# Global Temperature and Humidity Monitoring System For Reducing Natural Disaster Damages

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***Abstract***

*The main goal of this paper is to monitor the temperature and humidity values in earth to prevent damages while occurring natural disaster. The temperature and humidity are the main issues to predict disaster a minute ago. This paper aims to provide a solution to natural disaster damages such as human life, property etc., by using Sensirion Humidity and Temperature (SHT71) Sensor. The proposed system implemented with Advanced Risc Machine(ARM) processor with porting of Linux based Real Time Operating System(RTOS). Here in addition, the buzzer facility is there to intimation sounds when over limit and SD card for further reference and to stores the data instantly and contiguous. These things make to reduce damages in natural disaster.*

***Keywords****--ARM Processor,SHT71 Sensor,RTLinux, WSN,RTC, Communication Protocol, Gateway, SD card.*

## I. Introduction

Disaster situations [11] like earthquakes, floods, torrential rains etc., bring large damages. It is critically important that systems are designed to predict natural disaster [9]. It will help to reduce damages in earth and provide quick first aid, fire fighter, emergency services for medical, food, security, so that effective assistance to the affected people is provided. Hence the monitoring and control system established with LabView [3] tool and interfaces of microcontroller. But proposed system to share their ideas in this paper, to implement the monitoring and allotment the temperature and humidity system with ARM [2] .The proposed system which is implemented with RTOS [4] is having multitasking capability to monitor many tasks and controlling it. Also the system can add multi applications by patching to kernel. So the system updates also possible when it required. The ARM Controller is recent one and it support higher end applications.In here we choose the ARM controller ported with real time operating system(RTLinux).The system connected via the wireless sensor network(WSN) for monitoring remote area. RTLinux[4] is a hard real-time deterministic multitasking kernel for ARM Controller. RTLinux running with the use of Linux command and ANSI C source code for system and compilation. The hard real-time property makes it perhaps to control robots, data acquisition systems from RTLinux applications. The complete architecture of this paper has been divided into 3 parts: the system hardware details, software detail and conclusion.

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## II. Hardware Details

Real-Time Module support for USB storage devices, such as thumb drives and external USB hard drives, for RT targets.It have onboard USB hardware refer Fig 1.

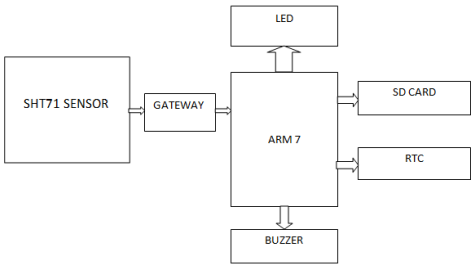


**Figure 1: Block diagram of Global monitoring system**

### *A. Arm Processor*

ARM [2] designs microprocessor technology is an heart of advanced digital products, from mobile phones and digital cameras to games consoles and automotive systems, and is leading intellectual property (IP) includes high-performance, low-cost, power-efficient RISC processors, peripherals, and system-on-chip (SoC) designs via involvement with organizations like Virtual Socket Interface Alliance (VSIA) and Virtual Component Exchange (VCX). ARM also has design and software consulting services.ARM7 processor family continues to be used today for simple 32-bit devices, more powerful and feature-rich ARM processors which provide advanced technique over the ARM7[2] family. System designers wishing to upgrade from ARM7 benefit from a robust ARM processor providing multiple upgrade options, including the latest Cortex processors. In most cases migration is straightforward, and proide significant benefits in PPA, features and efficiency.ARM's architecture is compatible with all four major platform operating systems: Symbian OS, Palm OS, Windows CE, and Linux. As for software, ARM also works closely with its partners to provide optimized solutions for existing market segments.

