Internet of Things (IoT) based Data Acquisition system using Raspberry Pi

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Abstract *— Data Acquisition is the process of measuring and analysing various electrical and physical entities like voltage, current, temperature, pressure etc. A DAQ system consists of sensors, signal conditioning circuitry, analog to digital converter, and application software. DAQ system has a wide range of applications including Research and Analysis, Control and automation, Design validation and Verification. DAQ's applications are not only limited to medical instruments, industrial equipment and other home appliances but are used for variety of products.*

Generally DAQ system consists of Sensors, acquired data measurement hardware and computer software. In contrast our System will be equipped with Raspberry Pi 2 which is Linux based powerful machine with a 900MHz quad-core ARM Cortex-A7 CPU and 1GB RAM and thus eliminates the need of any external computer software. Our compact Linux based machine will be having inbuilt Data Acquisition capability and an ADC converter which also supports an HDMI display, we will provide a Linux based application which can run on HDMI display. Our system covers all possible means of communication wireless and wired for ease and variety of operations. It will be equipped with WIFI and Bluetooth for medium range data transmission while GSM and Ethernet for long range transmission. The system will be using thus various Internet of Things protocol options. We will also provide support for Android based application so that acquired data can be analysed by our application using various means of communication. In this project we will be explaining working and acquisition of data using skin response and temperature of human body. With the number of connectivity options and various connectivity ranges, the system is generalized for being used for several applications and also it is portable to use.

Keywords — *data acquisition system, raspberrry pi, internet of things, ethernet, wifi, gsm, sensors, ADC, rtc, QT, GUI.*

I. INTRODUCTION

The Data acquisition system is simply defined as the system that either monitors or controls the parameters in the outside world. In today's time each and every field cannot be thought of without considering these data acquisition systems. For medical instruments, industrial equipment, appliances for home etc. has a necessary need for these systems.

Hence the need of such data collection and processing the collected data for further use led to the development of Internet of Things(IOT) based Data Acquisition system using Raspberry Pi. The system will be designed to collect (acquire) data from the skin response and temperature of human body. The basic need was to develop our system was portability of the system, no range limitation and also more than one connectivity options for transfer of data. The system will also be capable of displaying the acquired data over HDMI display.

Further, it is supposed to be designed in such a way that it transfers these data to various ranges. Thus it will be useful for data acquisition and transfer from short distances to longer. It could be regarded as a general purpose system with multiple transfer options. The system will be designed to be equipped with all possible features which enhance the working capability of the system. The system will be consisted of Raspberry Pi which is one of the advanced processor and has advantages like low price and small size. Our system will consist of an Analog to Digital conversion module which will be used to convert the analog output from the sensors to digital values for further processing. The Raspberry Pi also consists of SD card embedded in the same board, which will be used for storing the sensors data. The system will be using a number of protocols for achieving the concept of Internet of Things for our application. The system will be able to communicate with all possible wired or wireless ways thus have multiple way of communication. Wi-Fi will be used for medium range while GSM and Ethernet will be used long range transmission. Apart from using these, a Linux based application will be provided to run on HDMI display. Support to the devices will be provided with an Android application.

A. Proposed Block Diagram

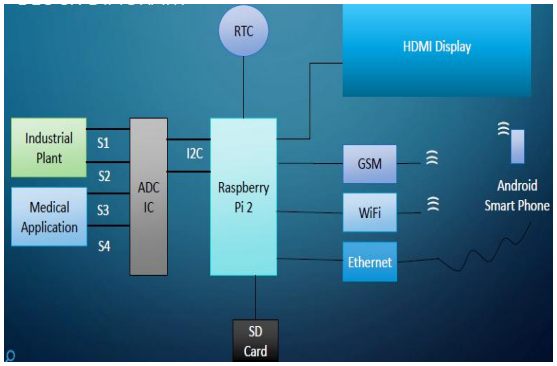

Fig. 1 Block Diagram – IoT based DAQ

The Sensors RTD senses the temperature and provides value in the form of resistance and a signal conditioning is used to convert this value to voltage. Similarly, the Grove Skin Response sensor measures the electrical conductance of the skin and provides analog output. Then the value is provided to the ADC module which converts all analog data into digital form, which is further introduced to Raspberry pi. Here at the processor all calculations regarding the sensor are done and the values of sensor are converted in human readable form which is also fed to the SD card at certain intervals. The RTC is used to keep track of the current time for the readings from sensor. Also an LCD display is used to show the current values of sensor. The values and related data can be transferred using GSM in the form of messages. We have also provided the WIFI facility for medium range of transfer. Ethernet option is also available. The mode of transfer can be selected through a software setting provided in the firmware.

