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AN APPLICATION STRUCTURE FOR INTEGRATING WIRELESS SENSOR AND ACTUATOR NETWORKS USING WEB OF THINGS TO CLOUD INTERFACE

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Abstract: The advances in sensor and inserted innovations have prompted quick improvements in Wireless Sensor Networks (WSNs). By and by scientists concentrate on the reconciliation of WSNs to Internet for their unavoidable accessibility to get to these system assets as the interoperable subsystems. The current processing advancements like distributed computing has made the asset sharing as a focalized framework with required administration interfaces for the mutual assets over the Internet. This paper presents application engineering for remote Sensor and Actuator Networks (WSANS) following web of things, which enables simple coordination of every hub to the Internet. The design empowers the sensors and actuator hubs got to and controlled utilizing cloud interface. The application design was executed utilizing existing web and its developing advancements. Specifically Representational State Transfer convention (REST) was reached out for the particular necessities of the application. Distributed computing condition was utilized as an advancement stage for the application to evaluate the likelihood of incorporating the WSAN hubs to Cloud administrations. The mushroom cultivate condition observing and control utilizing WSANs was taken as our exploration utilize case.

Keyword: WSAN, REST, Web of Things, ZigBee, Cloud interface, Sensor Gateway

1. Introduction

India is one of the biggest nations to deliver agrarian items. Mushroom is considered as a profitable nourishment both for its nutritious and flavor esteems. Naturally mushroom is not a plant so needs chlorophyll, in this manner needs extraordinary condition for its development [1-4]. Plants make their nourishment through photosynthesis utilizing daylight and CO2, while mushrooms depend on the substrate for their vitality and development assets. Mushrooms require an exceptional kind of development medium and condition for their ideal development. Indoor mushroom development is the regular technique for development. In this strategy mushrooms are developed in raised substrate beds normally encased with aluminum or wooden plate. The plate are set as the racks to oblige more beds in less space. The substrate shapes the development medium which contains everything for the mushroom development. Notwithstanding the substrate the development requires a good physical condition. The earth administration including substrate parameters like wetness and additionally other ecological parameters like temperature and dampness is important for the ideal development of mushroom developed in these controlled conditions[5].

The meshup of the individual hubs of the system was performed utilized on Web of Things (WOT) engineering. The Web of Things (WoT) enables us to interface physical items e.g. family unit contraptions, autos, wearings or sensor hubs to the WWW. Every element has a character spoke to by a URI and they are can be gotten to and controlled utilizing regular web programs and can be coupled to different applications. Relevance of distributed computing is expanding step by step in different figuring situations. Distributed computing has made the asset sharing as a joined framework with required administration interfaces for the common assets over the Internet. Cloud administrations enable people and associations to utilize programming and equipment that are overseen by outsiders at remote areas. The distributed computing model enables access to data and PC assets from anyplace utilizing accessible Internet association. Distributed computing gives a mutual pool of assets, including information storage room, systems, PC handling power, and concentrated corporate and client applications[9,10].

We are especially keen on web empowered WSAN hubs, which can give amassed spatiotemporal data about ecological wonders exhibit in mushroom cultivate situations. These WSAN hubs go about as detecting gadgets, taking up specific boosts and change them into helpful perceptions. Also these hubs are equipped for killing on and the relating gadgets e.g. a warming gadget will be on naturally, when temperature tumbles down to a coveted edge point. Notwithstanding warming and cooling gadgets for temperature checking, different gadgets which are controlled by the setup is Mist sprinklers for moistness control, water system framework for substrate wetness. The perceptions

gathered by the hubs are conveyed to the Sensor door by the hubs. The sensor door thus goes about as an interface between these IP less hubs to the Internet[12].

