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# Analysis of Soil Nutrition Analysis with HART Protocol a Review

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***Abstract*—** The IoT, the idea of getting real-world objects connected with each other, will change the way users arrange, get and expend data drastically. IoT empowers different applications (crop development observing and determination, water system choice help, and so on) in Digital Agriculture domain. Wireless HART is modern network protocols in WSNs which system of multiple small sensors (nodes), limited energy sources, used to sense any given sensing region (environment) of interest. Nodes in HARTs are provided with low power and are employed in a hazardous environment where replacement of the battery or any fault evaluation in the sensor network is impossible. With the help of this approach which gives continuous data about the terrains and harvests that will enable ranchers to settle on right choices.

***Keywords:*** **-** Internet of Things (IoTs), Wireless Sensor Network (WSN), Highway Addressable Remote Transducer (HART)

## I. INTRODUCTION

Informatization is the sign and key of horticultural modernization. Horticultural data can fundamentally change little size of agrarian generation, extraordinary fleeting and spatial variety, low scale merit and other mechanical shortcoming. In addition, it assumes a significant job in the advancement of farming and the full acknowledgment of a wealthy society [1]. The IoTs is characterized as things associated with things in the Internet. The rural IoTs is another pattern in world farming advancement, another sort of horticulture which joins the Internet of Things and rural creation. It will carry farming into the advanced data age [2]. Rural IoTs can execute advanced plan, smart control, exact task and logical administration for different horticultural components.

So it accomplishes an exhaustive discernment, solid transmission and keen handling, and at last accomplishes high return, high proficiency, superb, natural and security purposes. Citrus is biggest natural product crop on the planet. Its planting region and yield are the first of the natural product trees. What's more, it is the world's third biggest exchange horticultural items. Citrus is delivered in nations and locales everywhere throughout the world. Among these zones, China's citrus planting zone and creation is in any case on the planet, turning into the world's biggest citrus delivering nation. In China, most citrus the board techniques are still in the generally in reverse stage, observing of water, supplements, and the temperature is still in the manual checking stage [3]. They result in badly designed task, tedious and difficult, low exactness and the absence of data.

Moreover, the information obtaining will have a specific postponement. So administrators can't accomplish far reaching and clear handle of the plantation data. In view of this, the papers applies the IoTs innovation and single-point multi-layer discovery technique to the dirt dampness, temperature and supplement checking, sets up citrus plantation preparation water system master information base and settles on master choice as indicated by the dirt condition continuously to manage the real generation procedure of citrus. The rise of remote sensor, information combination and web innovation, can accomplish the remote programmed observing on the citrus water, supplement and temperature of development condition. Also, through the model examination and information handling, master basic leadership framework can give viable proportions of citrus the executives [4].

The IoT is the system of gadgets, for example, vehicles, and home apparatuses that contain hardware, programming, sensors, actuators, and network which enables these things to interface, associate and trade information. The IoT includes broadening Internet availability past standard gadgets, for example, work areas, PCs, cell phones and tablets, to any scope of generally moronic or non-web empowered physical gadgets and ordinary items. Installed with innovation, these gadgets can convey and interface over the Internet, and they can be remotely observed and controlled.

Inter-associated are gadgets where the gadgets are savvy enough to impart data to us, to cloud based applications and to one another (gadget to gadget) [6].

 

Shrewd gadgets or "Associated gadgets" as usually called as, are planned so that they catch and use all of information which you offer or use in regular daily existence. What's more, these gadgets will utilize this information to collaborate with you on everyday schedule and complete assignments.

IoT is short for Internet of Things. The Internet of Things alludes to the consistently developing system of physical items that element an IP address for web network, and the correspondence that happens between these articles and other Internet-empowered gadgets and frameworks [7].

## II. LITERATURE REVIEW

**Tao Li et al. (2018, [1]),** HART (Highway Addressable Remote Transducer) communication protocol is a popular industrial automation protocol. Field devices with HART are usually deployed in hazardous environments, such as petrochemical, pharmaceutical, paint & coatings, chemical & mining industries, etc. These devices should be highly reliable and function well to communicate with controllers, such as programmable logic controllers or distributed control systems. If they were out of order or needed adjustments, technicians have to enter the hazardous areas to diagnose or reconfigure them. In order to keep the technicians safe, this paper proposes a remote HART configurator, which is based on HAA-5191 and Raspberry Pi. The HAA-5191 is a HART modem module manufactured by FineTek Co., Ltd. It connects the HART field device(s) with any microcontrollers which support UART. Further, the Raspberry Pi connects the HART modem to the Internet through Wi-Fi or Ethernet. This scheme lets users remotely configure the HART field device(s) via the Internet.