B. Hardware Requirements:

1) ***ADC:*** The dc voltages acquired from the sensors are fed to this block which is then converted into digital data for further processing in the system. We will use the High-Precision AD/DA Board to add high-precision AD/DA functions to the Raspberry Pi. It includes on board ADS1256, 8ch 24bit high-precision ADC (4ch differential input), and 30ksps sampling rate.

Fig. 2 ADC expansion Board

2) ***Raspberry pi:*** The Raspberry Pi is a series of credit card–sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux) C, C++, Java, Perl, Ruby and Squeak Smalltalk.

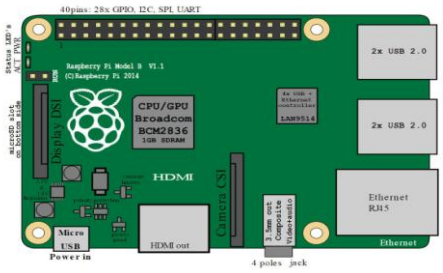

Fig. 3 Raspberry Pi Board Layout

3) ***GSM Modem:*** GSM MODEM is one of the wireless devices that are designed for communication of a computer with the GSM network. It does the following operations:

- Receive, send or delete SMS messages in a SIM.
- Read, add, search phonebook entries of the SIM.
- Make, Receive, or reject a voice call.

We have used SIM900A GSM Modem module with SMA Antenna.

Fig. 4 GSM Modem

4) Ethernet: Ethernet is the most widely installed local area network (LAN) technology. Here we will be using Ethernet as one of the means of transferring data from sensors to all desktop present in the network.

5) ***Wi-Fi:*** The Wireless adapter translates data into radio signal and transmits it using an antenna. We are using Edimax EW-7811Un 150 Mbps Wireless 11n Nano Size USB Adapter which complies with wireless 802.11b/g/n standards with data rate up to 150Mbps.

Fig. 5 Wi-Fi adapter

6) ***RTC:*** RTC holds information like current time (In hours, minutes and seconds) in 1 hour/24 hour format, date, month, year, day of the week, etc. and supplies timing reference to the system. We have used DS1307 RTC module which is shown below.

Fig. 6 RTC

7) Galvanic Skin Response: GSR, standing for galvanic skin response, is a method of measuring the electrical conductance of the skin. Strong emotion can cause stimulus to your sympathetic nervous system, resulting more sweat being secreted by the sweat glands. Grove – GSR allows you to spot such strong emotions by simple attaching two electrodes to two fingers on one hand, an interesting gear to create emotion related projects, like sleep quality monitor.

8) Resistance Temperature Detector: Resistance Temperature Detectors are temperature sensors that contain a resistor that changes resistance value as its temperature changes. We will use PT100 high precision Platinum resistance heat resistance sensor KG984

9) Thermocouple: Thermocouples are used to sense temperature and generate voltage rather than resistance, capacitance etc.

10) Heart Rate: Heart rate ear clip contain an ear clip and a receiver module.

11) *SD Card:* We will be using 16 GB class 10 SD card for storing sensors data for a week.

C. Software Requirements

1) QT Creator for GUI interface

2) Device Drivers in c for interfacing all hardware modules

3) Android for mobile application

II. CONCLUSIONS

The Internet of Things based Data Acquisition System will be equipped with different possible ways of data transmission. It uses Raspberry Pi as Processor. The data transmission will take place with WIFI and Bluetooth for medium range and GSM and Ethernet will be used for long range transferring capabilities. All the options of data transfer will be supported with Android application to observe and analyze the data and control accordingly. The system will be capable of skin response detection and heart rate detection of the human body and also can be used in an industrial plant to monitor the temperature. The system will be a generalized system to be used in various fields such as for medical, industrial, robotics etc. with all connectivity options and with different range options. The system is small in size and also portable.

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