# A Review on Web based Embedded System for Remote Monitor and Controller

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**Abstract**— An embedded web server enabled web access to distributed measurement or control systems and provides a scalable networking solution that is optimized for instrumentation, industrial and home automation. The web based monitoring and control system, applied to an industrial rotational moulding plasitc oven. Embedded control system is based on real-time ethernet to provide information environment for integration of real-time control and information exchange. 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.

**Index Terms**— Embedded control, Ethernet, Remote monitor/control, TCP/IP.

## 1 INTRODUCTION

IN traditional control ethernet, various control information and status parameters captured from locale and are transmitted, exchanged trough different field bus in different application area. Monitoring is employed in various applications, including temperature, pressure, flow rate, capacity, acceleration, and so on. The quantities, distribution and detected frequency of the monitored objects, there are different methods to acquire the measurements.

Integrating web and embedded techlogy for embedded equipement monitoring system based on web management. Operators can remote access, monitor and maintenance the onsite equipment through the network and using a web browser withought the limit of region and time. A web server can be embedded in a device to provide remote access to the device from web browser this type of web server called embedded web server. The embedded system can be utilized to serve the web documents, with static or dynamic information about external hardware systems, to web browser. The parameters like pressure and temperatue monitoring is widely used in various processes like in automotive industries, air conditioning, power plant and other industries that needs the data to be saved and analized. The embedded web server design is to have the data acquisition system to measure and log some parameters. It truly realized seamless connection between equipment and management, it greatly decreases the system building cost, with the development of etherent technology, and the real-time performance of sytem is improved further. The main purpose of this system model is to make it easy for the user to control and view the current status of the parameters.

The embedded system transplanted web server can be also be called embedded web sever through web page released by embedded web server. Remote users can obtain the real-time status information and control remote equipments without time and space restriction. This type of Embedded Web Server has many advantages, such as small size, low power consumption, low cost and flexible designed. It is easy to implement, and it is an effective way of leading Internet into embedded system.

Through the embedded web server system can connect any electronic device to web server and can get the real-time data of devices through the web pages that are released by the server. This method can overcome the problem of PC based monitoring system.

## 2 LITERATURE REVIEW

Parameters monitoring and controlling is employed in various applications, inlcudeing temperature, pressure, flow rate and so on. A research has introduced a remote wireless monitoring system applied in the building construction to get the concrete temperature [1]. M. Kassim et al. proposed web based temperature monitoring sytem. This is continuously monitoring the temperature condition of the room and data can be stored for future ananlysis [2]. B. Srinivas Raja and G. Srinivas Babu [3] proposed a system can complete the remote access, monitoring and maintenance operations of equipement through the network with web browser. Embedded web server system design is proposed, devices are connected via Zigbee Communication Module. This design can overcome the drawbacks of Java Applet [5]. Manikumar C and Nagabhushan Raju K [6] proposed ethernet based embedded system for the measurement of dielectric constant in solids. Measurement of Physical parameter is one of the most important tasks before it is put to use in any application. Rishikesh Kumar et.al, proposed the architecture of embedded monitoring system for Remote Powe Grid parameter monitoring system. It reduces the problem of Grid failure at excellent cost performances. The method using Microchip's ENC28J60 Ethernet controller interface with Atmega32 customized as a web server using open source TCP/IP stack for task of power monitoring, switching and control [7]. Yong-tao ZHOU et al. [8] proposed that the mature technology of web with the embedded and fully utilize the advantages of both. Applied the embedded web technology in the field of equipment condition monitoring, the equipment remote monitoring system is designed based on embedded web. The function and structure of the system are designed based on ARM9 technology. It greatly decreases the building cost and with the rapid development of industrial ethernet,

