

Live IOT machine data using Augmented reality

SESAP ZG628T PROJECT WORK

By

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2017SP93044

Dissertation work carried out at
SAP Labs, Bangalore



BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE
Pilani (Rajasthan) INDIA
(June 2019)

SE SAP ZG629T DISSERTATION

Live IOT machine data using Augmented reality

Submitted in partial fulfillment of the requirements of the

M. Tech. Software Engineering Degree Programme

By

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2017SP93044

Under the supervision of

Sumeet Raj (Senior Developer)

Dissertation work carried out at

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BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE

PILANI (RAJASTHAN)

(June 2019)

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

CERTIFICATE

This is to certify that the Project Work entitled Live IOT machine data using Augmented reality submitted by Aravind Prabhu ID No. 2017SP93044 in partial fulfillment of the requirements of SEWI ZC423T Project Work, embodies the work done by him under my supervision.

Date:_____

Signature of the Supervisor
Name
Designation

Acknowledgement

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

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SESAP ZG629T DISSERTATION

Dissertation Title: Live IOT machine data using Augmented reality

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Abstract

The main objective of the project is to make peoples life easier and to improve the business process. With the help of augmented reality now we can see the live data of a machine and know its state. So, this will help in maintenance of the machineries and to speed up the business process. There will be 8.4 billion connected things in 2017, setting the stage for 20.4 billion Internet of Things (IoT) devices to be deployed by 2020, according to analyst firm Gartner. So, with IOT and Augmented reality together we can get the information about the device/machine in front of you with ease and it will help in improving the efficiency of the business process .Smart engineering processes can save manufacturers millions of dollars by identifying potential flaws in products before they ship, in addition to reducing the time to ship a product. As the data in the world is exploding drastically, now data has become power. Also, the way we can access data also has changed over time. Now everyone has so much computation power in their hand that everything they need is available at a single click.

But even then, to get some information we must search online and surf through lots of webpages just for a simple task in like getting price of an item. In business domain also, we must go to a monitoring dashboard and do many clicks to know the to get current state of machine which is in front of you. So, this is an overhead which can be avoided and can be improved to make life easier.

(Signature of Supervisor)

(Signature of Student)

Problem Statement

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But even then, to get some information we must search online and surf through lots of webpages just for a simple task in like getting price of an item. In business domain also, we must go to a monitoring dashboard and do many clicks to know the to get current state of machine which is in front of you. So, this is an overhead which can be avoided and can be improved to make life easier.

Business Process Flow

The business flow would have the following:

- The IOT machine data will be streamed to the IOT service .
- The Machine floor manager can walk up to the machine and get the live data in the web interface .
- The Augmented reality is also integrated in the web interface.
- Using the Augmented reality web interface, the Machine floor manager can open the web application in his hand-held device and can see the status of the machine.

Objectives

The main objective of the project is to make peoples life easier and to improve the business process. With the help of augmented reality now we can see the live data of a machine and know its state. So, this will help in maintenance of the machineries and to speed up the business process. There will be 8.4 billion connected things in 2017, setting the stage for 20.4 billion Internet of Things (IoT) devices to be deployed by 2020, according to analyst firm Gartner. So, with IOT and Augmented reality together we can get the information about the device/machine in front of you with ease and it will help in improving the efficiency of the business process .Smart engineering processes can save manufacturers millions of dollars by identifying potential flaws in products before they ship, in addition to reducing the time to ship a product.

Uniqueness of the project

There are solutions focused on IOT or Augmented reality but their adoption in industry is very less. There are some solutions offered by companies like ptc and L2 Technology Services, but they are focused on the process of fixing/repairing of the equipment and not on the machine details at current time. The idea in this project is to make an AR solution which can integrate to any type of IOT device.

Benefits to the organization

SAP is leading in terms of adapting unique and upcoming technology solutions to help the world run better. There is currently no solution combining both IOT and the Augmented reality. Also, this coincides with SAP's vision that is, to help world run better and improve people's life.