### *B. SHT71*

SHT71 [1] sensor is used for monitoring temperature and humidity and it is Sensirion's family.The sensors integrate elements plus signal processing in compact format and provide a fully digital output. A unique capacitive sensor element is used for measuring relative humidity and temperature is measured by a band-gap sensor. The applied CMOSens® technology is excellent reliability and stability. Both sensors are seamlessly coupled to a 14bit analog to digital converter and a it is serial interface circuit. The final results in superior signal quality, a fast response time and insensitivity to external disturbances. The Long term exposures to conditions outside normal range, especially at humidity >80%RH, may temporarily offset the RH signal (+3 %RH after

60h).Reconditioning Procedure" to accelerate eliminating the offset. After return to normal range and it will slowly return towards calibration state by itself. Prolonged exposure to extreme conditions may accelerate ageing. It will maintain high accuracy specifications the sensor will not be soldered. The Standard wave soldering ovens may be used at maximum 235°C for 20 seconds.Sockets may be used such as "Preci-dip / Mill-Max R851-83-004-20-001" or similar. A manual soldering contact time must be limited to 5 seconds at up to 350°C7.After wave soldering the devices should be stored at >75%RH for at least 12h to allow the polymer to rehydrate. Alternatively the re-hydration process may be performed at ambient conditions (>40%RH) during more than 5 days. In no case, neither after manual nor wave soldering, a board wash shall be applied.

*C.* ***Gateway***

The wireless gateways [2] provide the functionality of a Wi-Fi router and voice modem in a single device. The wireless gateway functions such as port blocking, diagnostic tools, firewall, port forwarding and WI-FI Protected Setup.

**Table 1.1: Pin description**

| Pin number | Name | Type | Description |
|---|---|---|---|
| 1 | NCS | I | SPI card select (CS) (negative logic) |
| 2 | DI | I | SPI serial data in (MOSI) |
| 3 | VSS | S | Ground |
| 4 | VDD | S | Power |
| 5 | CLK | I | SPI serial clock (SCLK) |
| 6 | VSS | S | Ground |
| 7 | DO | O | SPI serial data out (MISO) |
| 8 | NC nIRQ | O | Unused |
| 9 | 1 | O | Unused |

It provide a secure wireless home network and connects your computers, laptops, and other Wi-Fi electronic products such as game systems, tablets The wireless gateway function in here is to receive the task from sensors and pass the task to ARM Processor.

ISBN: 978-0-9948937-1-0

*D.* ***RTC***

The DS1307 Serial Real time clock(RTC) [2] will counts seconds, minutes, hours, day of the week, date, month and year.It is used to provide precise time and date which can be used for various applications.The RTC is low power, 56 bytes of non-volatile RAM for data storage,8 pin Dual Inline Package and 2 serial interface wire in bi-directional.It is powered by an internal lithium battery. As a final result of which even if the power of the system is turned off, the RTC clock keeps running. It plays a very important part in the real time systems like digital clock, attendance system, digital camera etc.Using RTC, designing such application has always been a good designer's choice but the beginning might be a bit difficult. There are two steps of handling the time factor.One is to generate the time internally by using programming the timers of the controller and other is to use an RTC [2].The battery backup mode is less than 500nA.It has automatic power switching to battery when power fails at 25°C.In applications where time stamp is needed, RTC is a good optionThe DS1307 RTC is connected to ARM controller by using $I^2C$ bus with time counters refer Table 1.

| **Unit** | **Counting cycle** | **Carry to next unit** | **Content of the month counter** |
|---|---|---|---|
| Seconds | 00 to 59 | 59 to 00 | - |
| Minutes | 00 to 59 | 59 to 00 | - |
| Hours(24) | 00 to 23 | 23 to 00 | - |
| Hours(12) | 12AM<br>01 AM to 11 AM<br>12PM<br>01 PM to 11 PM | -<br>-<br><br>-<br>11PM to 12AM | - |
| Date | 01 to 31<br>01 to 30<br>01 to 29<br>01 to 28 | 31 to 01<br>30 to 01<br>29 to 01<br>28 to 01 | 1,3,5,7,8,10,12<br>4,6,9,11, |
| Months | 01 to 12 | 12 to 01 | - |
| Years | 01 to 03 | - | - |
| Weekdays | 0 to 6 | 6 to 0 | - |
| Timer | 00 to 99 | No carry | - |