2. Related Work

The emergence of pervasive computing, the rapid growth in embedded technology and sensor networks provides new opportunities to connect real world objects to the Internet. Internet-of-Things is an umbrella keyword for covering multitude of physical objects to the Internet and the Web. Internet of things enabled us to connect the devices with embedded identity anytime from anywhere using the existing ICT methods. Internet-of-Things envisions a future in which digital and physical entities can be linked, by means of appropriate ICT technologies to enable a whole new class of applications and services [16].

Cloud computing environment provides a great flexibility and availability of computing resources at a lower cost. This emerging technology opens a new era of e-services in different disciplines [6]. Popularity of cloud computing is increasing day by day in distributed computing environment. There is a growing trend of using cloud environments for storage and data processing needs. Cloud computing provides applications, platforms and infrastructure over the internet. It is a new era of referring to access shared computing resources. On the other hand, wireless sensor networks have been seen as one of the most essential technologies for the 21st century where distributed spatially connected sensor node automatically forms a network for data transmission [19]. RESTful Web services are based on Representational State Transfer (REST) architecture. REST uses the Web as an application platform and fully leverages all the features inherent to HTTP such as browser access, scalability and caching, authentication and encryption. In projects often unified under the umbrella of "Web of Things", REST is used and adapted for real world devices (e.g., WSNs, appliances or tagged objects, etc.) in order to create a universal API for things. [20] The Web of Things concept has been proposed to integrate heterogeneous devices and provide a light-weight and easy-to-use way for application development by leveraging RESTful web services. However, Web of Things still does not address the issue of composition of physical resources, especially of how business process could be managed among different organizations to automate process of activities. On the other hand, cloud computing framework is based on web services technologies which focus on reusing and composing legacy resources to facilitate developing and managing IT systems [21-23].

3. Case study

Indoor mushroom development is a typical technique utilized nova days to develop mushrooms which require the right mix of dampness, temperature, substrate and inoculum. In this strategy mushrooms are developed in raised substrate beds typically encased with aluminum or wooden plate. The plate are set as the racks to suit more beds in a less space. The substrate frames the development medium which contains everything for the mushroom development. Notwithstanding the substrate the development requires a great physical condition.

The development of mushrooms inside the ranch is affected by the different ecological parameters and furthermore the state substrate stuffed in the plate. So enhancement of mushroom development can be accomplished by controlling the ecological parameters and substrate profile. The ecological parameters for instance can be repaid utilizing some simulated means or essentially by a few activations like opening a window to permit ventilation. Likewise the dirt state can be kept up by appropriate water system supply wanted. To accomplish this programmed web empowered condition a particular WSAN is sent inside a mushroom cultivate setup which can watch and control the physical factors identified with the upgraded atmosphere of the ranch. The key factors which might be observed and controlled incorporate temperature, mugginess, and water system. The WSAN comprises of sensor and activation hubs. The detecting part comprises of different sensors (like temperature, stickiness, substrate dampness sensor and so forth) to screen the natural factors of the ranch. The activation components are dependable to make the required move to control the related variable when instructed by the control subsystem. The control subsystem has the rationale to decide whether any factor crosses the predefined limit. The controlling procedure comprises of the accompanying physical factors:

A. Temperature

To keep up the coveted temperature, warming is a standout amongst the most powerful and complex control issues confronted by cultivate administrators. Different sorts of warming gadgets are accessible which can be introduced or a few ventilation system, if possible with the outside condition can be connected to control the inward temperature.

B. Moistness

To keep up moistness levels are additionally wanted for mushroom development. Warming components to diminishing and water fog sprinklers to build the mugginess levels can be utilized to keep up the coveted moistness levels inside the ranch.

C. Water system

A coveted sum water supply to the substrate is fundamental for the development of mushroom. A programmed watering framework is introduced to deal with the water system needs of the developing substrate.

