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Secure Wireless an Embedded Based Web Server: Design and Realization

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ABSTRACT

Data acquisition systems with real time and remote accessibility are in great demand in most industry and consumer applications. In this work, a secure real time measurement of the temperature, humidity with full optimized web application will be presented. An efficient technique of both data transfer and store is fulfilled by using a Raspberry Pi based system. Reading, monitoring and controlling the targeted environmental parameters are either locally or remotely achieved. The system provides boundary conditions are called reference points that allows the user to trigger the adequate modes of systems operation. According to these reference points and the measured data, the system provides 5 different states (flags). These flags can be used for driving different suitable actuators, cooling fan is for instance one of these actuators. Vulnerability of the wireless data transmission hacked up is avoided by a real time firmware data encryption. This system proposes a responsive user interface that gives large scale of database availability based on the Microsoft SQL server. An attractive secure wireless system was designed with motivated GUI to facilitate the system functions.

Keywords: Embedded System, Raspberry PI, RTC, Data Base, SQL Server

INTRODUCTION

The great potential of Web application is being seen in industrial, consumer and commercial application. On one side, the wireless technology is becoming one of the most prominent areas of research. On the second side, the WSN has good functions of data collection, transmission, and processing [1-2]. An ever-growing range of wireless sensors for monitoring and controlling has shown that there is significant interest in monitoring all things in their everyday surroundings. It however remains challenge to merge information from several wireless sensors and applications [3]. This development makes many mobile devices, capable of carrying out complex computing tasks and thus can be used in monitoring the needs remotely [4-5]. Embedded systems technology with the development of network and communication technology, the WSN has solved the inconvenience into people's life. Niturkar Priyanka R., Prof. V. D. Shinde have been design and development of interactive data acquisition and control system (IDACS) by using ARM9 processor and embedded web server application. The Embedded web server application and RTOS (Real Time Operating System), both are ported on ARM processor. The web pages which are required for web server are written by Hypertext markup language (HTML). It can be a network, intelligent and digital distributed control system. Single chip IDACS method improves the processing capability of a system and overcomes the problem of poor real time and reliability [6]. Jianming Liu, Yunjie Zhang, Lili Xu, Jincai Wang have been indicated that the remote monitor and control mode based on embedded web server can provide real-time information [7]. Miguel Domingues showed that the 8051 microcontroller family remains one of the mostly used processors. Its ease of use and its relatively high performance make it considerable for implementing embedded systems for high volume applications [8]. M. Can Filibeli, Oznur Ozkasap, M. Reha Civanlar illustrated that Integrating web servers to intelligent devices will aid in controlling them over the Internet and also in creating effective user interfaces [9]. Tzeming Tan, Jeremy have been implemented embedded ATMEL HTTP Server mentioned that the interface with Ethernet as well as several internet protocols might be TCP/IP or ARP. This embedded web server could serve a small, static web pages as well as perform certain useful laboratory functions such as displaying the current temperature [10]. V.Billy Rakesh Roy1, Sanket Dessai1, and S. G.Shiva Prasad Yadav designed and developed ARM Processor Based Web Server by using embedded C language can be beneficial for mission critical applications, remote data acquisition systems, ATM network and more [11]. Soumya Sunny P1, Roopa .M2 realized an embedded web server, which enables data acquisition and status monitoring with the help of any standard web browser [12]. K.Bharath reddy, Ch. Rajendra prasad designed an embedded Web server for power network monitoring using high speed MCU (ARM7-LPC2148). They have been monitored and controlled from remote places via the desktop [13]. G.Sunil Kumar, T.Swapna presented the design of embedded web server based on ARM9 Micro-processor and Linux platform and analyses hardware configuration and software implementation for monitoring and controlling systems or devices [14]. S.A.N.Sandeep, P.Malyadri presented the Using embedded Ethernet simplifies the integration of a real-time

Communications network of an intelligence type robot system. TCP/IP compatible Hardware Real-Time Protocol (HRTP) is proposed for real- time capability. The microcontroller based remote monitor and controls the external hardware/devices over the internet. This illustrate the internet capabilities imparted to a microcontroller for the use of embedded Ethernet for data communication [15]. In this paper a real-time reading, monitoring and reacting according to desired running of both targeted devices and environmental parameters. The system also includes a very easy system based web application. To provide information about the environmental or devices parameters. A simplified block diagram of the proposed system is shown in Fig.1. The system operation will be discussed in the following subsections.

