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Design and Implementation of Prototype System for Industrial Warehouse Using Predix (Iiot)

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Abstract

An industrial warehouse is the area of a factory, machine shop, etc. for storing and retrieval of parts/objects used in production and sales. At this juncture, the current storage and retrieval system having difficulties with respective tracking the parts/objects information and space information in real time. The part/object information is usually retrieved by pulling a manual report in backend and this information is needed every moment, and also there is no availability of space information in the current system. This paper proposing a solution to overcome the problems which are faced by the operators and officers with the current system. In this approach Raspberry Pi used as predix device for sending sensor data to predix cloud, the sensors IR, Sonar and RFID used for gathering parts and space information in real time. Next, it uses the predix services for security and storage of data and predix user interface is for showing results to the users. This system also provides single window information about warehouses present around the globe, which reduces the human effort and waiting time to getting the information about single warehouse. The benefits get multiplied for total number of warehouses across the globe which is a big boost to the industry and at higher level they take decisions quickly and easily.

Keywords: ASRS; IIoT; Predix; IR; Sonar; RFID; Raspberry pi3; Cf-cli; Industrial warehouse

Introduction

In today's world they are too many industries are available like production oriented and service oriented. Most of the production oriented companies need physical storage space for storing the raw material and produced parts. These storage spaces called as warehouses and we can also call as industrial warehouse. For every production company may have multiple branches around the globe for different parts of their product. In the current industrial warehouse most of the work was done manually, like gathering the parts information and space information, calculating and sending reports to the higher officials [1].

For that most of the human power was wasted and they did not synchronize real-time information to higher officials. Every time the crane operator is facing difficulties to track the free space in racks in that warehouse and also facing difficulties to find where the particular part in the warehouse. They also need past reports on free space for next operation. And the manager/higher officials also require the real time information about different warehouse of branches around the globe of a company [2-4].

This paper proposed a prototype system to solve the above problems faced with warehouses using predix with an IIoT solution. Predix is General Electric's software platform for the collection and analysis of data from industrial machines. General Electric plans to support the growing industrial internet of things with cloud servers and an app store. Predix as a cloud-based PaaS (Platform as a Service) is claimed to enable industrial-scale analytics for asset performance management (APM) and operations optimization by providing a standard way to connect machines, data, and people. Predix provides a micro services based delivery model with a distributed architecture [5].

Industrial Internet of Things is a part of larger concept known as Internet of Things (IoT). The IoT is network of intelligent computers, physical devices, vehicles, home appliances, and other items embedded with electronics, software's, actuators, sensors and network connectivity to enable these objects to connect and exchange of data. The collected data is sent to central Cloud-based services where it is aggregated with other data and shared with end users. The application of the IoT to the manufacturing industry is called IIoT. The IIoT will revolutionize manufacturing by enabling the acquisition and accessibility of far greater amounts of data [6].

Motivation

Storage is one of the main parts in manufacturing industry. So it is key point to manage the storage (warehouse/shop floor) space. And also automation is one of the trending topics in industries. To reduce the human work we went for automation and also we need real time information or reports regarding space and parts, so that we have chosen an IIoT solution to manage the space and parts information effectively. They are multiple platforms for developing the IIoT applications. Predix is the one of the best platform. It is a Platform as a Service for IIoT applications, it was developed by GE [7].

ASRS Model

Automated Storage and Retrieval System Model is a system, the following diagram shows the architecture of ASRS. The Raspberry pi board is for transferring the information about the part and space to the cloud. Using RFID tag we are identifying the part information that will be connected to raspberry pi. And IR and Sonar sensor are for object detection and calculating the space information of rack in the warehouse. The data taken from raspberry pi is stored in predix time series database [8]. Adding the UAA security service to the

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application provided by the predix. Using predix user interface as web application will display the results taken from time series database in neatly designed format i.e., similar to the physical structure of racks in warehouse. So that the operators and higher officials get the real time information in predix dash board in 24/7 (Figure 1).