To understand the above utilize case, the sensor and actuator hubs should be sent in the ranch and associated with a neighborhood arrange by means of a Sensor portal. The neighborhood is proficient by utilizing ZigBee radios, as every hub is furnished with a ZigBee radio. The sensor door on one hand is outfitted with ZigBee handset to associate with singular hubs and then again it is implanted with an Internet interface. Each detecting hub should be modified to peruse ecological parameters and forward the perceptions to the entryway. In the mean time the actuators are additionally controlled by the portal by issuing control orders to take fundamental activities, for instance for turning the water engine on if there should arise an occurrence of less substrate dampness. The portal goes about as an interface between the web and the sensor and activation hubs that don't have coordinate web availability. Along these lines conceals the respectability correspondence conventions of every individual hub and make them open to Internet. With this model we show how the idea of physical meshups can be connected to the WSANs as Web of Things towards more adaptable and less expensive frameworks. A web application with RESTful API is utilized to meshup amongst Sensor and Actuator hubs and WWW. REST utilizes the Web as an application stage and completely use every one of the components innate to HTTP. In the ventures frequently utilizing on "Web of Things", REST is utilized and adjusted for genuine gadgets with a specific end goal to make a general API connected to certifiable things. The web application utilizing on Web of Things approach is worked with the Google Cloud Platform as Platform as a Service(PaaS) utilizing REST. The general design of the setup is appeared in Figure 1 along these lines there will be distinctive information and control representation for the approved customers by means of the web application conveyed on the cloud. Every hub can be gotten to as an asset by utilizing a particular URI. Since Cloud processing condition gives an awesome adaptability and accessibility of figuring assets at a lower cost. This makes it workable for high versatility of the comparable applications by even little scale cultivate proprietors.

Using the Template

The setup comprises of two types of major on site components, the local Wireless and actuator network and sensor gate way. The network consists of many nodes for physical sensing and actuations required to monitor and control the environment. In addition the network is interfaced by a sensor gateway acting as a base station for WSAN. So the setup leads to two types of hardware modules i) Wireless Sensor and Actuator Node ii) Sensor gateway.

Wireless sensor and actuator node

The wireless sensor and actuator node consists of three main subsystems, Sensing and actuation subsystem, Processing Subsystem, Communication Subsystem.

The sensing subsystem consists of array of sensors responsible for sensing the corresponding environmental factors, like temperature, humidity and substrate moisture. Three different types of sensors are being used in our case, LM 35 sensor for temperature, HSM 20g sensor for humidity and Soil moisture sensor for substrate wetness measurement. Figure 2 shows the WSAN node architecture and its operational components. The node consists of sensing unit implemented by different sensors, actuation part being

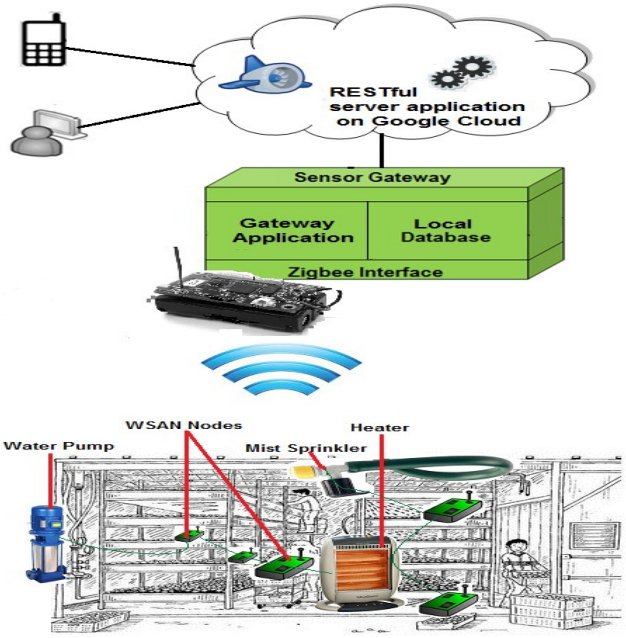


Figure 1. General Architecture

implemented using Single Pole - Double Throw sealed 12V Sugar Cube relays. These relays can be used to switch high voltage (240AC), and/or high current devices (7A). These ratings are sufficient to drive the Devices like water pump, heating blower and mist sprinkler used in our setup.

