing product offerings make it challenging to deploy a scalable, low-power, reliable system, cost effectively and securely.

This article will describe a one-stop, end-to-end solution to these problems in the form of the Grow House Evaluation Kit. Developed by Arrow Electronics in combination with Analog Devices, the starter kit combines best-of-the-best technologies, including signal conditioning, converter and power management technology from Analog Devices, as well as wireless connectivity, pH and moisture sensors, LED lighting and dimming control as a sample actuator, and remote accessibility through a cloud-based dashboard.

Necessity driving innovation

The current global population was estimated to be just over 7.36 billion in 2016.[1] While the actual *rate* of global population growth is slowing[2], the absolute number continues to rise dramatically, reaching 11.2 billion by 2100 (Figure 1). This creates a food and potable water security problem that can be addressed through innovative application of technology. One area in which technology can bring about clear benefits is in farming, agriculture, and indoor agriculture in particular.

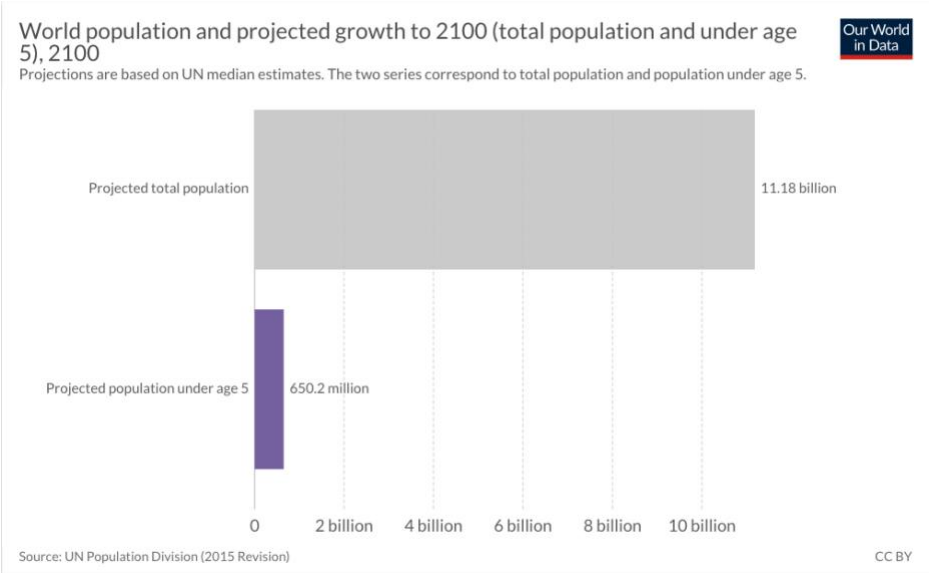

Figure 1: With global population expanding rapidly, technological advancements can help ensure ample food supply, if applied correctly. (Image source: Our World in Data)

Indoor agriculture as a market is expanding rapidly. Valued at $18 billion in 2017, the market is expected to grow globally at a CAGR of 5.95% to reach $34 billion by the end of 2028.[3] The needs of this application include

productivity per square foot of indoor agriculture space, as well as overall energy efficiency and cost reduction. Such requirements are custom made for the application of core technologies such as environmental sensors, soil moisture and pH level monitors, innovations in LED wavelengths and dimming for optimal growth. More recently, wireless connectivity and IoT has allowed savvy growers to put the components in place to allow remote monitoring of their operation using cloud-based dashboards.

While individual growers are capable of developing systems to effectively address the needs of this application, often the developers of these custom solutions are unaware of the nuances and importance of low-power techniques, proper sensor calibration, signal conditioning, and accurate conversion and acquisition.

Often based on older technologies and off-the-shelf enclosures, the solutions tend not to scale cost effectively, are not sufficiently well-designed for electronically “hostile” environments, and can’t adopt the latest cloud connectivity, security, and data analysis techniques. These techniques allow analytics and actionable intelligence to be presented in real time on mobile devices and dashboards, anywhere.