Benefits

- Real time space information is available, so that operator/workers easily place/store the manufactured parts and raw materials.
- Real time parts information is available, so it will be easy to track where it contains.
- Real time warehouse information is available, so it will be easy to find the reports of individual warehouse.
- We get all the warehouses information across the globe in the single dashboard.
- PREDIX IIoT benefits can further be leveraged with minimal efforts.
- Easily and quickly take decisions with help of single dashboard.

Process flow of the system

- Getting the space and parts information from the racks in warehouse using the IR, Sonar, RFID sensors.
- Applying needed operations (calculations like size of warehouse, part information with added location information) on sensors data.
- Sending the data from raspberry pi to predix cloud.
- Designing the user interface using predix web app seed. And clone it cloud.
- Apply one of the security services as UAA to user interface provided by predix cloud.
- Using polymer javascript to get the predix time series data and show it in user interface.

Implementation

Interfacing IR, sonar sensors to raspberry pi board

The IR sensor have three pins named as 5V vcc, ground GND, output OUT, and Sonar sensor (HC-SR04) have four pins as vcc, ground, trig (trigger), echo. Using the raspberry pi pin architecture connect these pins. The following steps shows how we interfaced IR, Sonar sensors.

- Plug the jumper wires to the pins of IR, Sonar sensors and put it on breadboard in different series with different colours for identification like red for vcc, black for ground, green for OUT, white for echo and blue for trigger.
- Plug female black colour jumper point to the ground in raspberry pi pin 6.
- Plug two female red colour jumper points to raspberry pin 2 and pin 4.
- Plug OUT female green colour jumper point to GPIO 2 .raspberry pi pin 3.
- Plug trigger female blue colour jumper point to GPIO 23 pin 16.
- The ECHO will be "low" (0V) until the sensor is triggered when it receives the echo pulse, once a return pulse has been located ECHO is set "high" (5V) for the duration of that pulse. But raspberry pins are with 3.3v, so we are using resistors to avoid the damage to pins.
- Rail the 1 kΩ resistor from white wire in the bread board. And plug the 2 kΩ from end of first resistor and connect to ground pin series in bread board.
- Plug white male jumper wire in between two resistor and plug female jumper point to the GPIO 24 pin 18 in raspberry pi (Figure 2).

Interfacing RFID reader to raspberry pi

RFID sensor have 8 pins those are VCC, GND, BEEP, ANT, ANT, SEL, TX, D1, D0 where ANT pin was no use with our system.

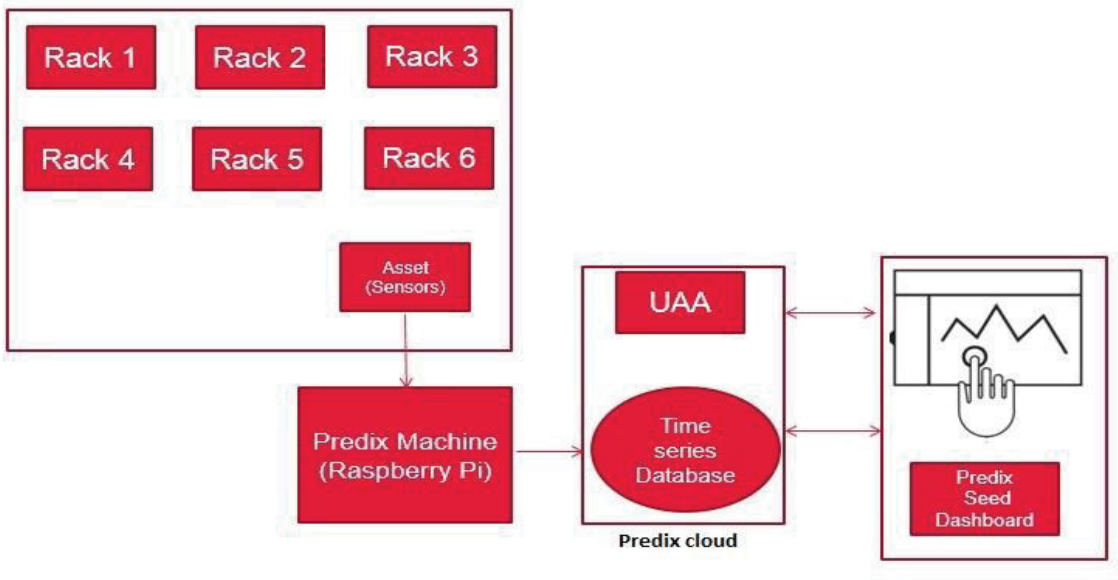

Figure 1: Architecture of ASRS model.