applying embedded web technology to the equipment condition monitoring field, this is a solution for remote monitor and control based on embedded and web technology. V.L.Varaprasad Nagula et al. [9] has designed an ARM processor based embedded ethernet interface system. The design method adopted and the system is mainly composed of SPI communication module, processor module and ethernet interface module. M.R.Gaikar et al.describe a temperature control experimental setup using microcontroller and ethernet module. That sensor data can be accessed monitored or controlled via the internet [10]. Internet based control system possibilities are virtually unlimited by attaching modules with appropriate interfaces. Atmega 16 is the main microcontroller and ethernet interface card WIZ812MJ used to send or publish data on web page [11]. Indu Hariyale and Vina Gulhane [12] proposed the design of an embedded web server system, which is based on ARM920T processor.The server is implemented in VB and ASP. It is possible to controlling and monitoring any electrical device remotely, via clicking on the server page devices can be switched on or off. The design will overcome the drawbacks of Java Applet. Savita Lad [13] presents the design concept of the embedded web server and the policy of TCP/IP reduction, special the reduction of TCP, whose goal is to allow easy access to and exploitation of remote equipment. Ma Jun [14] proposed a new design, that is introduced on intelligent data acquisition node of industrial ethernet. It is based on LPC2210 microcontroller with a 32-bit ARM core. The software is based on uC/OS-II which is an embedded real time multi-task operating system. The real time data sampled by the intelligent node in the field will be sent the host control computer. Q.N.Cao et al. [15] proposed the design of embedded linux network communication system is based on ARM9 platform. The hardware was built on connecting the microprocessor S3C2410 and the industrial net chip CS8900A. The software system was designed with includes transplanting the embedded linux operating system. Network information can be exchanged well between the embedded device and other communication systems. Chen Guo-Ju [16] presented s design of ARM processor based embedded ethernet interface. An existing SPI serial device can be converted into a network interface peripheral to obtain compatibility with the network. The design mainly consists of SPI communication module, processor module and ethernet interface module. The embedded real time operating system uC/Linux is transplanted into the LM3S8962 microcontroller. The data can be transmitted between remote SPI serial devices and host computer. Jiang Xiaolin [17] prosposed the framework of hardware platform CC2420 chip supports IEEE 802.15.4 protocol and is used as an RF transceiver controlling chip. LPC2138 is a high performance 32-bit ARM processor used as both protocol controller and data acquisition through the network to improve the transmitting power and receiving sensivity. It realizes the communication between platforms. Mo Guan [18] reported an embedded web server which takes ARM9-S3C2440AL processor as a core. The process of Linux operating system is being transplanted on ARM processor. The understanding of an opensource, small footprint web server and dynamic interaction between the browser and the embedded system by using CGI are especially analyzed. Li Ju-Guang et al. [19] reported a new Networked Control System (NCS), Embedded Ethernet Control System (EECS). The general design methods of smart nodes based on ARM microcontroller for embedded ethernet control system are emphasized. They analyzed the main problem in the typical ethernet control system, network-induced time delay. The main reason of time delay in typical ethernet control systems is disadvantage of traditional network architecture and design of network node. There is no way to resolve the network-induced time delay completely. We propose a new NCS architecture EECS and smart node structure based on high-performance and cost-effective ARM processors, and resolve this problem well. Bo Qu [20] presents the system of remote data monitoring and recording is designed based on the ARM LM3S8962 processor core. A small HTTP server is built in the processor. It is connected with a remote monitoring via ethernet. Ethernet enabled remote data monitoring system with the ability of data recording is built on the chip. This design has the advantages of cost-effective, easily realized, stable and reliable transmission. Chengen Wang et al. proposed the conceptual design of a distributed information system of condition monitoring and fault diagnosis for a growing number of gas turbine-based power generation systems. The condition monitoring and fault diagnosis are of fundamental importance for many industrial systems [21]. Dr. Aditya Goel et al.[22] have developed an integrated wireless SCADA system for monitoring and accessing the performance of remotely situated device parameters such as temperature, pressure and humidity on a real time basis. For this using the infrastructure of the existing mobile network that is based on GPRS technique Supervisory Control and Data Acquisition (SCADA) which is a field of constant development and research. Wu Min-hua [23] proposed the design of web server based on ARM processor, and analyzed the hardware configuration and software implementation. In various internet applications based on client/server architecture, it is better to use embedded web server other than PC server for decreasing volume, cost and power consumption. Embedded web server excels traditional PC-server for its small size, high-performance, portable, and easy to deploy. It will be surely widely used in flexible environments, which require real-time response and high system reliability. Zhan Mei-qiong [24] proposed and designed an embedded web server which is based on Atmega128 microcontroller. With the increasing development of embedded and network technology, more and more embedded systems are connected to the internet, in order to manage embedded equipments more effectively. Lingbo Zhu, Guanzhong Dai [25] proposed a model of embedded DC motor ethernet control system with analysis on transmission time delay and data packet dropout. Based on this model, the ECS is described as a two-state asynchronous dynamical system with output feedback control and then implemented on a platform which uses a PC as a central controller and an ARM9 as a remote controller. Embedded programs including client program and linux module are realized. The platform has proven to be flexible to run different control algorithms and extensibility to add nodes. Zafer Aydogmus et al. [26] proposed a web-based remote access real-time laboratory us-

