blues wireless

Connecting Legacy Systems to the IoT

"Retrofitting legacy systems with a simple IoT device for thermal anomaly detection can help prevent catastrophic failure and provides significant ROI."

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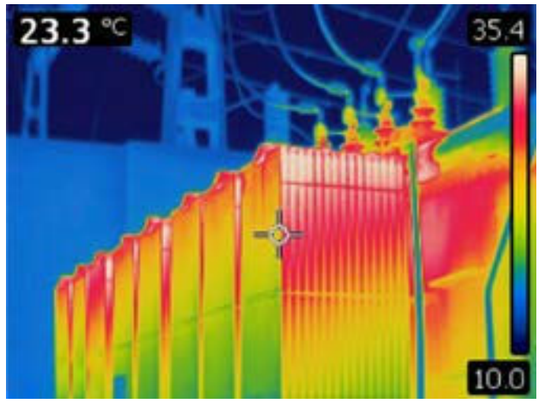
Instructions on Hackster



How do you convert older machines, equipment and appliances to smart devices? Owners of physical assets often find they want to monitor systems that were not built for digital integration. The standard digital transformation playbook often involves expensive custom upgrades or machine overhauls. Retrofitting legacy equipment with digital sensors is an affordable way to collect data and report on key conditions.

When building IoT device PoCs or prototypes, it's best to use a Blues Wireless Notecard System on a Module because it's the quickest and most affordable way to add connectivity. Did you know with Blues Wireless you can go from unboxing the product to sending arbitrary data over the global cellular network in less than 30 minutes?

Creating IoT Analog Devices

Legacy equipment often represents significant capital expenditures, years of planning, and investments in operational systems and training. The investment is made with the knowledge that equipment will last many years and will be depreciated over time. Some equipment may also be closed for modification due to OEM intellectual property agreements or conditions necessary to maintain warranty status.

Modern techniques emerged to facilitate the remote monitoring of analog devices without requiring expensive modifications. By adding external sensors, equipment owners can gain key insights while maintaining budgets and production.

IoT analog devices are created with some or all of the following hardware categories:

- **Sensors:** Low-cost IoT sensors that collect environmental data and can be quickly deployed in industrial settings.
- **Cameras:** Small, high-res cameras combined with machine learning and image classification can read analog gauges and capture remote equipment status by detecting anomalies (observationally, or thermally - as covered in this use case).
- **Embedded Technology:** When it comes to connectivity, cellular offers the most flexibility for pumping sensor and camera data to the cloud, and helps you avoid the expense and complexity of IT-managed Wi-Fi networks.

Nearly any piece of legacy equipment can be retrofitted for the IoT with the following system(s):

- **IoT Devices:** Connected devices near or attached to equipment that collect desired environmental data via sensors and/or cameras and pump that data to the cloud.
- **Edge Gateways:** Low-cost LoRa-based edge gateways enable multiple devices to pump data to your cloud through a single hub.

Learn how to build an IoT analog device that detects and reports on thermal anomalies for just over $100 using only 3 hardware components.

Anomaly Detection with Machine Learning

Follow this project to build a device that collects cellular and location data from the Raspberry Pi Pico and Blues Wireless Notecard and maps the data using Python and Google Cloud Platform. With built-in sensors and embedded SIM, the Notecard is the quickest and easiest way to add GPS and cellular connectivity to any device. You can find the complete project assembly instructions on Hackster and the full source code on GitHub.

- **Safety and Compliance**: Maintain and validate proper safety and compliance conditions for worker safety.
- **Predictive Maintenance:** Prevent downtime by ensuring key systems are functioning in the correct range and getting an early warning if a system is malfunctioning.
- **System Efficiency:** Monitor the frequency and usage of systems to adjust resource consumption, improve sustainability, and reduce costs.

Building a Thermal Anomaly Detection and Monitoring Device

Follow this project if you are looking to create a IoT device prototype that can pump thermal data to the cloud and provide monitoring and alerting to anomalous system behavior. The IoT device

uses a thermal camera module to observe analog equipment. A custom machine learning model is created to train the device to recognize normal thermal data from the system and pump that data to a cloud service using the Blues Wireless cellular Notecard System on a Module.

The Notecard is the quickest and easiest way to add cellular connectivity to this device, and it comes with 500 MB of data usable over 10 years. You can find the complete project assembly instructions on Hackster and the full source code on GitHub.