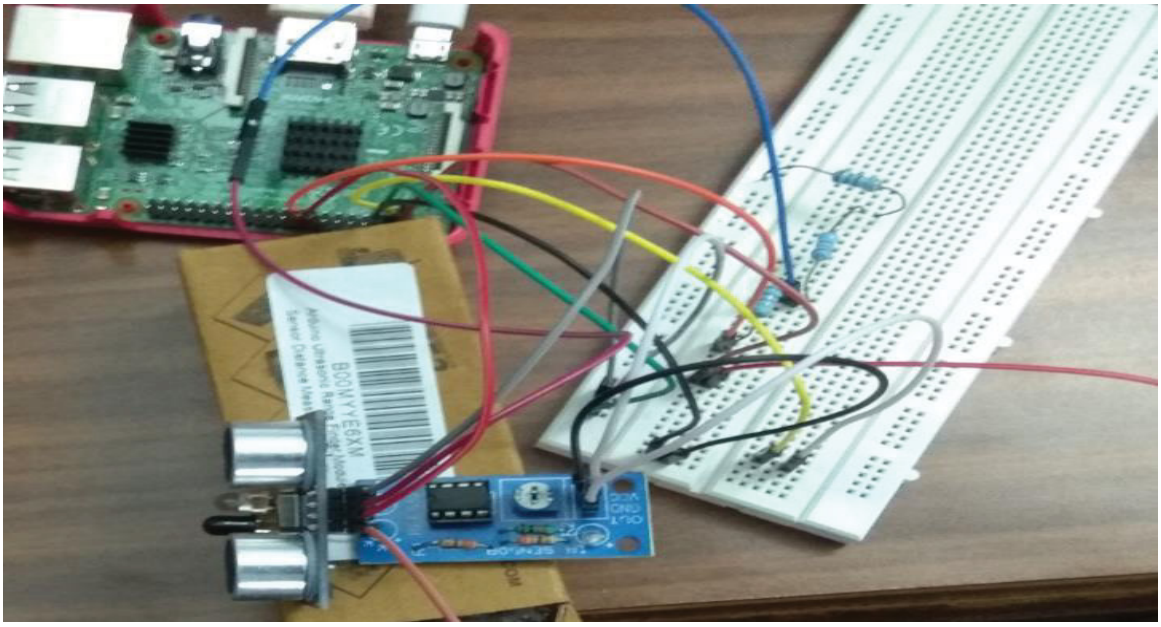

Figure 2: Interfacing sensors to raspberry pi.

- As like HC-SR04 and IR sensor connect the VCC and GND to respected pins in Raspberry pi.
- Plug Buzzer to BEEP using transistor (BC 552) and resistors (2.2 kΩ) and join the VCC to this junction for power supply to buzzer.
- Plug the TX to GPIO 15 of pin 10 in raspberry pi with help of two resistors of (4.7 kΩ and 10 kΩ).

Configure Raspberry pi to connect the predix time series database

- Configure the raspberry pi and set the proxy settings if you are behind the network firewall.
- Setups the maven build tool in Raspberry pi with settings.xml file and then after review the configuration with following steps.
- Hoover Configuration. The configuration file <PREDIX_MACHINE_HOME>/configuration/machine/com.ge.dspmicro.hoover.spillway-0.config contains the properties for configuring the spillway. The machine adapter received the data for each data node and forwards the data on to the spillway.
- Web socket River configuration. Review the<PREDIX_MACHINE_HOME>/configuration/machine/com.ge.dspmicro.websocketriver.send-0.config. The Spillway then forwards the data on to a data river; in this case it's flowing over a web socket connection to predix time series in the cloud. The Zone ID is the instance of predix time series that the quickstart script created.
- UAA configuration: Review the <PREDIX_MACHINE_HOME>/configuration/machine/com.ge.dspmicro.predixcloud.identity.config. The Web Socket River needs to get a secure token from UAA before it can send data to predix time Series.
- Note: Please make sure the values in the configuration are wrapped in double quotes like "this".