ing SCADA (supervisory control and data acquisition) control. Internet provides an opportunity for students to access laboratories from outside the campus. The control of an induction motor is used as an example to demonstrate the effectiveness of this remote laboratory, using real instruments (a two-level inverter, measurement equipment, a magnetic powder brake and an ac/dc converter). Z. H. Tee et al. [27] presented a web-based caregiver monitoring system for assisting visually impaired people. The objective of this system is to assist blind and low vision people, to walk around independently and safely in transportation centers, providing speech guidance on their current location and navigation information on how to move to a particular location. The system will also alert caregivers when the visually impaired person needs assistance using a web-based monitoring system. Ma Jun et al. [28] proposed a new design, that is introduced on intelligent data-acquisition node industrial ethernet. Hardware is based on LPC2210, which is an embedded micro-controller with a 32-bit ARM core. The program is based on μC/OS-II, which is an embedded real-time multi-task operating system. The real-time data sampled by the intelligent node in the field will be sent to the host control computer. The intelligent node is managed and maintained by the upper control computer. The application practice has proved that the intelligent node based on ARM is greatly worthy of use and spreading. Adnan Salihbegovic et al. [29] proposed the synthesis and architecture of a multilayered distributed SCADA/HMI system that is used for monitoring and control of refinery terminals for truck loading and oil products pipeline shipping. The Network-centered, distributed PLC system with SCADA functions and several levels of fieldbuses, interconnected with the HMI part of the system. CAO Qing-nian et al. [30] proposed to design a embedded linux network communication system based on ARM9 platform. The hardware circuit was built on connecting the microprocessor S3C2410 and the industrial net chip CS8900A, and the software system was designed which includes transplanting the embedded linux operating system. The server was built based on the ARM9 platform and embedded linux system, communication between the server and the client was realized successfully. Chen Guo-ju [31] presented a design of ARM processor based embedded ethernet interface. In the design, an existing SPI serial device can be converted into a network interface peripheral to obtain compatibility with the network. The design mainly consists of the SPI communication module, processor module and ethernet interface module. The embedded real time operating system μC/Linux is transplanted into the microcontroller LM3S8962. This design can be used widely in remote data acquisition and control system in the industry. Guoling Liu et al. [32] reported a new design of the remote monitoring system based on ZigBee and STMP. Users can use a PC or mobile phone to achieve real-time data acquisition and control instruction implementation remotely. Except for the gateway, other nodes work in sleep mode most of the time on the system, and thus the lifetime of the whole system improves efficiency. Zhao Ruimei et al. [33] proposed a design of ARM processor-based embedded ethernet interface. SPI serial device can be converted into a network interface peripheral to obtain compatibility with the network. It mainly consists of the SPI communication module, processor module and ethernet interface module. The embedded real time operating system μC/OS-II is transplanted into the microcontroller LM3S8962. The data can be transmitted between remote SPI serial devices and host computer. Mo Guan et al. [34] reported an embedded web server, which takes Samsung Corporation's ARM9-S3C2440AL processor as core. The design uses linux as operating system, and the system hardware architecture is presented. Then the process of the Linux operating system being transplanted on ARM is introduced. The realization of a open-source, small-footprint web server and dynamic interaction between the browser and the embedded system by using CGI are especially analyzed. Finally the implemented embedded web server is tested to indicate that it is responding rapidly and operates efficiently and steadily, which achieves the expected design purpose. Bo Qu et al. [35] reported the system of remote data monitoring and recording is designed based on the core processor of LM3S8962. A small HTTP Server is built in LM3S8962 processor. It is connected with a remote monitoring terminal via ethernet. The data can be recorded in the SD card through the SPI interface at the same time, for the sake of the versatility using the FAT file system. Ethernet enabled remote data monitoring system with the ability of data recording is built on the chip. This design has the advantage of cost-effective, easily realized, stable and reliable transmission and so on. Yang Zhongbo et al. [36] presented a kind of distributed online water quality monitoring system by combining CAN bus, embedded web and ethernet technology. The measuring principle is based on spectrophotometry used in the system. The microprocessor C80S1F040 is used in water quality monitoring node, the water quality signal is obtained by the optical sensors. The hardware platform of embedded web server based on S3C241OX is constructed. The system can achieve the real-time remote water quality monitoring and alarm with CGI technology, and have a good price-performance ratio. Jie Zhang and Xuedong Zhang [37] presented a novel design an embedded environmental monitoring system, for grain storage based on ARM technology. They transmit data to each other over industrial ethernet or GPRS networks. On this basis, the implementation methods of data monitoring terminal for grain situation based on S3C2410 microprocessor are studied. Lixia Liu [38] reported a new kind of embedded web server system based on SX52 communication controllers. Aimed at the characteristic of embedded application, it simplifies the TCP/IP protocol and provides a kind of "thin server" solution. Manivannan M et al. [39] proposed the design of Data Acquisition and Control System (DACS) as the challenging part of any measurement, automation and control system applications. The realtime Linux operating system is the better choice for any embedded real time applications with minimal real time constraints. GPRS module eliminates the need of the internet software suite in ARM processor and mass storage for web applications and allows the user to interface with many real time embedded applications like remote DACS and embedded processors like ARM Core. Raja Vara Prasad Y et al.[40] proposed to develop an effective solution for pollution monitoring using wireless sensor networks (WSN) on a real time basis namely real time wireless air pollution monitoring