Even in instances where such features and capabilities are available, implementers are often not aware of how to act upon the intelligence using appropriately connected actuators and precisely-controlled dimmable LED lighting.

Looking forward, it’s becoming increasingly clear that the right hardware, software and know-how required for accurate, reliable, scalable solutions are becoming fundamental elements of cloud- and edge-based artificial intelligence (AI) techniques that allow a system to learn, adapt, and improve processes continually over time.

Single kit forms scalable indoor agriculture manager

To help growers and horticultural solutions providers address current and future requirements for a digital transformation, Arrow Electronics worked Analog Devices and with other strategic technology partners to develop the Grow House evaluation kit (Figure 2). The kit comprises four key enabling technologies, starting with system power and sensor signal conditioning and analog-to-digital (ADC) conversion technology from Analog Devices.

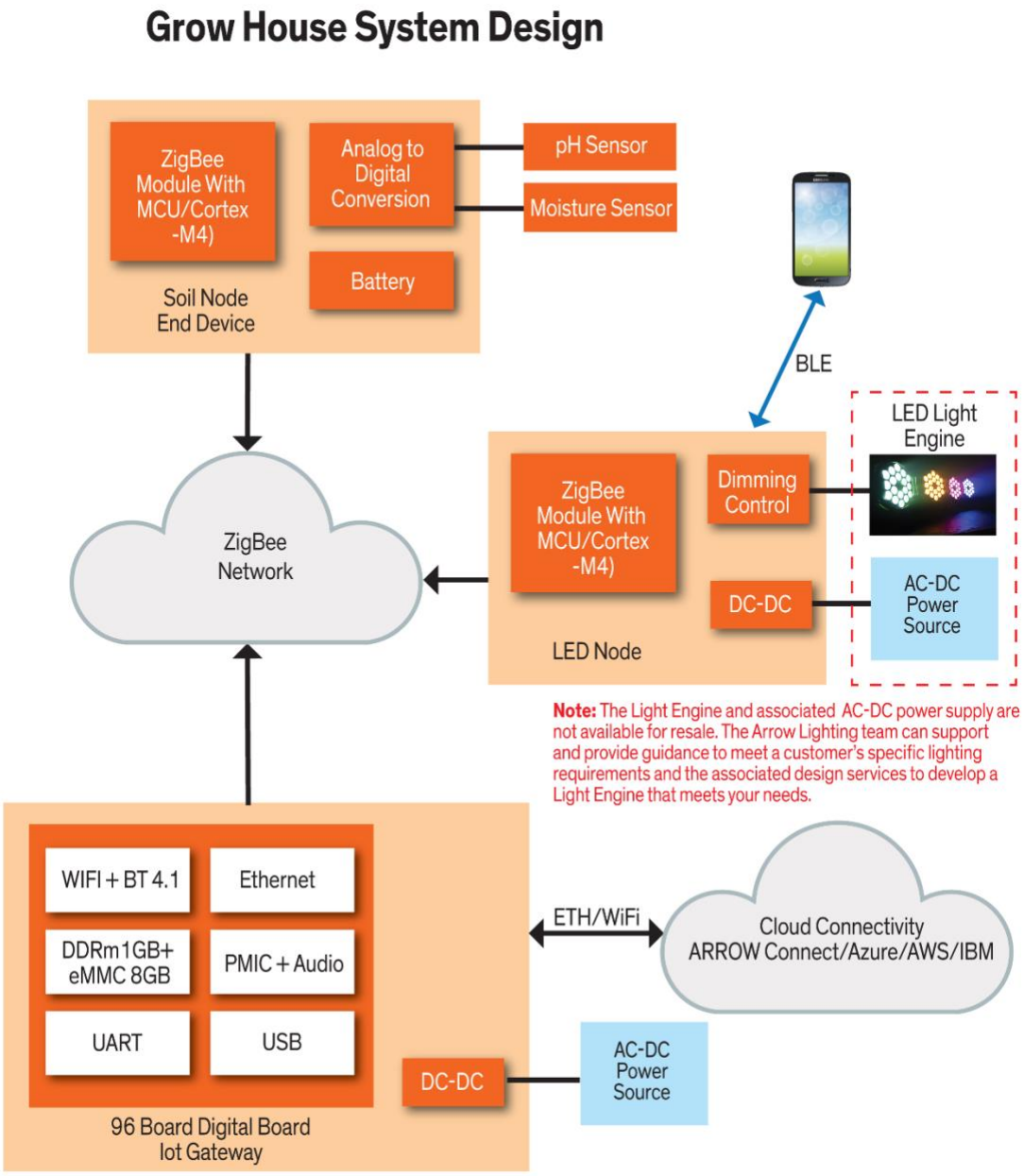

Figure 2: The Grow House evaluation kit provides an end-to-end scalable, reliable, future-proof solution for wirelessly enabled sensing, remote monitoring and active control of indoor farming and horticultural systems. (Image source: Arrow Electronics)

For any high-reliability system in a sustainability-conscious environment, stable power management with minimal noise and maximum efficiency is critical. To that end, the evaluation kit relies upon Analog Devices Power by Linear technology. This technology extends from the gateway (Figure 1, bottom left) all the way to the sensing node, in this case connected to a pH and moisture sensor. At the node, battery power management circuits ensure maximum battery life for lowered maintenance costs and maximum reliability.

Between the sensors and the ADC is a low-noise, high-resolution signal-conditioning chain that detects and amplifies the signal and is optimized for maximum sensitivity to the sensors' changes. The ADC accurately captures and digitizes the amplified signal and passes it to the local microprocessor.

For many DIY growers, farmers and even professional system developers and installers, wireless connectivity can be a major stumbling block. RF layout and antenna placement can greatly affect performance, and poor placement of the sensor node with respect to the gateway can further degrade or even prevent communication entirely. In addition, the wrong operating band can result in the radio causing and being susceptible to interference. What's more, range and poor design can push the RF power and EMI emissions beyond regional regulatory limits, such as those set by the Federal Communications Commission in the United States.

On top of RF requirements, for a system to be scalable, it needs to be interoperable with multiple sensor nodes from various providers. To ensure a solid, reliable connection the Grow House kit uses pre-certified radio modules from Silicon Labs on top of which it is running both ZigBee and Bluetooth protocols for both performance as well as maximum interoperability across wireless sensor vendors.

Each node wirelessly connects back to the gateway which can connect to the main network via Ethernet. From there, data can be sent to the cloud for analysis and dashboard presentation using third-party cloud integration for Microsoft Azure, IBM Watson, or Amazon Web Services (AWS) (Figure 3).