Results

Gathered sensor data from raspberry pi was stored in predix time series database. Using predix web app seed we will design the user interface as web application using polymer javascript and predix ui components and css. The following screens show the results of our system with hardcoded data. Figure 3 shows the single window representation of various warehouses present around the globe of a company. Where each warehouse may have multiple racks which are shown in numbers. The rack with red colour indicates that rack contains items whereas green colour indicates the empty rack. The progress bar shows the utilization status of respective warehouse. Figure 4 shows various racks with their free space of a warehouse and Figure 5 shows the various parts of manufactured industry, and which warehouse that part was located.

Conclusion

Storage space is essential in manufacturing industries, so it is important to utilize the warehouse effectively with reducing the human power. This paper proposed a prototype system for industrial warehouse using predix platform. The prototype system was data to predix time series database, where applied some calculations and the results will show in predix user developed using three sensors as IR, Sonar and RFID for gathering space and parts information. And these sensors are connected to raspberry pi board as predix machine to send sensor interface application. So that crane operators and higher official can take decisions quickly and easily.

Future Scope

In proposed solution we are using two sensors to gathering space information. This may increase the cost of prototype. In future instead of using two sensors IR and Sonar, we are planning to use single sensor as sonar sensor with range feasibility. So it could reduce the cost of prototype development for warehouse. And there is scope to change the proximity/range with respect to direction of object. We can also use these predix device connections as Raspberry pi and sensors to parking