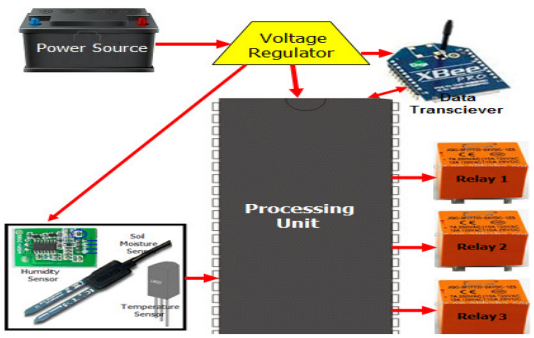


Figure 2. Node Architecture design

The preparing unit utilizes the microcontroller board with Atmega 328P-PU microcontroller. The microcontroller has 14 advanced information/yield pins and 6 simple info pins. The simple pins are utilized to accumulate the contributions from the sensors which are simple in nature. These information sources are then encouraged to the Analog-to-advanced converter (ADC) for the change. The changed over advanced information would then be able to be passed to the preparing unit for additionally handling. The advanced pins are utilized as yields from the microcontroller as the contributions to the activation unit, as transfers utilize these pins as contributions to stumble on or off contingent on the inside rationale control.

Sensor Gateway

The Sensor entryway is planned utilizing a motherboard which permits a mix of the required equipment parts. The mother board is furnished with a 2.93 GHz Intel(R) Core(TM) 2 Duo CPU, 2GB RAM and 80GB HDD mass stockpiling for information gathering, information stockpiling and to run the earth for running the application to process the administration demands from the primary cloud application and push back the reaction for the solicitations. The above particulars were utilized as a result of accessibility; on the other hand different implanted web servers are accessible which can get the job done the reason. The web network is built up by a 3G/Edge GPRS perfect USB gadget with the goal that all gathered and prepared information is made accessible to the cloud application server.

The ZigBee on this side is modified as an organizer. Information got from the WSAN hubs is in this manner sent to the mother board through USB port utilizing serial convention. The interfacing between the serial port and zigbee radio in this setup was proficient by a Zigbee voyager board. The pioneer module is self controlled from USB Port itself. The board is worked with FT232RL Chip from FTDI.

Web of Things architecture for WSAN

The Web of Things is considered as the development of the Internet of Things. Web of Things concentrates on mix of ordinary items like home machines, wearing, labeled articles, autos, implanted gadgets remote sensor systems and so on to the WWW. For the simple and quick combination of such gadgets, Web of Things reuses the current web framework and its developing innovations like HTTP, REST, URI, and JSON. As per ABI explore directly there are 10 billion remote gadgets associated with the Internet in the market and is normal that more than 30 billion gadgets will be associated by 2020. The Web of things expects us to stretch out the current web advances to particular needs of the application with the goal that these items and inserted gadgets can mix flawlessly into each other [9]. In this application as opposed to utilizing HTTP as a vehicle convention as utilized as a part of web benefit frameworks, it is utilized as an application convention. For this reason we will be utilizing REST API over HTTP. The key reflection of data in REST is an asset. Any data that can be named can be an asset. Assets are tended to by URIs and their usefulness is gotten to through the all around characterized HTTP techniques like GET, POST, PUT, DELETE and so forth. These REST APIs notwithstanding connect with sensor hubs through web can be utilized to show different representations produced from information assembled by the hub [10]. This empowers each hub of the WSAN sent as a thing on the web. So every hub can be gotten to and controlled by Internet utilizing Sensor entryway as an interface to the WWW. The sensor passage has IP availability and runs a web application on it.