Scope of Work

The Augmented reality will be an Android app which will communicate with this Gateway service that will be deployed on Cloud foundry to get the data. Also, Hardware sensors will be used to send data to gateway. So main scope of this project is the Augmented reality application showing the IOT data .The IOT sensor and the gateway services that will be built will help in showing the end to end scenario of the application.

Resources Needed

Software (Frameworks, Cloud platform)	<ol style="list-style-type: none">1. AR.js framework.2. Spring boot.3. Cloud Foundry Account.
Hardware	<ol style="list-style-type: none">1. Any Windows PC2. Node MCU3. Temperature Sensor4. Humidity Sensor

Potential Challenges and Risks

1. We are going to deploy our IOT Gateway service to in cloud platform, so there might be an issue in terms of data access when the cloud is down.
2. Making the android app efficient to get the real time data.
3. Choosing current AR framework to work with android.
4. Potential challenges in managing IOT sensor data.
5. Time required to learn and adopt the Augment reality framework.

Solution Architecture

Architecture diagram of the application:

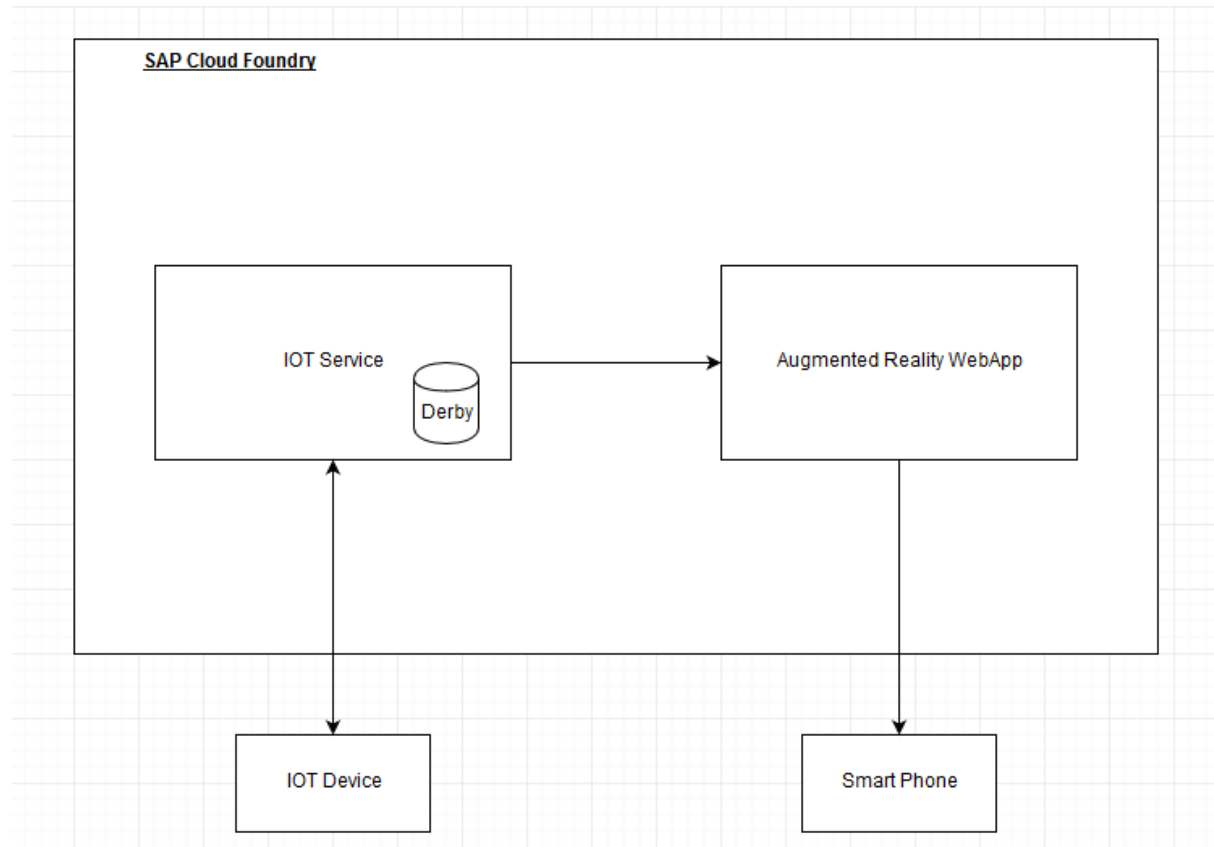


Fig 1 :Solution Architecture

This Architecture has two main components:

- IOT Service
- Augmented Reality Service/ Web App

IOT Service

This service is where the IOT devices push data and the IOT service provides the device management and the persistent of the Realtime data. This data is used to create analytics and create alerts for the device. This is the core service which is the OT(Operational Technology) part of the IOT. In fact, it's one of the essences of the IoT (although IT and OT convergence goes back earlier, certainly in some of the just mentioned areas). Yet, with IoT is happening faster and at a broader scale than before and Gartner's words become more actual than ever. In case you're not familiar with the – by now – 'good old' IT versus OT debate: IT is what you think it is. Information technology

or the corporate IT team, led by a CIO. OT is operational technology as we'll see but it's in the mix of both that interesting things happen. Of the previously mentioned markets IT and OT integration is, for instance, key in building management in the age of IoT.

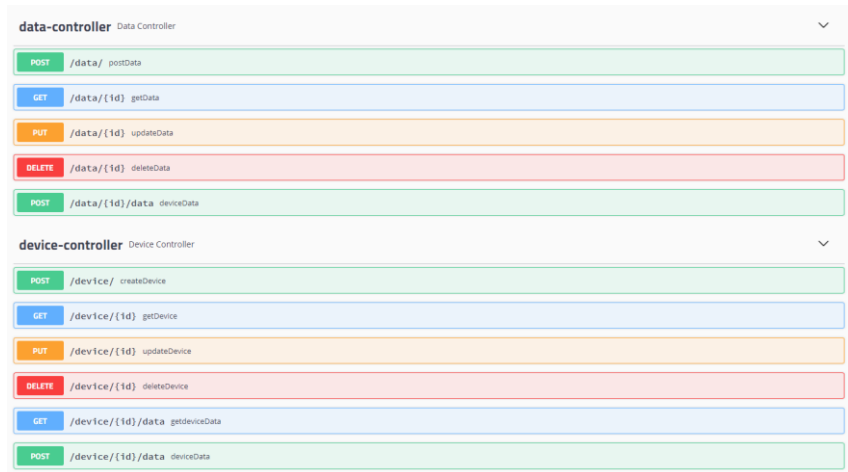


Fig 2 :IOT Service API Endpoint

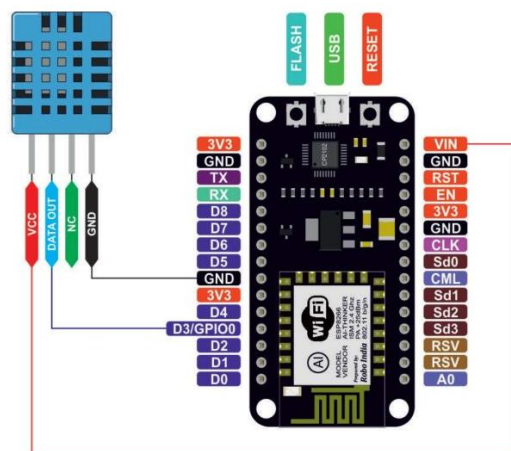


Fig 3 : Circuit Connection

DHT11:

The DHT11 is chosen because it is lab calibrated, accurate and stable and its signal output is digital. Most important of all, it is relatively inexpensive for the given performance. It can measure relative humidity in percentage (20 to 90% RH) and temperature in degree Celsius in the range of 0 to 50°C. It has 4 pins; one of which is used for data communication in serial form. Pulses of different TON and TOFF are decoded as logic 1 or logic 0 or start pulse or end of frame.