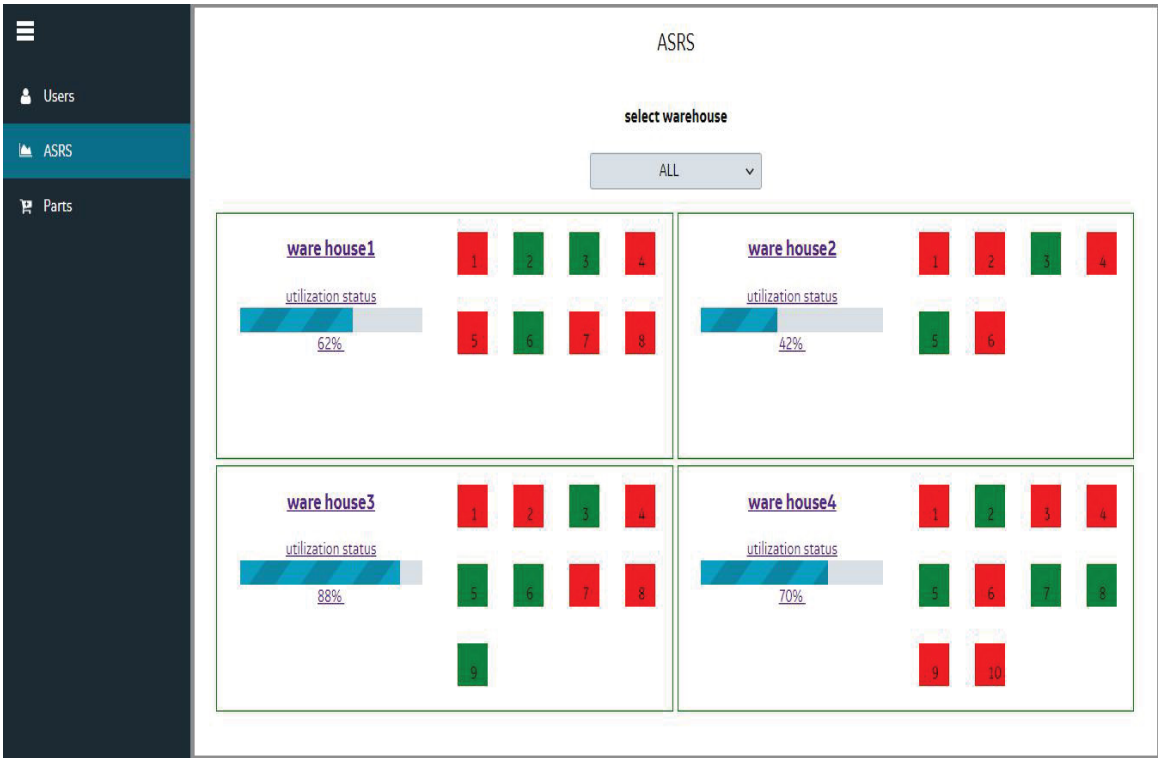

Figure 3: ASRS home page.

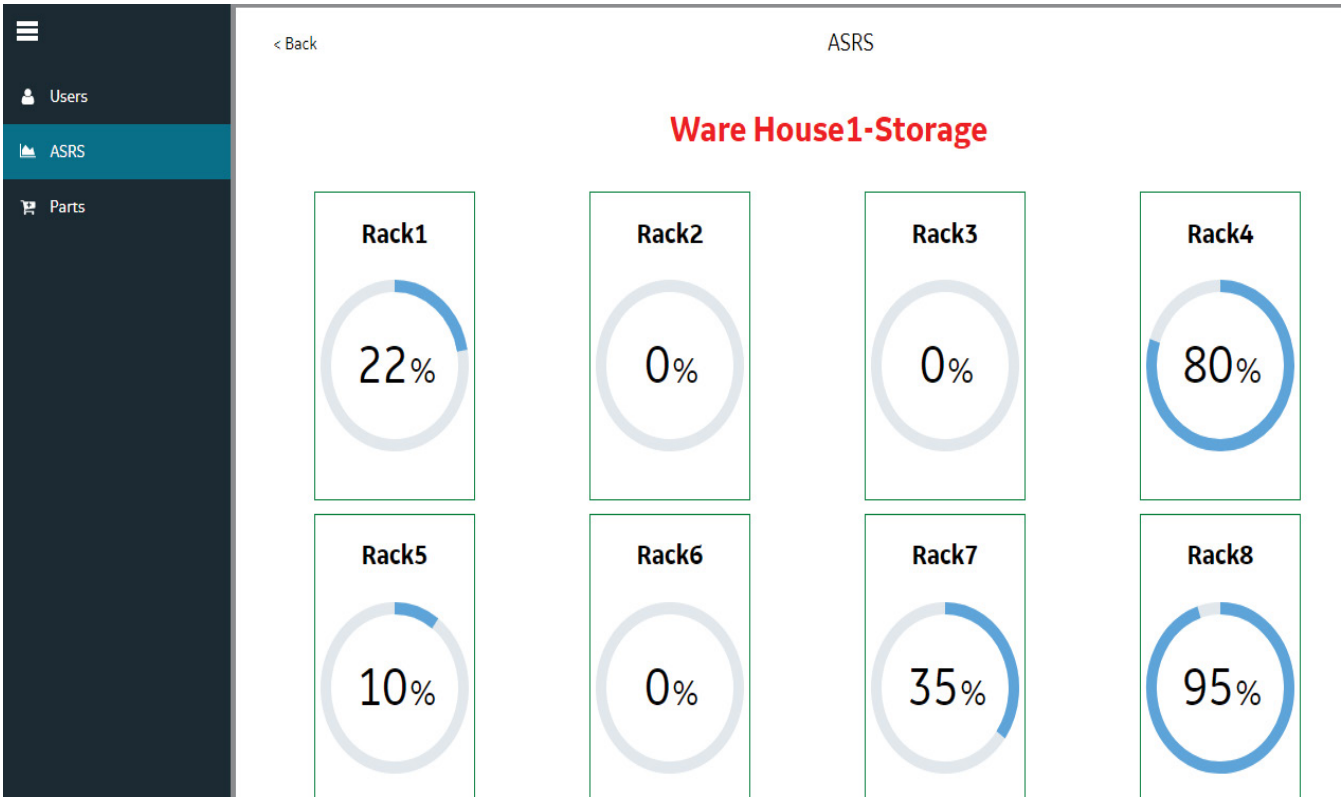

Figure 4: Various racks in warehouse.

