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Development of remote monitoring and control of Web-based distributed data acquisition system

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ABSTRAC

To design of Distributed Data Acquisition System (DDAS) and its control is a challenging part of any measurement, automation and control system applications. The Web based distributed measurement and control is slowly replacing parallel architectures due to its non-cage architecture which reduces complexities of cooling, maintenance etc. for slow speed field processing. This paper proposes a new kind of remote distributed I/O data acquisition and Control System (DDCS) based on low cost embedded web server for industrial process plant; whose hardware boards use 8-bit RISC processor with Ethernet controller, and software platform use AVR-GCC for firmware and Python for OS independent man machine interface. This system can measure all kinds of electrical and thermal parameters such as voltage, current, which are used for Industry plants which provides an industrial compatible protocol over TCP/IP that achieves the same functionality as Profinet but at a much higher bandwidth (10/100 Mbps). The measured data can be displayed on web pages at different geographical locations, and at the same time can be transmitted through RJ-45 Ethernet network to remote DAS or DCS monitoring system (clients) by using HTTP protocol. A central embedded single board computer (SBC) can act as a central CPU to communicate between web servers automatically. The novelty of this proposed system is a substitute of web based PLC for industry application.

Keywords— **Distributed Data Acquisition System, AVR-GCC, Embedded Web server; remote I/O data; embedded single board computer.**

I.INTRODUCTION

Remote monitoring and intelligent maintenance is one of the most important criteria for maximizing production and process plant availability 1 -3. Majority of industries use distributed data acquisition system and its control (DDAS) for high reliability, improved response time, improved operator interface to plant, improved accessibility of plant data to engineering & management personals and improved historical storage and retrieval system. This study proposes an Embedded Web based remote monitoring system as part of DDAS of process plant.

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II.EXISTING DATA ACQUISITION SYSTEMS

A. Distributed data acquisition and Control System (DDACS)

DDACS collects data from process plant for formulating advanced process control strategies (Fig. 1).

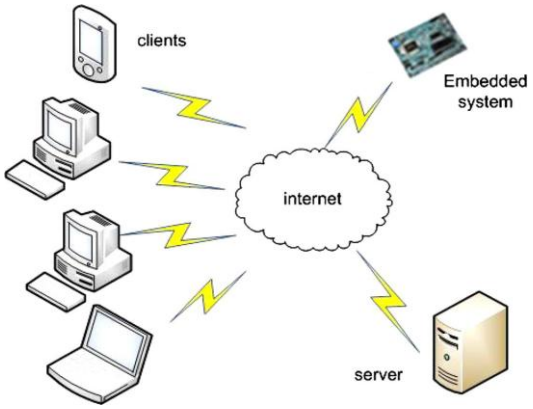

Fig. 1 General Diagram of a data-acquisition and control system.

B. Supervisory Control and Data Acquisition (SCADA) System

SCADA system is a software package positioned on top of hardware. It is interfaced with industrial processing units through Programmable Logic Controllers (PLCs). It is not always possible and feasible to monitor industrial processing units physically in extreme environmental conditions of process plants. This leads to improper maintenance causing breakdown. This delay in identifying causes of failure renders industrial units unusable. Again implementation is a cost effective. Such problems can be solved by constantly monitoring and control plant using distributed embedded web based data acquisition system.

III.PROPOSED DISTRIBUTED DATA ACQUISITION AND CONTROL SYSTEM (DDACS)

The whole structure chart of the remote distributed data acquisition and monitoring system based on embedded web server platform is shown in Figure 3. In any industrial plant running with DACS, following parameters of DACS are : i) alarm (process alarms, critical alarms etc.) monitoring; ii) mimic/graphic display; iii) trend display; iv) operator guidance display; v) system & diagnostic display; vi) control; vii) bar chart; viii) sequence display; and ix) fault analysis display. Alarms are used in any plant for ensuring fault free operation. In the scheme of the system, the remote I/O data acquisition modules are developed as embedded web servers having static IP with port 80, which can be widely used to diversified industries such as electric power, petroleum, chemical, metallurgy, steel, transportation and so on. This system is mainly used for the concentrative acquisition and control.