**Table 1.2: Cycle length of the time counters, clock modes**

ISBN: 978-0-9948937-1-0

### *E*. ***SD CARD***

The SD-memory card is a portable device used in mobile, computer and other consumer appliances. It can provide high security, memory size can vary depends on cost and used in audio and video recording.It is a Secure Digital Input Output (SDIO) card, it provide data protection, avoid the duplication sensed value in same timing and security systems over identification cards in International standard ISO-7816.The interfacing of SD card with ARM using Serial Peripheral Interface (SPI) bus and operates in 3.3volts. It runs up to 8-bit wide interface and can be applied in SD-memory card compatible hardware interfaces and SD-memory card adds an advanced data storage functions to an application and easily accessible.

### *F*. ***BUZZER***

Buzzer[4] is an audio signaling device. It is mechanical, electro mechanical or piezoelectric. It is used as alarm device in timing manner, confirmation of user input over personnel computer or other devices by making sound. Buzzer is connected to ARM using one wire connecting wire.

### *G*. ***LED***

Light emitting diodes (LEDs)[4] is a semiconductor light sources and it has two terminals. The light emitted from LEDs varies from visible to infrared and ultraviolet regions.It operate on low voltage and power. LEDs are one of the most common electronic components and it is mostly used as indicators of circuit. LED display the monitoring value of temperature and pressure in real time environment.

## II. **Software Details**

It is a written description of a software product, that a software designer writes in order to give a software development team overall guidance to the architecture of the software project. An SDD usually accompanies an architecture diagram with pointers to detailed feature specifications of smaller pieces of the design. Practically, a design document is required to coordinate a large team under a single vision. A design document needs to be a stable reference, outlining all parts of the software and how they will work.

### *H*. ***RTLinux***

RTLinuxis[4] open source hard real-time RTOS microkernel.The function of the RTLinux is mostly depends on kernel. The programming of RTLinux is written in Linux command and C coding. It is portable, scalable, preemptive, high-performance interrupt handling and multitasking kernel. It is developed for commercial purpose by FSM Lab and Wind River System and it has connectivity with GUI and File Systems. It is multi-environment real time kernel running in core environment and supports multiple porting of devices. It is easy to implement and highly secure real time system. It supports processors and

ISBN: 978-0-9948937-1-0 

controllers embedded applications in real time. RTLinux program coding supports compiler, assembler and linker operation of embedded product in real time in fig 2.

RTLinux design is the system should be transparent, modular, and extensible. Transparency means,there are no unopenable black boxes and the cost of any operation should be determinable. Modularity it is possible to omit functionality and the expense of that functionality if it is not needed. The base RTLinux[4] system supports high speed interrupt handling and no more. And extensibility means that programmers should be able to add modules and tailor the system to their requirements. It has simple priority scheduler that can be easily replaced by schedulers more suited to the needs of some specific application. When developing RTLinux, it was designed to maximize the advantage we get from having Linux and its powerful capabilities available.

RTLinux functions schedule a priority scheduler that supports both a "lite POSIX" interface described below and the original V1 RTLinux API, which controls the processor clocks and exports an abstract interface for connecting handlers to clocks. It posix IO supports POSIX style read/write/open interface to device drivers, FIFO connects RT tasks and interrupt handlers to Linux processes through a device layer so that Linux processes can read/write to RT components. RTLinux[4] is a semaphore contributed package by Jerry Epplin which gives RT tasks blocking semaphores and POSIX mutex support is planned to be available in the next minor version update of RTLinux. RTLinuxMemorybuffer is a contributed package written by Tomasz Motylewski for providing shared memory between RT components and Linux processes

And the other application supporting codes are can develop with C and C++ language which are generally used for development of usual general purpose and special purpose system.