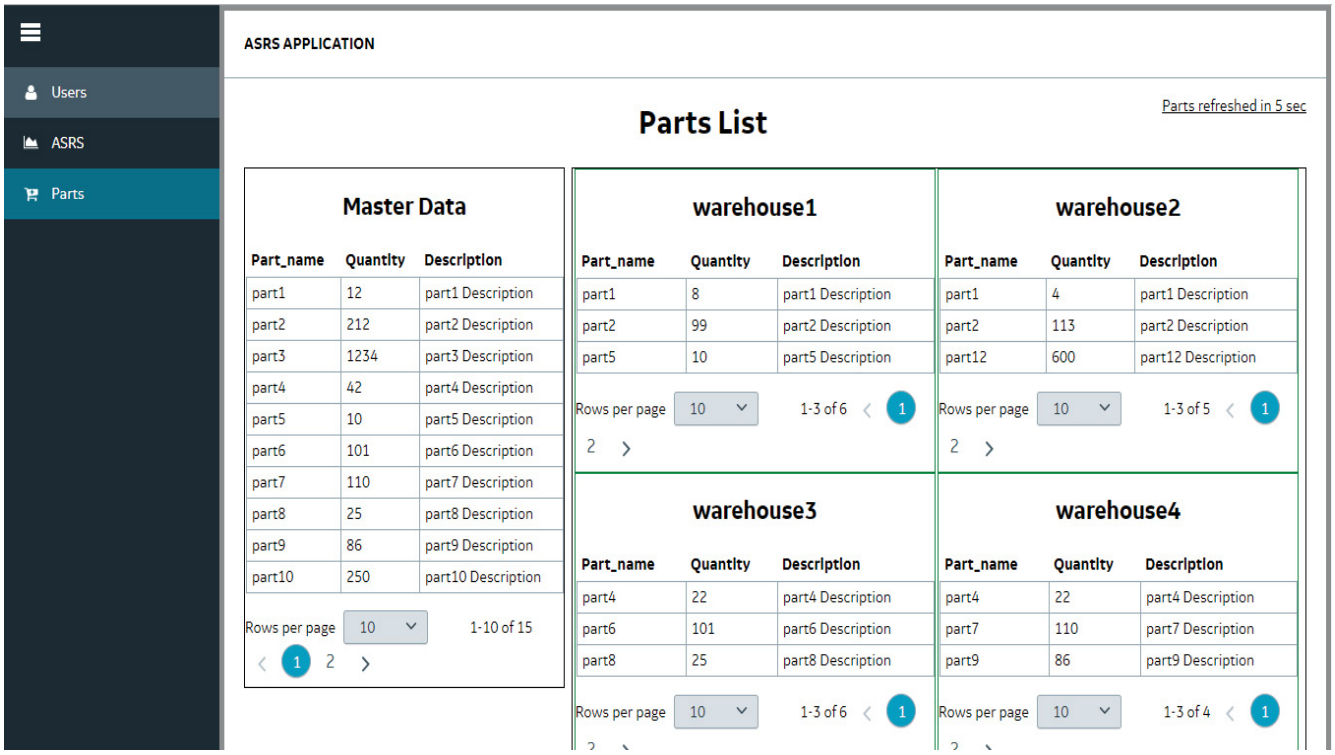

Figure 5: Parts information in various warehouses.

automation. IR sensor is used to check whether there is any vehicle in slot. And RFID tag was used to track vehicle information with respect to the time. Just change the user interface to corresponding architecture with slot allocation.

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