**Mahfuzulhoq Chowdhury et al. (2018, [2]),** low errand execution times and low vitality utilization of working together portable human clients and robots are imperative necessities of developing human-specialist robot collaboration (HART)- driven Tactile Internet applications. Specifically, errand relocation among portable HART individuals has raised as a critical research theme, taking distinctive undertaking types, assignment due dates, communitarian hub abilities, and versatility designs into record. We propose a setting mindful assignment relocation conspire for productively coordinating the ongoing cooperation among human portable clients, focal and decentralized computational specialists (cloud/cloudlets), and collective robots (cobots) crosswise over merged fiber-remote (FiWi) correspondences foundations. We examine the issue of whether and, assuming this is the case, when and where a HART-driven undertaking ought to be best moved to. For asset productive assignment execution, the relocation choice is made by given errand handling abilities of cloud/cloudlet operators and cobots, undertaking execution due date, vitality utilization of included cobots and cell phones, and undertaking movement idleness.
We assess the execution of our setting mindful HART-driven assignment movement plan and contrast it with ordinary errand execution without relocation. Towards this end, we build up an expository structure for evaluating its execution regarding an assortment of assignment movement key execution measurements, including errand relocation increase overhead proportion, due date miss proportion, undertaking reaction time, and vitality utilization productivity.

**Yun-Shuai Yu et al. (2018, [3]),** HART (Highway Addressable Remote Transducer) communication protocol is a popular industrial automation protocol. Field devices with HART are usually deployed in hazardous environments, such as petrochemical, pharmaceutical, paint & coatings, chemical & mining industries, etc. These devices should be highly reliable and function well to communicate with controllers, such as programmable logic controllers or distributed control systems. If they were out of order or needed adjustments, technicians have to enter the hazardous areas to diagnose or reconfigure them. In order to keep the technicians safe, this paper proposes a remote HART configurator, which is based on HAA-5191 and Raspberry Pi. The HAA-5191 is a HART modem module manufactured by FineTek Co., Ltd. It connects the HART field device (s) with any microcontrollers which support UART. Further, the Raspberry Pi connects the HART modem to the Internet through Wi-Fi or Ethernet. This scheme lets users remotely configure the HART field device(s) via the Internet.

**Cristian Patrascioiu et al. (2017, [4]),** the paper presents trial look into identified with pH estimating and to the plan of an arrangement of pH checking. The paper is organized on three sections. The initial segment displays the standard of estimating the pH of an answer matter, the transducer structure and of the connector utilized. The second part is committed to the test investigate effectuated going for the utilization of PACTware programming condition for the design and checking of the pH transducer working by utilizing the HART convention. The last piece of the article is bound to the introduction of the examination work for the elaboration of the checking and control framework utilizing Labview programming.

**Sindhu R et al. (2017, [5]),** Highway Addressable Remote Transducer (HART) is an open fieldbus protocol for industrial automation and implemented in almost all the commercially available field transmitters and actuators. This paper details the intricacies and challenges involved in designing a HART Analog Input Module (HAIM) for the indigenous Supervisory Control And Data Acquisition (SCADA) solution developed at the Control and Instrumentation Group of Centre for Development of Advanced Computing (C-DAC), Thiruvananthapuram,

 

based on C-DAC's proven Industrial Controller (iCON) platform. The paper outlines and discusses the various hardware and software components developed as part of this module and presents the bigger picture of how this module seamlessly integrates with the existing iCON platform. Results obtained with the upgraded iCON system with HAIM in place are pondered upon. The main objective of this paper is to bring out the salient features of employing an open and widely accepted fieldbus standard like HART over the proprietary architecture deployed by iCON based SCADA systems in the past.

**Shylaja S.N. et al. (2017, [6]),** the agricultural yield primarily depends on soil fertility, the moisture level of soil and use of appropriate fertilizers. In the current scenario, the manual method of measuring the soil nutrients is less accurate because of the time difference of soil sample collected at the field and when it is measured in a laboratory. It becomes necessary to create a smarter agriculture practice through Internet of Things (IoT) to address this challenge. Soil nutrient analysis using wireless sensor networks (WSN) enables various applications like remote monitoring of soil fertility, analysis, provide a selection of crop and build irrigation decision support systems.