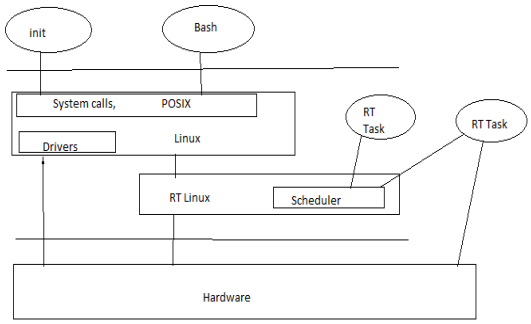


**Figure 3.1: Linux operating system**

### *I.* Communications Protocol

All communications between devices require that the devices agree on the format of the data. The set of rules defining a format is called a protocol. Communication protocols[4] cover authentication, error detection and correction, and signaling. They can also describe the syntax, semantics, and synchronization of analog and digital communications.. There are thousands of communication protocols that are used everywhere in analog and digital communications. It supports both wired and wireless communication.

### *J.* *SPI BUS*

SPI (Serial Peripheral Interface) bus[2]is a low power, full duplex, master-slave interfacing bus. It is solid role in embedded systems whether it is system on chip processors, both with higher end 32-bit processors such as those using ARM, MIC or Power PC and with other microcontrollers such as the AVR, PIC etc. These chips usually include SPI controllers capable of running in either master or slave mode. In-system programmable AVR controllers can be programmed using an SPI interface. Chip or FPGA based designs sometimes use SPI to communicate. So, SPI is a common technology used nowadays for communication with peripheral devices where we want to transfer data speedily and within real time constraints. There are many serial interfaces right from Morse code telegraphy, RS232, USB, Fire wire, Ethernet and many more. Each serial interface offers advantages or disadvantages for many designs, depending on criteria such as needed data rate, space availability, and noise considerations. It is simple 4 wire serial communication bus and it operates on 10MH. In SPI data is shifted in /out one at a time and transmit data from master device to/from one or more slave devices over short distances. It is high speed data transferring bus and no limit upto 8 bit transfer.The SPI bus is straightforward and versatile, enabling simple and fast communication with a variety of peripherals. A high speed multi-IO mode host adapter and some invaluable tool in debugging as well as adding SPI communication capabilities to any test system.

### *K.* *$I^2C$ BUS*

Two wires: serial data (SDA) and serial clock (SCL). All I2C [2] master and slave devices are connected with only those two wires. Each device can be a transmitter, a receiver or both. Some devices are masters – they generate bus clock and initiate communication on the bus, other devices are slaves and respond to the commands on the bus. In order to communicate with specific device, each slave device must have an address which is unique on the bus. I2C master devices (usually microcontrollers) don't need an address since no other (slave) device sends commands to the master .It supports both Multi-master and Multi-slave, so it can detect the collision easily. It supports 7 and10-bit addressing and each device connects to the bus using software with unique address. The maximum speed of the $I^2C$ bus is 3.4Mbits/sec and it varies depends on the modes of

application. $I^2C$ bus is simple and flexible used in many applications.I2C bus is transferred in 8-bit packets (bytes). There is no limitation on the number of bytes, however, each byte must be followed by an Acknowledge bit. This bit signals whether the device is ready to proceed with the next byte. For all data bits including the Acknowledge bit, the master must generate clock pulses. If the slave device does not acknowledge transfer this means that there is no more data or the device is not ready for the transfer yet. The master device must either generate Stop or Repeated Start condition.

### *L. One Wire Bus*

One –wire bus is a makes connection to one master and multiple slaves. 1-Wire technology is a serial protocol using a single data line plus ground reference for communication. A 1-Wire master initiates and controls the communication with one or more 1-Wire slave devices on the 1-Wire bus. The 8-bit family code, a subset of the 64-bit ID, identifies the device type and functionality.

Typically, 1-Wire slave devices operate over the voltage range of 2.8V (min) to 5.25V (max). Most 1-Wire devices have no pin for power supply; they take their energy from the 1-Wire bus (parasitic supply). It is a unidirectional bus and it is connects the LED display to ARM processor.

## III. Conclusion

In this paper, the proposed system is develops the idea to monitor the temperature and humidity value using SHT71 in Real time. The result of this paper is reduce the damages while occurring natural disaster. In future, ability to add some more tasks to monitor, such as seismic wave Monitoring etc., The values of the monitoring data in real time are displayed on the LED and Buzzer for intimation of warning.

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