Node MCU:

NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consist of ESP8266 Wi-Fi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. As the operating voltage range of ESP8266 is 3V to 3.6V, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as 80mA during RF transmissions. The output of the regulator is also broken out to one of the sides of the board and labeled as 3V3. This pin can be used to supply power to external components.

Augmented Reality WebApp

This augmented reality service is a browser-based application which does not need any application to be explicitly installed on the device. This is based on a JavaScript library AR.js which provides the augmented reality capability. AR.js is a solution for efficiently doing augmented reality on the web. This AR.js used A-frame for its rendering. A-Frame is a web framework for building virtual reality (VR) experiences. A-Frame is based on top of HTML, making it simple to get started. But A-Frame is not just a 3D scene graph or a markup language; the core is a powerful entity-component framework that provides a declarative, extensible, and composable structure to three.js. AR that can be easily experienced on today's phones and easily designed using web technology. The AR.js project is about enabling those people. So now, anybody with a modern phone can enjoy open-source AR, free of charge, cross-platform and without installation.

Augmented Reality (AR) brings digital information and virtual objects into the physical space. With AR, the digital world comes to life inside the view captured by your tablet or phone camera. This article is for those who want to dig deeper into how we can trigger the display of digital content. Read our other article on "how does AR work" if you want to know more about the technology that allows AR to come to life. There are several key questions we must ask before a user can interact with the digital world. What content do we display on the live camera view? And where exactly should we put that content within the user's view? The answer to these questions depends on which application of AR you choose, as each requires different types of user interaction. In some cases, we need to know exactly what the user is looking at, we call this "marker-based AR". In other instances, we just need to display 3D augmented reality models, which we can do without a marker, so we call it "markerless AR". Finally, in a few instances we need to provide local information, such as walking directions or road signs. In this case we need to know the user's location, so we use "location-based AR". As marker-based AR is more reliable and for that reason they are used in majority of the augmented reality scenarios. For this project I have used the marker-based AR to make the augmented reality more reliable.

Marker-based Augmented Reality:

A marker is giving the Augmented Reality (AR) application a visual clue or trigger where to position AR content. The marker can be an image, a logo or any type of distinguishable 2D object that can be recognized by the camera. Due to its use of image recognition, this type of AR is sometimes also called recognition-based AR. The quality of the image that is being used as an AR trigger is important. Quality does not necessarily refer to resolution but to how recognizable the marker is for

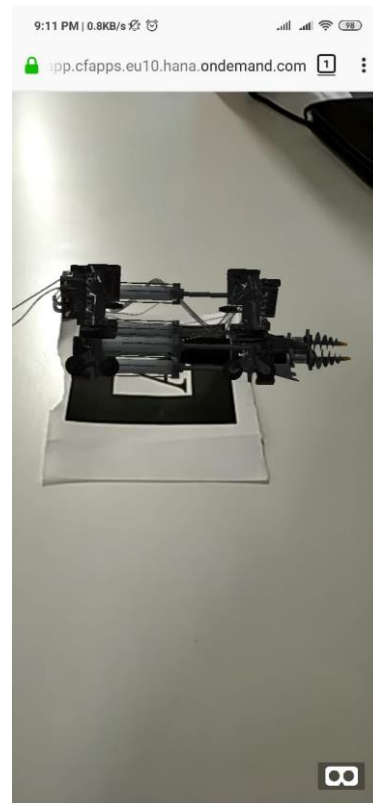
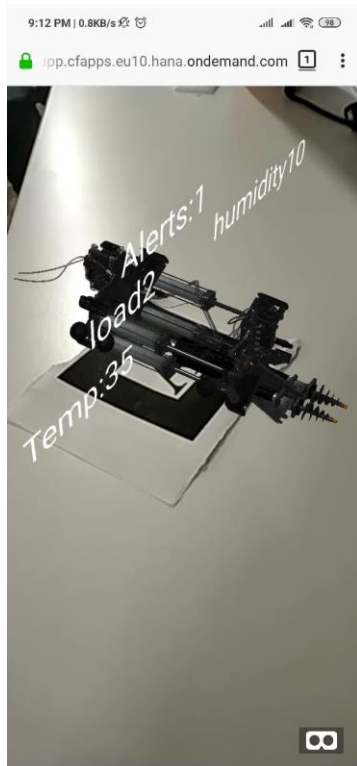
the camera and the underlying image recognition software. Important aspects are the contrast, number of lines, texture changes etc. The quality of the marker depends on the number of key points that are found when pre-processing the marker. The more visual details a marker has, the better it is going to work.