system. A lightweight middleware and a web interface to view the live pollution data in the form of numbers and charts from the test beds was developed and made available from anywhere on the internet. Hua Fang et al. [41] proposed the LPC2200ARM7 processor combined with an embedded real-time operating system μc/OS-II. It realizes the data acquisition system and remote transmission through the wireless communication and can be used in a wider field. It has many channels online real-time data acquisition, processing and transmission, and other functions. Joby Antony et al. [42] presented a new kind of expandable and distributed a large I/O data acquisition system based on low cost microcontroller based web server. The hardware used here is an 8-bit RISC processor with ethernet controller and software platform AVR-GCC for firmware and Python for OS independent man machine interface. This can measure all kinds of electrical and thermal parameters such as voltage, current, thermocouple, and RTD. The measured data can be displayed on web pages at different geographical locations. Indu Hariyale et al.[43] proposed to develop such an embedded web server system in which the four layer TCP/IP protocol will be implemented inside ZigBee protocol. N. Monita et al. [44] reported a web based remote monitoring and controlling system that would directly connects the equipment to the network as node using Atmega16 processor and network module. It also it greatly decreases the system building cost. Alen Rajan et al. [45] reported a system consists of an ARM cortex processor LPC1768 with an integrated ethernet interface and the whole system can function as a web server. Since the ARM processor has fast execution capability and ethernet standard can provide internet access with reasonable speed. This system is suitable for enhancing security in industrial conditions by remotely monitoring various industrial appliances where high safety and care is a necessity. Varsha Karambelkar and A.A. Shinde [46] proposed the system to capture waveforms at higher speed to implement the design using ARM microcontroller. The basic idea is to implement the design using ARM controller to capture waveforms at higher speed. ARM based embedded systems, RISC machine unlike simple processors provide a low-cost solution to meet the request of flexibility and testability as logic analyzer is a dedicated application. Kumbhar Trupti Sambhaji and Patil S.B. [47] proposed a design of PIC microcontroller with the ethernet interface. In the design, existing SPI serial devices can be converted into a network interface peripheral to obtain compatibility with the network. The system is implemented to monitor industrial parameters like temperature, speed with help of different sensors which can act as a network node using the LAN to SPI communication. S.A.N.Sandeep and P.Malyadri [48] reported principles and to design a system for internet based data acquisition and control by using advanced RISC machine. The embedded device communicates through general packet radio service (GPRS), and it also helps us to communicate with the GSM as most of us were communicating with GSM. This makes an accessible from anywhere in the world through a web server built into the embedded device. The proposed system eliminates the need for server software and maintenance. R.V. Sonawane and A.A. Naik [49] reported the design of a new type of gateway for data converting from serial ports to ethernet based on embedded system is highlighted. The design is based on ARM7 processor and serial ports to the ethernet data conversion gateway, which will convert the serial data of various components to ethernet data. N. Ram kumar and Dr.K.Sasidhar [50] proposed a design is based on S3C2440 processor, a 16/32-bit microcontroller with ARM920T as its core. Developing an embedded display driver for a board based on S3c2440 (ARM9) processor, and it's having a DM9000 ethernet controller to enable ethernet support for embedded applications on the board. R. Lakshmi Narayana et al. [51] presented the system to support the capabilities of remote supervisory and controlling based on web services technology for embedded devices. The system adopts browser/server mode and realizes the interconnection of the embedded devices like ARM Cortex-M3 processor target board. It is applicable to a variety of fields like industrial control, automation and medical instrumentation. Rekha George and Varghese Paul [52] reported a design of real time personnel monitoring system based on wireless technology. The traditional data acquisition system using wires, it cannot be satisfy these requirements due to its heavy cost and impracticability. ARM embedded processor and Wi-Fi module are used as hardware platform. Data transfer over the wireless network is based on the TCP/IP protocol which is a part of the Wi-Fi module. The system is compatible with IEEE 802.11n which is more throughput and range than other wireless technologies like Bluetooth. Gopi Krishna S et al. [53] proposed the remote monitoring of a medical device in critical conditions. It is an emerging trend where cost reduction, portability and mobility are the main focuses. The controller that is used is an ARM cortex-m3, which supports all the networking protocol. CGI script will act as a bridge between the controller and the browser, helps for accessing the devices that are connected to the controller from the browser.