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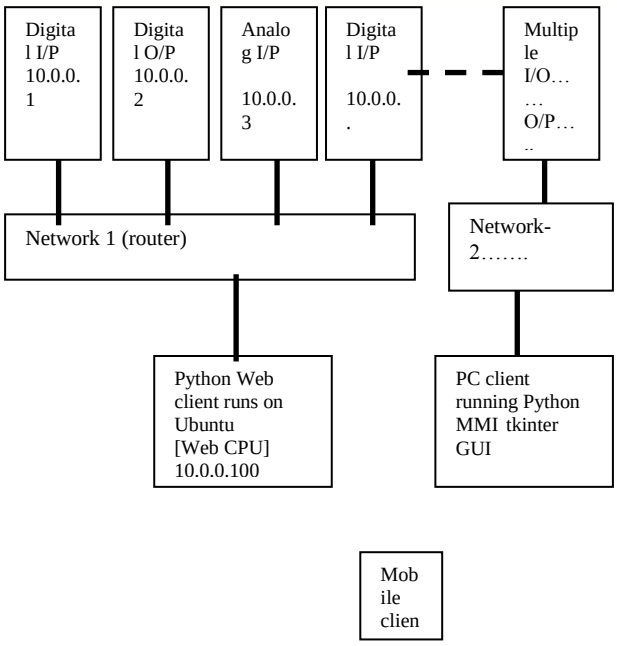

Fig. 2 Architecture of proposed remote monitoring system for distributed control of industrial process plant

The data in the embedded controller platform is transmitted to the remote client centers by Ethernet. At the same time, these data can be stored in the real time of the server. The system has the dual redundant network and global communication function, which can ensure the disturb rejection capability and reliability of the communication network. The hardware platform of the proposed system based on embedded web server, a smart small TCP/IP stack by Guido Socher [1], uses 8-bit RISC processor with Ethernet controller. The MMI software platform uses the Python which runs HTTP Client GET-method on Ubuntu operating system. The system is based on utilizing Embedded Web Servers (EWS) technology to design a Web-based Distributed Data Acquisition System (DDAS).

The overall distributed I/O data acquisition and control system based on embedded web server has each acquisition and control device equipped with 24-way acquisition/control channels for Analog input, Digital input & output. Each I/O channel can select a variety of electrical and non electrical signals like current, voltage, resistance etc. The measured data are stored in memory in which the memory is act as a data base during web server mode. The Ethernet controller directly supports the Ethernet service and RJ-45 communication. Hence the data has been stored and controlled by some other PCs or network via Ethernet.

IV.SOFTWARE DESIGN AND REALIZATION OF THE SYSTEM

A. Python for Control applications Headings

Python is a high level object-oriented programming language whose main features is that it is intrinsically very readable. PyQt are a set of Python bindings for Qt- a cross-platform application development framework that is used for creating GUI programs. PyQt allows creating custom-designed, Python-based GUI easily.

Python runs on Windows, Linux/Unix, Mac OS X.

The basic functions including task management, system management, timer management, information management, queue management and so on. These functions are used though GUI service functions of the core.

The pseudo code for acquiring data from different I/Os are given below. Data1, data2, data3, data….n represents every I/O read return value which contains status of read. Database1..n.html will contain the result data string.

```
mydatastations = [ ’10.0.0.1’, ’10.0.0.2’, ’10.0.0.3’]

import httplib

conn1 = httplib.HTTPConnection("10.0.0.1")

conn1.request("GET", "/database1.html")

r1 = conn1.getresponse ()

print r1.status, r1.reason

data1 = r1.read ()

save data1 into MMI data base

  conn2 = httplib.HTTPConnection("10.0.0.2")

conn2.request ("GET", "/database2.html")

r1 = conn2.getresponse()

print r1.status, r1.reason

data2 = r1.read()

save data2 into MMI  data base

import httplib

conn3 = httplib.HTTPConnection("10.0.0.3")

conn3.request("GET", "/database3.html")

r1 = conn1.getresponse()

print r1.status, r1.reason

data3 = r1.read()

save data3 into MMI  data base
```