WIRELESS INTERFACE SYSTEM

Free and easy mobility are the most important advantages of wireless system. In spite of, wireless communications can offer more merits, still possible to

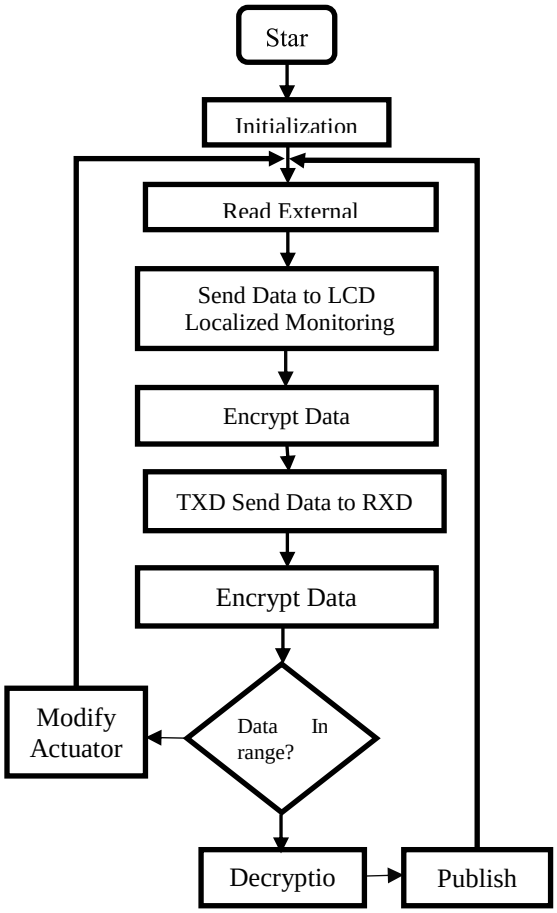

Fig.2: The simple flow chart of the system procedures

suffer from lower bandwidth as well as hacking up. Indeed, the most challenge in this case is the privacy weakness. This paper implements the Tribble Data Encryption System (3DES) to protect the wireless data transmission. The simple flow chart of the system procedures is shown in Fig.2. Three parts of the HC-11 Low current consumption wireless module of 434MHz frequency band, multiple types of serial port and transparent transmission modes are used in this work. One can switch between these modes by

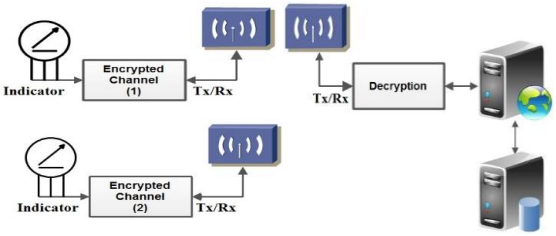

Fig.1 System Block Diagram

Command Line Interface (CLI). In this work four modes are responsible for receiving and sending serial port data. The full duplex mode of current 22mA is configured for data transmission. Furthermore, two HC-11 modules (clients) are used to read the sensor outputs and wireless send it to the third one (sink node). The system operation and the firmware design will be discussed in the following sections.

EXPERIMENTAL WORK

As an accurate constraints, the system is turned on for one second before data transmission In order to avoid an instability condones. Single-bus data format is used for communication and synchronization between Micro Computer Unit (MCU) and DHT11 sensor. Data bus has the advantages of dealing with both the float decimal and integer numbers it has data transmission