Fig 4 : A simple marker

A camera is used with AR software to detect augmented reality markers as the location for virtual objects. The result is that an image can be viewed, even live, on a screen and digital assets are placed into the scene at the location of the markers. Limitations on the types of augmented reality markers that can be used are based on the software that recognizes them. While they need to remain simple for error correction, they can include a wide range of different images. The simplest types of augmented reality markers are black and white images that consist of two-dimensional (2D) barcodes.

Screenshots



Conclusion

This aim of this project was show the integration between augmented reality and the IOT device and a seamless flow and interaction between both with the augmented reality must be rendered in the browser and doesn't need a augmented reality specific device or an application to be installed.

- The Augmented reality application is completely browser based.
- The Augmented reality application supports multiple device with its own marker to render its dat.
- The IOT device pushes the live data into the IOT service.
- The Augmented reality application displays the live data in to an browser with its device model when it identifies the marker of that device.

Directions for future work

Some enhancements need to be made to make the device model rendering into the Brower.

Also, this project can be extended into many scenarios such as:

- One Machine with multiple markers on each part so we can show only the data of that part.
- Show how-to do a task in the augmented reality service , which can be used to fix the machine parts by following the steps shown in the augmented reality service.
- Optimize and use geo-location-based marker in a smaller space instead of marker based augmented reality.

Detailed Plan of Work

#	Task Name	Expected date of completion	Deliverables
1	Validation of Augmented reality Framework	18 Feb	Testing multiple AR frameworks
2	Browser Based AR Validation	25 Feb	Browser Based AR sample test code
3	Designing the Flow	4 Mar	Design the classes and interfaces for the application
4	Documentation	11 Mar	Create initial versions of documentation
5	IOT Service Initial Setup	11 Mar	IOT Service Design
6	IOT Service Prototype Development	20 Mar	IOT Service prototype Implementation
7	Cloud Foundry Deployment of IOT Service	28 Mar	Application hosted on Cloud foundry
8	Prototype of Augmented Reality Design	30 Mar	Designing and prototyping the Augmented Reality App
9	Integration of IOT service and Augmented Reality App	1 April	Integration of IOT service and Augmented Reality service.
10	Deployment of Augmented reality to Cloud foundry	3 April	Augmented Service hosted to Cloud foundry
11	Testing the end to end sample scenario	4 April	Testing sample low level integration.
12	Enhancing the IOT service	8 April	IOT Service Enhancement.
13	Hardware Connection to IOT service	20 April	Streaming of data from hardware sensors to IOT service.
14	Testing	22 April	Perform end to end tests and bug fixes
15	Enhance the Augmented Reality application	29 April	Multiple IOT devices Marker detection
16	Multiple Sensors to Hardware	17 Jun	Testing with Multiple Sensors
17	Bug fixes	21 Jun	Fix issues during tests, continue till zero bugs found
18	Documentation	26 Jun	Update documentation for missing information (if any).

Completed Work

#	Task Name	Expected date of completion	Deliverables
1	Validation of Augmented reality Framework	18 Feb	Testing multiple AR frameworks
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Plan for Remainder of the project

#	Task Name	Expected date of completion	Deliverables
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- Cloud Foundry - <https://www.cloudfoundry.org/>
- SAP Cloud Platform - <https://cloudplatform.sap.com/index.html>

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