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A test GUI designed to test such a set-up in Python is given below:

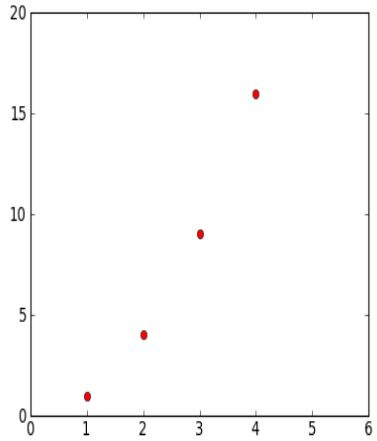

Fig. 3 Pyplot data plot

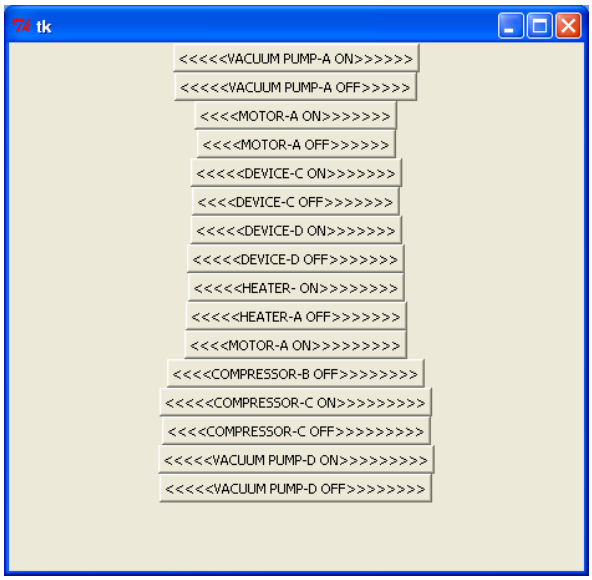

Fig. 4 A sample python control test screen

A web server concept is useful to stream data through text files through standard http clients. So designing an MMI can have multiple options of language selection. Some of the common options to explore web server PLC MMI are LabVIEW, Python, Qt, PyQt, HTML & JavaScript.

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V.COMMENTS ON THE PROTOTYPE

The proposed system has a lot of benefits. The usage of standard protocols both for the acquisition network and for the distributed remote controlling. Moreover the Internet connection can be realized using both Ethernet and also be realized by Wi-Fi data link protocols [1]. Also embedded web servers guarantee a high robustness in terms of boot time and they can work also without any power supply (PoE) [1]. The prototype can be easily extended to more devices or machines. The system is demonstrated to be suitable for different embedded applications by attaching several real-time modules through appropriate interfaces.

Regarding the security issue, the prototype takes into account only a cipher authentication. So, adding security to this system is currently not in the scope of this work, presently it is for network which is private and standalone. So, using the screenshots coming from the developed application we will show how it is possible to use the proposed data acquisition system for a controlled channel. For that we have to reach the embedded web server by typing its address into the web browser (for example we tested the prototype in a LAN, where the server has the 10.0.0.40 address) and each web clients differ by the IP addresses. This produces the login form of Fig. 4. During the programming stage we set the credentials of the authorized users.