## 3 Design And Implementation of Web based Embedded System for Radar Transmitters Remote Monitor and Controller

Radar transmitters were installed with control and interlock units based on LSI TTL logic devices, with control unit and interlock spreading over 15 PCBs in each transmitiers. The interlock subsystem receives input from the sensors that are placed in the amplifier cavities and monitors a total of 12 safety interlock parameters. This unit has independent logic circuits to process inputs for indication of any abnormal voltage, temperature and current deviations and also switch off the transmitter subsystems in case of any faults with the help of control unit resides in the transmitter. This ensures the protection of expensive devices from any failure in the transmitter system. Simplification of radar testing, control and interlock methods is utmost important in this complex system. The development of industrial ethernet technology facilitates the installation of remote monitoring/controlling for improving the real-time performance of radar system.

### 3.1 Hardware Design

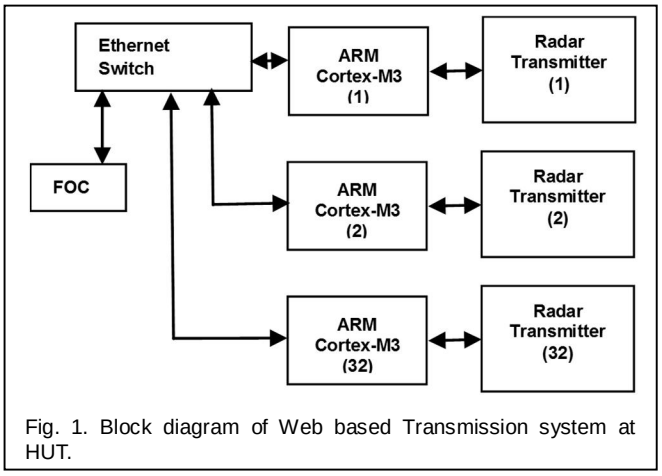


Fig. 1. Block diagram of Web based Transmission system at HUT.

The hardware implementation consists of the development of ARM Cortex-M3 microcontroller based control and interlocking system in transmitter. The ARM Cortex-M3 is a low power controller that features low gate count, low interrupt latency, and low cost debug intended for deeply embedded applications that requires fast interrupt response features.It is with ARMv7-M architecture.The 32-bit device architecture delivers the art implementations for FPGA and SoCs. With the improved Thumb2 instruction set, support a 4GB address space, provide a bit addressing and interrupts with at least 8 interrupt priority levels. The inbuild Ethernet peripheral is used to send and receives the data or commands from embedded target board to a personal computer. The ARM Cortex-M3 acts like the brain of web based remote monitor and controller system for MST radar transmitter control and interlocking system. The embedded target board is interface between transmitter control and interlocking system and to remote computer for safe monitoring and also controlling of transmitters control and interlocking system through ethernet is shown in Fig.1. The two 10-bit ADCs 9 channels ADC1 to ADC9 are used to interface triode amplifier sensors PDR, DR and HPA Heater currents, Anode supplies, Airflows. The output controls pins PJ5 and PJ7 are interfaced to the Tx ON/OFF and RF ON/OFF control circuitry in control and interlocking system.