## III. HART PROTOCOL

Wireless HART is the latest release of Highway Addressable Remote Transducer (HART) Protocol HART standard was developed for networked smart field devices. The wireless protocol makes the implementation of HART cheaper and easier. HART encompasses the most number of field devices incorporated in any field network. Wireless HART enables device placements more accessible and cheaper– such as the top of a reaction tank, inside a pipe, or at widely separated warehouses. Main difference between wired and unwired versions is in the physical, data link and network layers. Wired HART lacks a network layer.

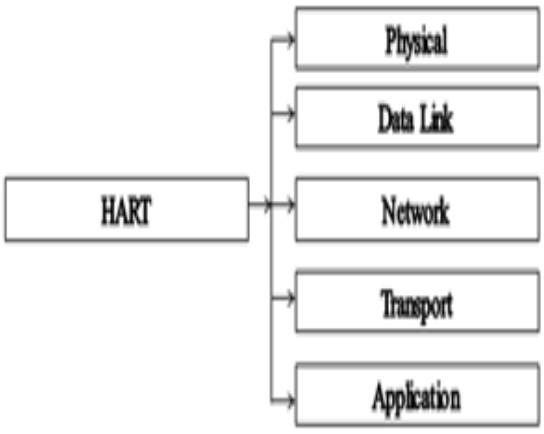


**Figure 1: Protocol Layer**

**Physical Layer**

- It operates only in the 2.4 GHz ISM band.
- Employs and exploits 15 channels of the band to increase reliability.

**Data Link Layer**

- Collision free and deterministic communication achieved by means of super-frames and TDMA.
- Super-frames consist of grouped 10ms wide timeslots.
- Super-frames control the timing of transmission to ensure collision free and reliable communication.
- This layer incorporates channel hopping and channel blacklisting to increase reliability and security.
- Channel blacklisting identifies channels consistently affected by interference and removes them from use.

**Network & Transport Layers**

- Cooperatively handle various types of traffic, routing, session creation, and security.
- Wireless HART relies on Mesh networking for its communication, and each device is primed to forward packets from every other devices.
- Each device is armed with an updated network graph (i.e., updated topology) to handle routing.
- Network layer (HART)=Network + Transport + Session layers (OSI)

**Application Layer**

- Handles communication between gateways and devices via a series of command and response messages.
- Responsible for extracting commands from a message, executing it and generating responses.
- This layer is seamless and does not differentiate between wireless and wired versions of HART.

## IV. HART ALGORITHM

Wireless HART is a datalink protocol that operates on the top of IEEE 802.15.4 PHY and adopts Time Division Multiple Access (TDMA) in its MAC. It is a secure and reliable MAC protocol that uses advanced encryption to encrypt the messages and calculate the integrity in order to offer reliability. The architecture, as shown in Figure 2 consists of a network manager, a security manager, a gateway to connect the wireless network to the wired networks, wireless devices as field devices, access points, routers and adapters. The standard offers end-to-end, per-hop or peer-to- peer security mechanisms. End to end security mechanisms enforce security from sources to destinations while per-hop mechanisms secure it to next hop only.

 

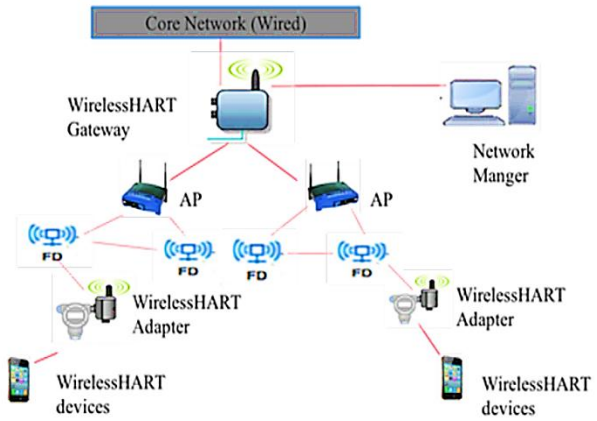


**Figure 2: Wireless HART Architecture**

Consists of a large number of sensor nodes, densely deployed over an area is present. Sensor nodes are capable of collaborating with one another and measuring the condition of their surrounding environments (i.e. Light, temperature, sound, vibration). The sensed measurements are then transformed into digital signals and processed to reveal some properties of the phenomena around sensors. Due to the fact that the sensor nodes in WSNs have short radio transmission range, intermediate nodes act as relay nodes to transmit data towards the sink node using a multi-hop path.