Hackster: https://www.hackster.io/rob-lauer/thermal-image-anomaly-detection-with-tinyml-36831c

GitHub: https://github.com/rdlauer/pizero-thermal

Cost: $117 Lines Of Code: 35 Project Time: 3 Hours	Languages: • Python

Hardware

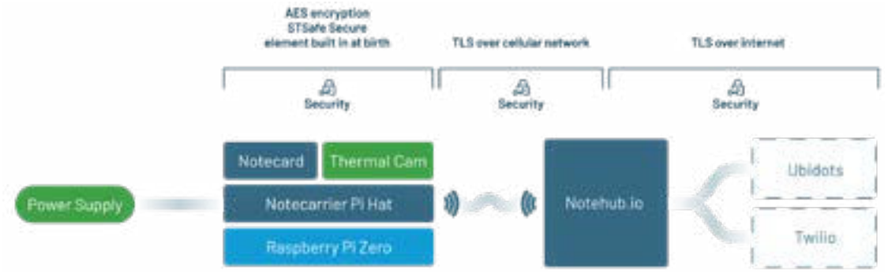
- Raspberry Pi Pico
- Blues Wireless Raspberry Pi Starter Kit
- Pimoroni MLX90640 Thermal Camera Breakout

Software apps and online services

- Blues Wireless Notehub.io
- Edge Impulse Studio
- Ubidots
- Twilio SMS Messaging API

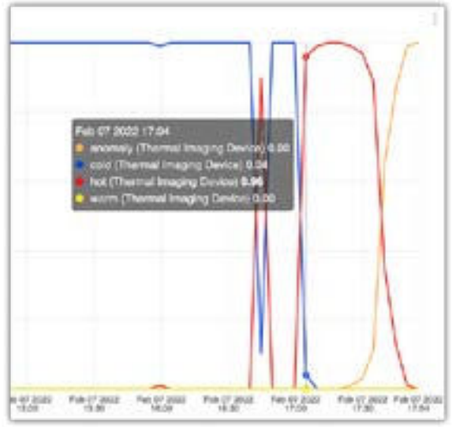
The main parts of the project are:

- Assemble the hardware for a thermal detection edge device.
- Build, tune, and deploy an image classification model that detects and interprets the various thermal signatures.
- Send results to the cloud.
- Create a route to receive text message alerts when readings fall out of normal range. (Optional)



Using Cellular at the Edge to Send Inferencing Results

Usually, machine learning models generate inferences based on known data. In this case, you'll be training the model to create an inference about unknown data – the anomalous behavior. Edge Impulse is recommended to streamline the machine learning portion of your build. Their tools help you go from training data to an optimized model in just a few hours.



Using Blues Wireless, you can send your inferencing model results to any cloud app without streaming across bandwidth-hogging, privacy-skirting image data. Blues Wireless provides edge-to-cloud IoT infrastructure, with hardware, firmware, and cloud communication components, and can be embedded into any device:

- **Notecard**: A tiny 30mm x 35mm System on a Module (SoM), the Notecard is a cellular and GPS-enabled device-to-cloud secure data-pump that comes with 500 MB of data and 10 years of cellular for $49.
- **Notecarrier**: To make integration in an existing project easier, Blues Wireless provides host boards called Notecarriers. For this project, use the Notecarrier Pi HAT and put it between the PiJuice Hat and Raspberry Pi.
- **Notehub.io**: On the cloud side, the Notecard ships preconfigured to communicate with Notehub, which enables secure data flow from device-to-cloud. Notecards are assigned to a project in Notehub. Notehub can then route data from these projects to your cloud of choice or integrate with third-party services like Twilio.

Blues provides a Python SDK and it can be installed with a single PIP command. Then, to add the Notecard to an existing Python app running an Edge Impulse model, you'll do the following:

1. Initialize the Notecard and configure it for communication with the Notehub.io cloud service.
2. Send an event (called a "Note") with the result of each inference run from the model.

3. And finally, if the result indicates that the readings are out of range, send a second alert event that will be picked up by Notehub and forwarded to Twilio.
4. The final steps will be getting thermal detection data securely pumped to your cloud with Notehub and custom text message alerts routed through Notehub and Twilio.

Applications of This Project

While there are increasing options for purchasing connected equipment or opening systems to embed smart technology, often the best approach is to build a device that can monitor legacy equipment without modifications. This is especially important for systems that are prohibitively expensive or impossible to modify.

The primary purpose of thermal cameras is the measurement of temperature and differential temperature to maintain safe operations. Temperature changes indicate dynamic equipment states while unexpected temperature readings usually indicate a problem requiring intervention. Unlike humans, thermal cameras are available 24/7 and don't mind staying in the same place monitoring the exact same thing day in and day out.

Two primary results of utilizing thermal cameras include reducing downtime and increasing energy efficiency. Common use cases for industrial thermal monitoring range from electrical, mechanical and HVAC condition monitoring and can expand to include a variety of commercial settings. There are many use cases for this type of device, including:

- Monitor HVAC systemsSupply chain analytics
- Detect equipment malfunction
- Indicate unsafe worker conditions or provide data to prove compliance Smart city counters (pedestrian, vehicle, etc.)
- Oil field support
- Cold chain monitoring
- Predictive maintenance and preventive maintenance
- Back-up generators monitoring
- OEM servitization solution

Ready to Discuss Your Project with Us?

Blues Wireless makes it easy to make connected devices. In the article above, you've seen how little effort it takes to build an initial proof-of-concept device that reports sensor data over the cellular network. In some cases, it's best to start with one of our proof-of-concept applications, then swap out sensors or cloud apps until you get what you want. In others, it would be best to take a different tact entirely.

We can help. Our team of experts will discuss your project idea with you and help you find the shortest path to a proof-of-concept device so you can get your product or device connected to your cloud.