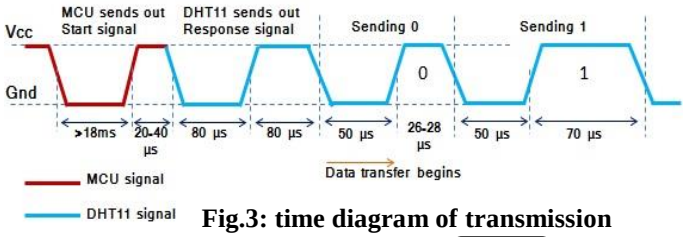

Fig.3: time diagram of transmission

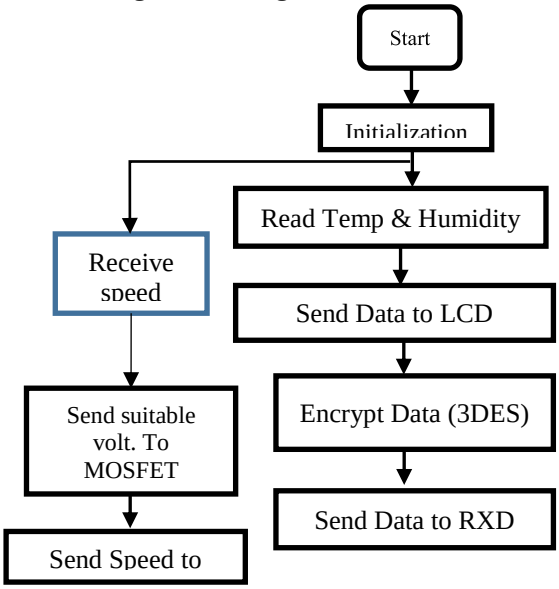

Fig.4: Application flow chart

of five octets, (40bit), where the sensor sends higher data bit first. Data time diagram is shown in Fig.3. When MCU sends a start signal, DHT11 changes from the low-power-consumption mode to the running-mode, waiting for MCU completing the start signal. Once this process is completed, DHT11 sends a

response signal that includes the relative humidity and temperature information to MCU. The duration of one

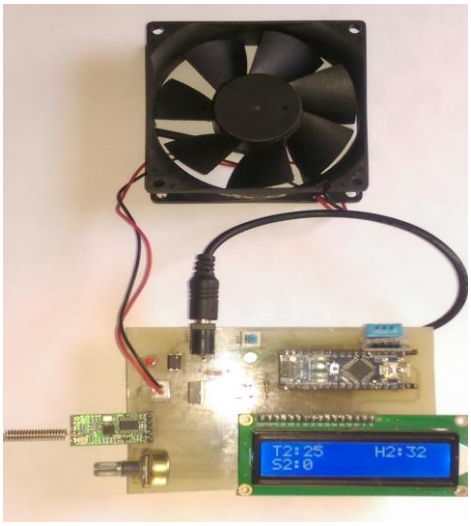

Fig.5. Module of controlling &monitoring temperature and humidity wireless sensor.

Communication process is about 4ms. The DHT11 sensor interfaced with the Arduino Nano based system. The Arduino chip with 2kB and Atmel AT mega 328 microprocessor at clock speed 16 MHz process the input data before sending it. The system is provided with a soft application (embedded program) to read the measured data and sends it to localized LCD monitor. This soft application is developed and realized as a firmware that is implemented as shown in flow chart of fig.4. This application is burring up on the Arduino Nano based system. One advantage of data security is achieved by encrypting the wireless data using the 3DES algorithm. A private key is precisely selected and crypto graphing the data before sending it through wireless module. Arduino chip provides suitable driving signals of The MOSFET (IRF9530) that control the FAN Speed. The system provides five DC voltage levels that drives the cooling FAN. The OPTO Coupler PC817 is used to isolate between the power and digital sides. The realized client of the system that measured, send and control the environmental targeted parameters is shown in Fig.5. The sink node sends the code through the wireless module, a watchdog signal allows the environmental data to be measured. Each client has a specific access code. The created program with python language control various client from the specific server through the network and bypass it to the wireless module. Fig.6 shown the flow chart of python program on Raspberry PI.

1.1. SYSTEM GUI

The system GUI configured of the individual source codes; database (data base server), desktop application (log server) and finally the web server. These three servers connected through network, each server has a specific role. Fig.7, shows the layout of network. The log server has a program that records the logs of data for each client into the database. Every 10ms the service call the sink node to get the data for