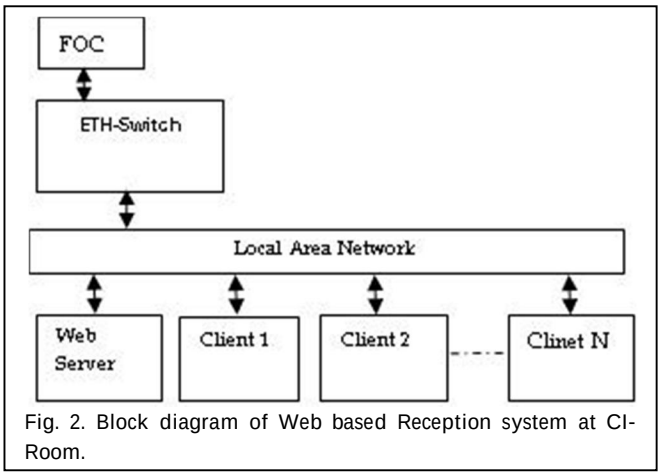


Fig. 2. Block diagram of Web based Reception system at CI-Room.

The web based centralized system monitors the status of all 32 transmitters remotely is shown in Fig.2. Records 9 parameters through web server using with MS-SQL data base system. This ensures the proper functioning of the control and interlocking system in transmitters for safty guard of very expensive vaccum based triode amplifier chain.

### 3.2 Software Implementation

The software implementation of the system is developed using embedded C, ASP.NET, C# and MS-SQL database. The software tools Visual studion 2010 and Keil-4 are used to write and debug the application. The microcontroller unit software receives analog signals from transmitter and converts into digitalized format, then frames into ethernet packets for transmission of web server. The web server receives the digitized data from the MCU using the TCP/IP protocol and displays on the web page with .NET framework and web application. The SQL database server stores the sensors digitized data for future analysis which is running on the web server. A common web browser acts as a client.

## 4 EXPERIMENTAL TEST

The total 9 parameters values are shown in Fig.3. When the transmitters interlock and control system is ready to use. The operator is required to press the Transmitter ON button on the web page before monitoring the parameters. Stable RF output power is desirable for radar transmitters for estimating correct target characteristics. The first left text box is the RF Power cut off of the RF drive to the transmitter in the event of malfunctioning of any transmitter parameters, or in absence of appropriate synchronization pulses required for pulsed radar transmitter operation. This is interfaced to the safety interlock and control system to switch off RF drive to the transmitter by RF ON/OFF control on webpage. Another text box is Tx Power and it indicates the corresponding transmitter is ON state. The right top text box is the selection tab to select the transmitters through IP address of the interlock and control system arrangement in transmitters. The remaining 12 text boxes are the 3 groups PDR, DR and HPA. Each group has a Cathode voltage, Fan sense, Filament current and Anode voltage.

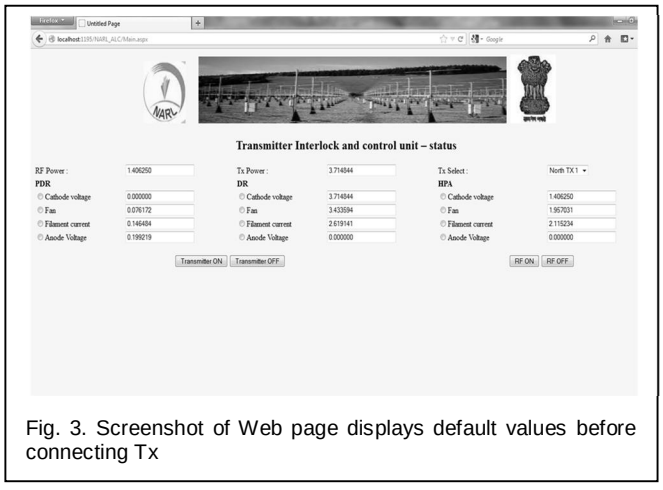


Fig. 3. Screenshot of Web page displays default values before connecting Tx

The Fig.4 is to get previous parameters data from web server. It is used to analyse the data with the corresponding date, time and year. The first left side text box is to enter the starting date of the experiment data and right side text box is to enter the end of the date of experiment data. After the correct values are entered in text boxes then press the GetData button will get the historical parameters data.


Fig. 4. Screenshot of Web page displays the sensors data in tabular form.

## 5 CONCLUSION

In this paper, different design techniques available in the literature using ethernet, webserver and Linux based systems for remote monitor and controlling of electronic equipments or industrial parameters. The web based remote monitoring and controller system for MST radar 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 devices like ARM Cortex-M3 Processor target board. Therefore, remote users can access, control and manage the embedded devices "ARM Cortex-M3 processor through the MST radar 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.

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