IoT Manufacturing Demo: Optimizing CNC Toolpaths Using Fusion 360 and Forge

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Learning Objectives

• Understand the problem space
• Understand the solution space
• Build a MQTT broker
• Build a IoT Sensor Device
• Build IoT Sensor Firmware
• Understand how to easily upload models to Forge account
• Customize a Forge Viewer Sample Project

Description

In this class demo, we will walk through a simplified example of capturing real-time manufacturing data (cutting temperatures) from a hobby-class computer numerical control (CNC) router as it machines aluminum, visualizing that data on the visual model of the part being manufactured. Cutting tool and workpiece temperatures are direct indications of cutting efficiency and tool health.

Mapping temperatures can help validate and suggest adjustments to feeds, speeds, and depth of cut to achieve the nominal chip load. While this is far from an industrial solution, this demo will show the power of IoT manufacturing within a simplified context to explore the utility and promise of cloud-based manufacturing solutions, built with Forge.
About the speaker

Nathan Skalsky
I’m a senior product manager for Autodesk Forge and a ‘maker-of-things’ at heart. I enjoy enabling workflows and capabilities that enable more efficient expression of human creativity through automation and simplification.

I started my career at IBM designing small parts of big systems, a software development manager for Fusion 360, a couple startups, and happy to be back at Autodesk as a Forge product manager!

About the speaker

Varun Patil
I’m full stack developer, working in Autodesk for more than two and half years as part of Forge development team. I create sample projects using Forge APIs and help our customers along the way.
Deploy the Database
Building a Simple MQTT Broker (+MongoDB Bridge)

- **Libraries Used:** mongodb, mosca (MQTT)
- **Description:** Listens to port 1888, receives MQTT messages, inserts them into the results database using a simple sensor schema

```javascript
// Client Init

var client = mqtt.Client({
    host: 'localhost',
    port: 1883,
    keepalive: 60
});

client.on('connect', function () {
    console.log('Connected to MQTT broker!');
});

client.on('message', function (topic, message) {
    console.log('Received message on topic: ' + topic + ', message: ' + message.toString());
});

client.subscribe('#', function (err) {
    if (err) {
        console.log('Error subscribing to topic: ' + err); return;
    }

    console.log('Subscribed to topic #');

    client.unsubscribe('#', function (err) {
        if (err) {
            console.log('Error unsubscribing from topic: ' + err); return;
        }

        console.log('Unsubscribed from topic #');
    });
});

client.connect();
```

Testing a Simple MQTT Broker

- **Libraries Used:** mongodb, mosca (MQTT)
- **Description:**
  - MQTTPublish.js – Will send MQTT messages when the user passes in Topic/subtopic string and the sensor value
  - MQTTSubscribe.js – Will subscribe to receive MQTT messages using the specified topic/subtopic string.
Build the IoT Device

Building IoT device

- See class video and handout for details

- BOM:
  - ESP8266 NodeMCU ESP-12E
  - DS18B20 Digital Thermometer
  - 4.7k Resister

- Connections:
  - Temp Sensor.VCC = Vin on ESP board
  - Temp Sensor.GND = GND on ESP Board
  - Temp Sensor.Data = GPIO 5
  - 4.7k resister connected to GPIO 5 and Vin
Build the IoT Firmware

- See class video and handout for details
- Nathan’s Four Essential IoT Device Features
  1. WiFi client to connect to access point
  2. Ability to act as WiFi access point to receive WiFi credentials from user
  3. Feature to allow user to reset controller to an unconfigured state (double reset)
  4. MQTT Client to publish and subscribe to MQTT events
Unit test the MQTT to Database Connection

Unit testing MQTT to database

- See class video and handout for details
Upload a Fusion 360 model to Forge developer account

Upload Fusion 360 model to Forge

- See class video and handout for details
- Upload model to models.autodesk.io using forge API credentials
Configure and Extend the Forge Viewer to represent our CNC data

Build the visualization web experience

• See class video and handout for details
We Discussed

- Deploy database
- Build the MQTT broker
- Build the IoT sensor
- Build the IoT firmware
- Test MQTT → Database
- Translate our Fusion 360 model
- Build Forge visualization service
- Put it all Together
- Wrap things up

Digital Resource and Links

- Download this Sample Project > https://github.com/Autodesk-Forge/forge-iot-cnc
- Forge API Documentation > https://forge.autodesk.com/developer/documentation
- MongoDB Atlas > https://docs.atlas.mongodb.com/
- MQTT > https://mqtt.org/mqtt-specification/