Software architecture

The software Architecture of the application is shown in Figure 3. In its bottom layer, is the Sensing and actuation logic, since each sensor node gathers the raw sensor data and is able to process them to observations with more descriptive metadata (e.g. unit of measure, Node ID, Location). The microcontroller firmware programming language is used to process the raw sensor data and send the processed information to the Sensor Gateway using ZigBee Protocol APIs. At the Sensor gateway, there is the ZigBee interface, which provides communication interface to WSAN nodes to Sensor Gateway. Sensor Gateway uses the Serial interface for communication to individual nodes. Once received the observation from a sensor node by the serial interface, the event is triggered to push the observations to the Cloud server application by the gateway application. The cloud application is developed in Java 1.6.0 using Google app engine which makes all the sensor nodes available as shared web resources, interfacing with them via sensor gateway. In order to provide data gathered by the Sensor nodes to the clients, a REST API for accessing measured observations is designed. It makes their functionalities available through simple URIs over web. The gateway application was developed in Eclipse -3.7.2 which uses the data pushing client of the cloud server application

to upload the sensor observations and to receive the observation requests and control commands by data pull approach. On the other hand the gateway application implements the logic to access and control the actual sensor and actuator nodes to serve to the cloud application. The application at the lower level maps the URIs to native requests for the ZigBee protocol API

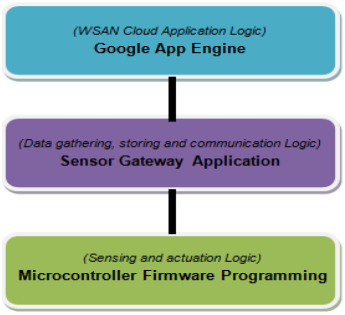
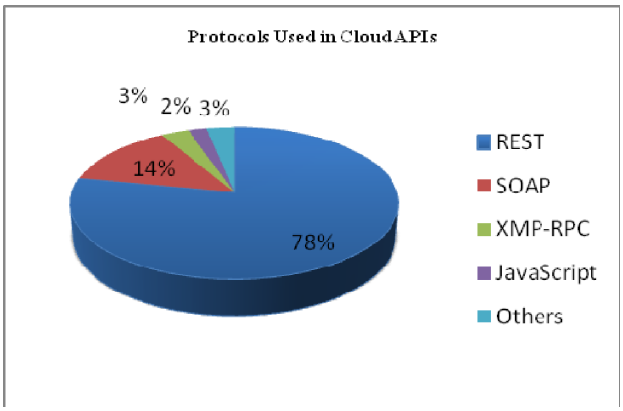


Figure 3. Software Architecture

4. Conclusion and Future work

In this paper we have explored the use of WSAN close by Web of Things to develop a dispersed registering application for the mushroom develop checking and control. In view of the confined capacities of the individual center points in the WSAN, the coupling of physical centers and the web was capable by using widely appealing sensor entry. The setup in this way engaged the sensor centers as the REST resources on WWW using sensor entry mappings. The system gives steady watching and control close by customized alerts to the customer using fundamental means like SMS, twitter and mailing organization and also using neighborhood shows and alarms. The application was made using Google App engine as PaaS and sent on Google cloud organize. We are using RESTful API over HTTP instead of web organizations like SOAP-WS, As showed up in the going with outlines created utilizing data sourced from 'Twilio Cloud exchanges', demonstrates the comfort experiences of REST tradition and its reinforced data positions which transformed into the basic motivation to use REST for the meshup. Thusly, the application designing can be seen as a versatile, negligible exertion, and interoperable with extraordinary execution control structure for mushroom develop environment checking and control. In future, this usage case setup will be refined, yet furthermore other use cases will be explored to show the more broad degree of the Concept. The further congruity of the setup can be analyzed after examination of legitimate achievability, tried and true designs of activity, dependability, et cetera. In future, we expect to propel the arrangement using on Web of Things thought to pass on disseminated figuring structures for other certified checking and control circumstances[25-27].



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