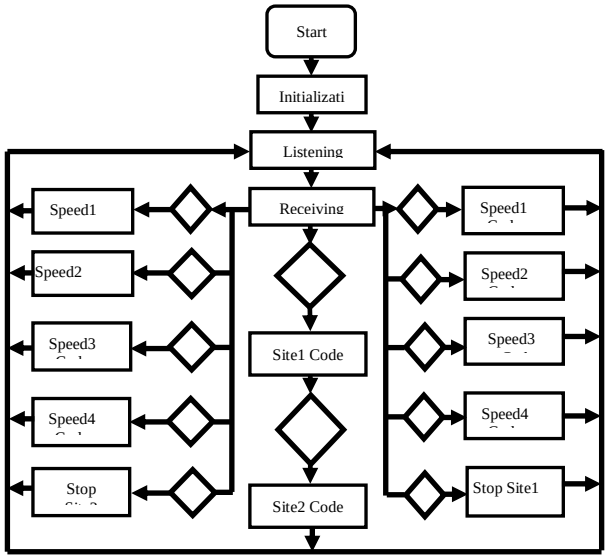

Fig. 6 Python program on Raspberry PI

each client, checking the data health and hit the Database to save the records. Reach textbox for the program shows the log of data and indicates that the process was done successfully. The timer control the interval for capturing the NIC port before the insertion process. The log server uses the code at specific code for cooling degree for the site depend on the rules saved on database server and send it to sink node. The database server configured on the network and has the Microsoft SQL Server 2014 Enterprise installed, that Manage, control, design and implement the database. Main entities were designed to store the basic data of various target to be monitored, managed and controlled, handle the log that recorded each 10ms, the codes of each site that used in the process of the system and holds the user privileges for user system authorization and store the system settings for whole system. The database server has procedures to insert update and delete. The functions and views

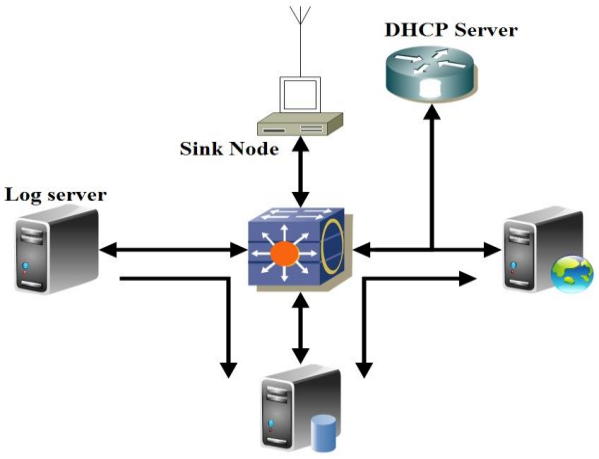

Fig.7 Server environment diagram

are integrated to complete the database functionality. Manage the database for the system. Fig.8 shown the database block diagram. Web server has been implemented using the asp.net technology is it was to build the web site for the system with membership powerful security tool and C# programing language. The home page is the page for collecting the system links to reach the system parts as it is. The Sites page defines the sites will be monitored and controlled by the system. Also we use to use the Settings page defines the rules for each site that will be sent automatically by the windows service to site by raspberry Pi to control the cooling degree at the site. The privileges page is used to create user for the system and grant him permissions on the system parts. The Actuator page is a Graphical control to show the site information to and shown the decision is taken automatically by successfully way. The graphical user interface of web system acts to room 1 at the site 1 is 31˚ and humidity is 29%. On the other hand the second room at the site2 is 35˚ and humidity 30%. For two different sites.

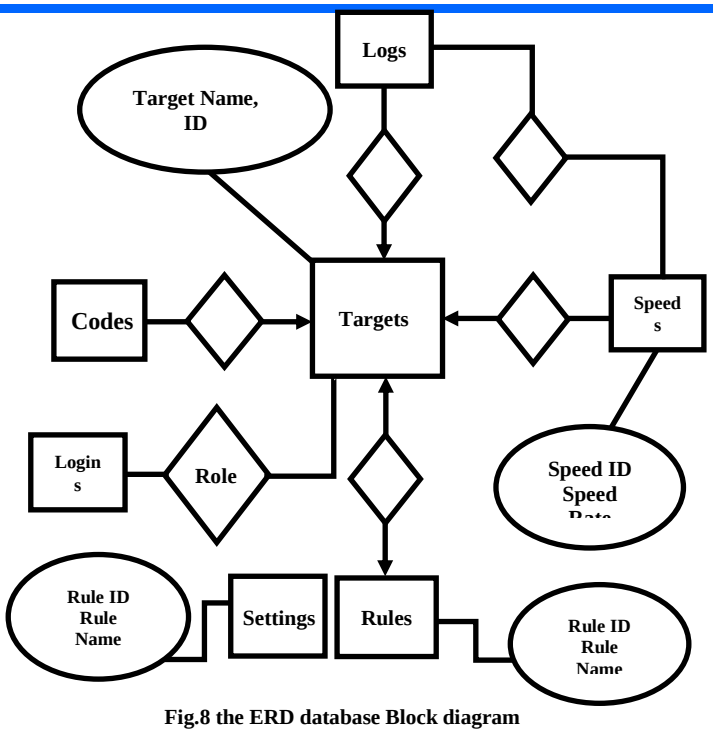

Fig.8 the ERD database Block diagram

5. Experimental Results & Discussion

The Universal Real Time Communication System (URTSC) consists of:

5.1: System Interface

Simply by writing www.UTRSC.com in the address bar of the internet browser you can get the authentication page as shown in fig.9, then one can login using the name and password. The web site authentication is powered by Microsoft membership. ASP.NET membership gives you a built-in way to validate and store user credentials. ASP.NET membership therefore helps you manage user authentication in your Web sites. You can use ASP.NET membership with ASP.NET forms authentication by using with the ASP.NET login controls to create a complete system for authenticating users.

5.2:The administration page: is consists of four items; settings, privilege, actuators and the targets. As shown in fig.10.

Settings: The system give you the ability to define five levels for cooling degree on each target.

Sites: depend on it to change the cooling degree automatically at the different target. The fig. 11 showed that the definition for each target. For example if the degree at target1 =34˚ and Humidity = 34% the fan at target1= 1750 RPM. Sites: Define all targets that the system will be monitor and control.

Privileges: Create new user and give him privilege on

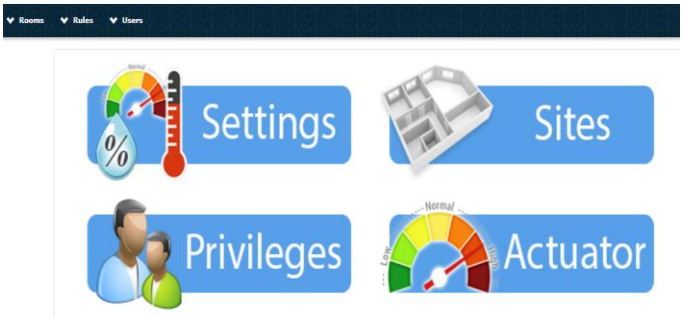

Fig.10 the system main parts.

the system.

Actuators: The user use actuator to monitor the allowed target to insure that the system is going well and take action if he need that.

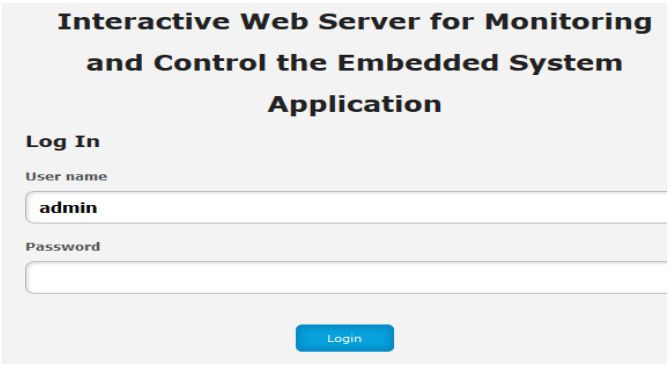

Fig.9 URTCS authentication page.

5.3 DATA PROCESSING:

The system is configured of soft and hard platforms, the initialization is fully software controlled, and moreover the hardware is interacted with the software as shown in the following paragraphs.

5.3.1 SYSTEM STARTUP AND OPERATION

Initially the system is provided with desired environmental parameters as set points. For example, before 30^0 and 30% humidity no actuator action is required as shown fig.11.