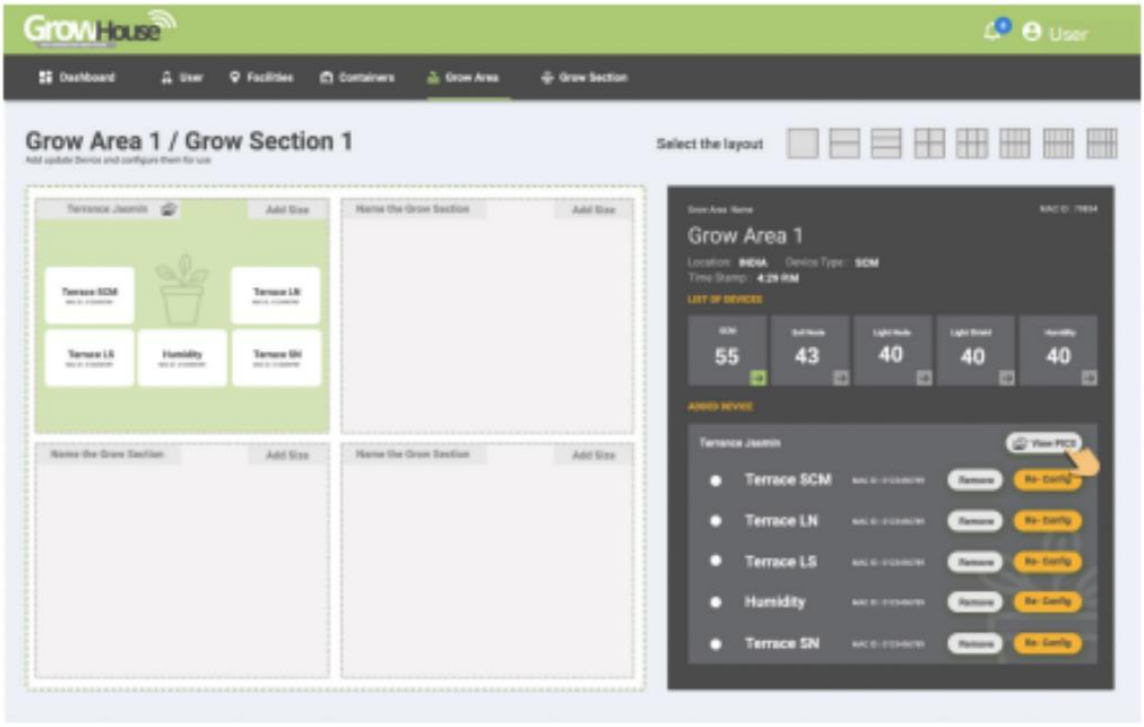

Figure 3: From the Grow House gateway, data can be sent to the cloud for analysis and remote access using a ready-made dashboard. (Image source: Arrow Electronics)

While many systems allow remote monitoring and data analysis, sometimes users are frustrated by the lack of ability to effect change based on the actionable intelligence provided. Motors, pumps, lighting, and even doors and windows may need to be turned on, closed, or adjusted remotely using appropriate actuators attached to each system.

Using the Grow House kit, growers can add Zigbee- or Bluetooth-enabled nodes to allow control of motors, pumps via digital signals to a control system or via power relays. In the case of an indoor greenhouse application, being able to intelligently control LED lighting at the right wavelength and intensity, based on the type of plant and its optimum growth cycle, plays a critical role in enabling maximum productivity and sustainability. With this in mind, Arrow/ADI partnered with OSRAM to develop a remotely accessible and controllable light engine actuator based on OSRAM's OSLON® SQUARE High-Power LEDs.

Finally, to keep the system operating over extended periods of time across environmental extremes of heat, cold, and corrosion-inducing moisture, Arrow/ADI partnered with Amphenol to develop IP67-rated connectors and a ruggedized enclosure. Key specifications for the kit are shown (Figure 4).

Specifications	
Operating Temp	0 – 50 degrees C
Power	
Gateway	12 VDC @2A
Soil Node	2x AA batteries
LED Node	12 VDC @2.5A
Sensors	
Soil	Atlas Scientific ENV-40-pH
Humidity	Meter Group DECAGON EC-5 MOISTURE with 3.5-mm stereo plug connector
Light Engine Control	
Dimmer Channels	Up to 6 channels
Dimmer Voltage	0V to 10V
Application Support	
Mobile Support - Growhouse	App for Android available
Mobile Support	Android and iOS app available. iOS version can control LED node without gateway via BLE MESH
Web Support	Dashboard through ARROW Connect
Supported Protocols	HTTPS & MQTT from Gateway to Cloud
Third Party Cloud Integration	Support through Microsoft Azure, IBM Watson and Amazon Web Services

Figure 4: Key specifications for the Grow House kit show a high operating temperature range, a wide number of Light Engine channels and wide application and cloud support. (Image source: Arrow Electronics)

Conclusion

Whether for local or global food supplies, maximum productivity at the lowest possible cost, balanced with efficient and sustainable practices are increasingly important as population growth continues. As shown by the Arrow/ADI Grow House evaluation kit, technological innovation based on strategic partnerships can provide key enabling solutions to carry farming and horticultural activities into the cloud-connected, AI era.

References:

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