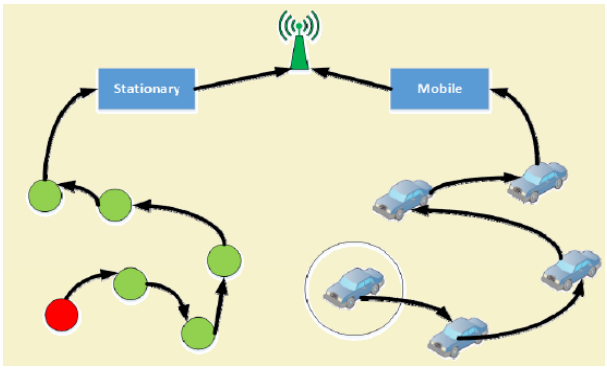


**Figure 3: Multi-hop Network**

**Algorithm:-**

The symbol in the algorithm: Node[n](n=1~n), represents the network node in wireless HART. Node [1] is the network AP. Node [2]~Node[n] express field device.

Step1: For the routing of node [2], the first path and the second one simultaneously point to the gateway, then n is equal to n+1;

Step2: The hierarchy algorithm of node [n] is used to calculate the layer of node[n];

Step3: If node[n] is on the first layer, the first path points to the gateway and the link quality weight of the neighbor table of the node that is earlier to join network is calculated. Then the 2nd path points to biggest weight neighbor then it is switched to step 6. Otherwise, the upper node in neighbor table is put into the array and the next step is the step 4.

Step4: Sort node in the array according to the link quality.

Step5: The path whose link quality weight is the biggest is selected as the first path by the node. The second biggest weight one is the 2nd path.

Step6: n=n+1 and if n is a new node, you have to switch to step2. Otherwise it goes to the exit.

**Algorithm Verification**

In order to verify the effectiveness of the algorithm, the wireless HART network in figure 3 is selected as an example. Node 1 is AP and 2 to 11 represent field devices. The graph shown in figure 3 is acquired by the application of the hierarchy algorithm. The graph routings from node 2 to node 11 are obtained respectively by the application of the algorithm proposed. In the paper the graph routing for node 2, 3, 7 and 11 is taken as an example.

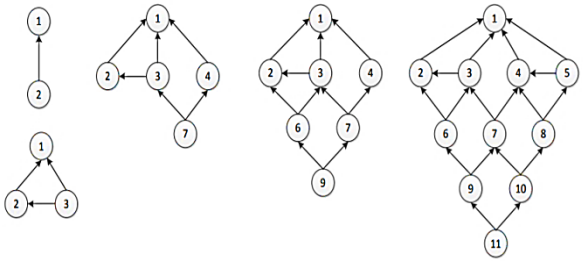

**Figure 4: Routing in Wireless Hart Routing**

## V. SIMUALTION PARAMETER

**Throughput (Kbps) analysis:** To gauge the convention execution, throughput fills in as the better parameter. The throughput is characterized as the proportion of number of bundles got to the quantity of parcels transmitted and it is in a roundabout way corresponding to the overhead. The throughput is figured by utilizing the condition 1.

$$Throughput = \frac{x \times 8}{t \times 100} Kbps \quad (1)$$

Where x is number of bytes received and t is simulation time

**Analysis of Packet Delivery Ratio (PDR):-** To find the efficiency of the protocols, PDR is one of the important qualitative metrics. It is defined as the ratio of data packets received and packet sent, it is calculate as follows

 

$$PDR = \frac{x}{y} \times 100 \quad (2)$$

Where x is the total number of packets received and y is the total number of packets sent at end of the simulation time.

**Delay: -** The ratio of the total delay of each data packet to total data packet received for wireless sensor network.

$$Delay = \frac{Total\ Delay\ of\ Each\ Data\ Packet}{Total\ Data\ Packet\ \mathrm{Re}ceived} \times 100 \quad (3)$$

## VI. CONCLUSION

Farming will play vital role in next few years in country. Thus there is need of smart farming. Internet of Things will help to enhance smart farming. IoT works in different domains of farming to improve time efficiency, water management, crop monitoring, soil management, control of insecticides and pesticides etc. It also minimizes human efforts, simplifies techniques of farming and helps to gain smart farming. Along with these features smart farming can help to grow the market for farmer with single touch and minimum efforts.

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