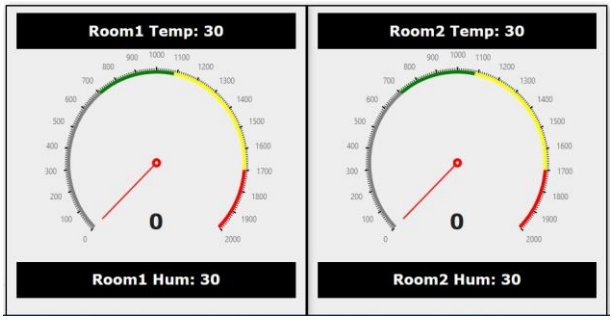

Fig.12: No cooling at Target 1, 2 when Temp=30 and Hum=30

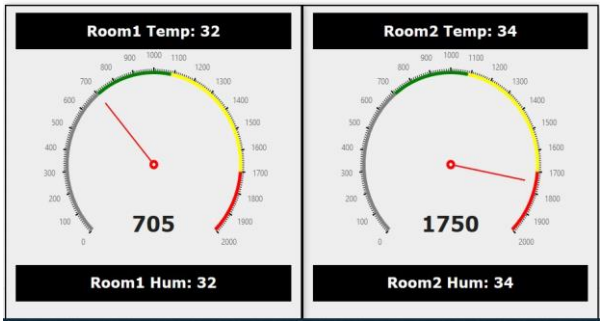

Fig.13: Shown Target1 cooling Speed 705rpm at Temp=30 and Hum=30 And Target2 cooling Speed 1750rpm when Temp=34º and Hum=34%

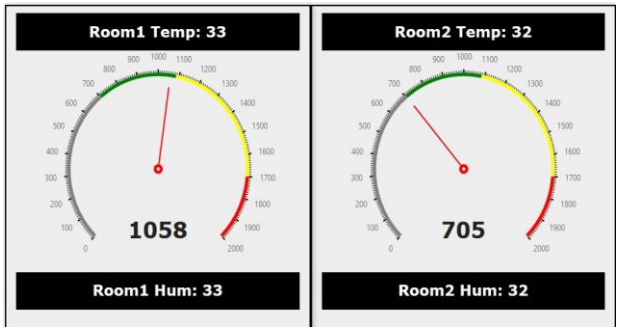

Fig.14: Shown Target1 cooling Speed 1058rpm at Temp=33 and Hum=32 And Target2 cooling Speed 705rpm when Temp=32º and Hum=32%

Room	Temprature	Humidity	FAN SPEED
Target1	30	30	R1S0
Target1	31	31	R1S1
Target1	32	32	R1S2
Target1	33	33	R1S3
Target1	34	34	R1S4
Target2	30	30	R2S0
Target2	31	31	R2S1
Target2	32	32	R2S2
Target2	33	33	R2S3
Target2	34	34	R2S4

Fig.11: The web system interface

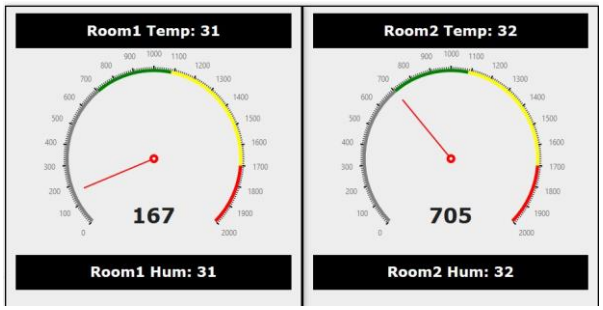

Fig.15: Shown Target1 cooling Speed 167rpm at Temp=31 and Hum=31 And Target2 cooling Speed 705rpm when Temp=32º and Hum=32%

5.3.1 SYSTEM SECURITY

The system data security is embedded using modified DES-256 encryption technique is based on one talking authentication. The ciphered output of the transmitted data is shown in fig.15, where the two different ciphers are for the same (32 32% and 2) state.

RMID	Date	ERM	DRM
1	2016-10-12 14:07:30.707	wCQ38jeVSiLud6ft/kKLlw==	35290368
2	2016-10-12 14:07:32.040	ezvTsOQ56JUBBTMHOAlmAA==	35290368

Fig.12: The encrypted results.

6. CONCLUSION & FUTURE WORK:

In this paper, different design techniques available in the literature using Ethernet, webserver and Linux based systems for remote monitor and controlling of electronic equipment's or industrial parameters. The web based remote monitoring and controller system for HC11 wireless transmitters and for embedded devices is designed and implemented in the present work. The system adopts browser/server mode and realizes the interconnection of the embedded device. Therefore, remote users can access, control and manage the embedded devices "DHT11 Temperature and Humidity Sensor through the HC11 wireless transmitter" using a standard web browser over the internet. It has advantages of small size, data logger, system maintenance, longer work time and stable performance. It is applicable to a variety of fields like industrial control, industrial automation, medical instrument etc. In the future will eliminate the windows service and the computing part (raspberry PI or sink node) will do the injection job into the database. The web server will be also available on the sink node. The channel will announce its GRPS and more detailed data about itself.

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