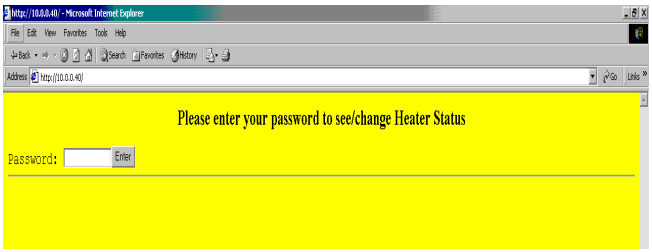

Fig. 5 Snapshot of Home page, PC client 1

Fig. 6 Snapshot of Monitor and Control page, PC client 2

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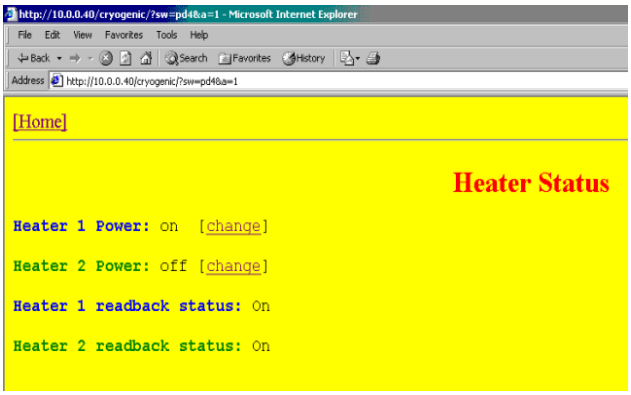

Fig. 7 Snapshot of Status and Control page, PC client 3

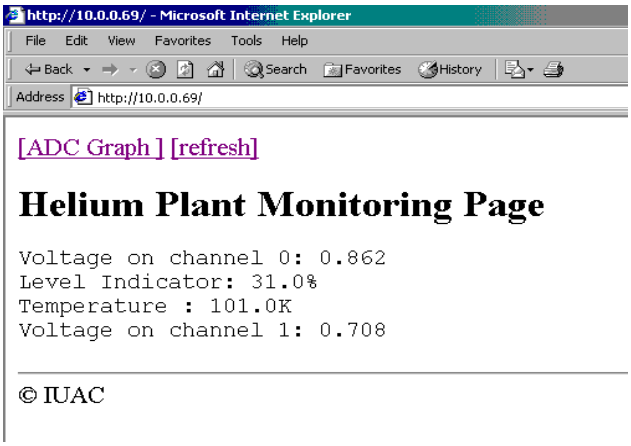

Fig. 7 Snapshot of Monitering page, PC client 4

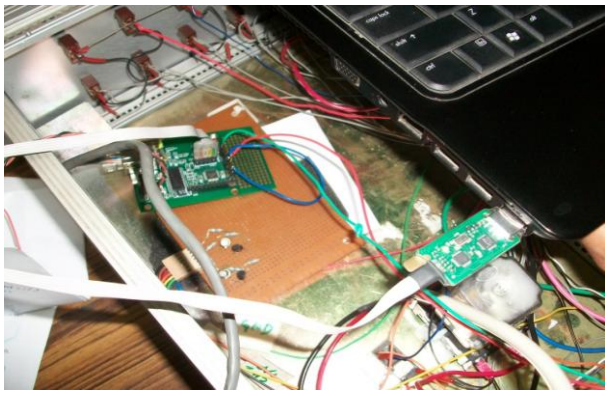

Fig. 8 Snapshot of Installation Syatem

VI.CONCLUSIONS

A distributed and data acquisition and control system based on embedded Web server is designed in this paper. The system adopts Browser/Server mode and control the remote systems. Therefore, remote users can control and manage the operation using a Web browser over the internet.

With the rapid development of the field of industrial process control and the wide range of applications of network, intelligence, digital distributed control System, it is necessary to make a higher demand of the data accuracy and reliability of the control system. This embedded system can adapt to the strict requirements of the data acquisition and control system such as the function, reliability, cost, size, power consumption, and remote access and so on. This system operated by DDACS mode to acquire the signals and control the devices remotely. Embedded web server mode is used to share the data with clients in online. This concept can be widely applied to write MMI using Lab VIEW, .NET etc.

VII.ACKNOWLEDGMENT

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