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CONTROLLING AND MONITORING OF INDUSTRIAL PROCESS

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***Abstract**: The goal of this project is to develop a GM-based wireless system for real-time monitoring and control of industrial processes, with the goal of eliminating the need for human intervention. Different machines in factories will have to be run depending on the condition of others. A load monitor should be hired for this specific reason. However, there is always the potential that they may forget to actually do the operation. These devices need strong currents and a lot of power, making them difficult for a human to operate by hand. This project provides the finest answer for such cases, and it will also entirely do away with the need for human operation. The idea behind this app's development is wireless connectivity. As an example of a wireless communication system, the GSM system is taken into account here due to its low cost and ease of implementation. The connection to the outside world is made possible using a GSM modem. It employs a serial link to the network to carry device protocols invisibly. An example of a wireless modem that is compatible with GSM networks is the GSM modem. This GSM Modem works precisely like a mobile phone, complete with its own phone number and the ability to take SIM cards from any GSM network provider. The RS232 connection on this modem will be useful for developing embedded programmers and communicating with other devices. Easy application development allows for features like SMS Control, data transmission, remote control, and logging. The modem may be wired to a micro controller, or it can be linked straight to a PC's serial port. In this project, we will automate a business process by keeping tabs on boiler temperatures and water levels. In this project, we will use an 8-bit micro controller to read data from a temperature sensor and three water-level sensors. The controller will communicate serially with a GSM modem. There will be three water level sensors installed at various heights inside the boiler, and an analog-to-digital converter (ADC) will connect the temperature sensor to*

the controller. The readings from the temperature and water level sensors are continually analyzed by the micro-controller. When a sensor is activated, the micro-controller receives a signal and promptly relays that signal to the user's mobile device via GSM modem. Sending specified signals to the modem enables the user to regulate the temperature and water level by activating the coolant fan for temperature regulating and the pumping motor for water level control. The controller will be connected to a 16x2 LCD that will show the sensors' current states. The electricity for this project comes from a controlled 5V, 500mA source. The relay operates on 12V DC of unregulated power. The voltage is controlled using a 7805 three-terminal regulator. The secondary ac output of the 230/12V step down transformer is rectified using a bridge type full wave rectifier.

I. INTRODUCTION

Traditional methods for remote plant monitoring and control rely on structured cables connecting field equipment to a central control centre [1]. The required human-machine interaction is handled by custom-built programmers used in the control room. In order to keep up with the constant shifts in the plant's most important characteristics, new gadgets (mobile phones with wireless application protocols) are becoming on the market. To alleviate the need for human oversight and control in the plant, this project integrates a prototype wireless remote monitoring and control system. The suggested system demonstrates how GSM-short message service (SMS) and other cellular phone technologies may be used to improve process plant management and monitoring. The current study aims to free plant decision-makers from the constraints of wires while providing them with instantaneous access to as much plant data as feasible through portable devices. This work allows for the monitoring and control of equipment and processes to be performed by technical and maintenance employees using a single mobile phone. In a process plant, the job may be carried out in real time. Experts' mobile devices successfully received online data transfers at predetermined times. When any incoming data exceeds a certain threshold, the alarm management programme sends out an alarm signal. These novel data communication methods are predicted to vastly enhance the plant's operating range.

Therefore, the primary goal is to use GSM technology to track and manage all relevant industrial metrics. The suggested system has been validated for its ability to remotely monitor and control parameters such as temperature, pressure, humidity, and level, and it may be adapted to meet the needs of other industries with similar monitoring and controlling needs, so long as the appropriate industrial sensors are used. The proposed system satisfies user demands and requirements by providing a high-performance, low-cost, secure, ubiquitously accessible, automatically adjustable, remote-controlled solution for automating process industries utilizing GSM - SMS.

II EMBEDDED ARM CONTROLLER

In various applications, including industrial, agricultural, etc., it is required to regulate many factors, including temperature, pressure, and humidity, in order to decrease costs and maximize productivity. Typically, a plant has a number of sensors and actuators spread out along its length, all of which are controlled by a central computer. Effective systems distribute their duties throughout a hierarchy, from the lowest degree of direct management to the highest [3]. The direct control setting enables hands-on experience with the plant. Micro-controller devices [4] are often present at this level, where they monitor sensor readings and direct actuator operation. These micro-controllers may be found at various nodes all across the facility. Micro-controllers, namely Advanced RISC Machine (ARM) processors that aim their products at the confluence of computing, communication, and consumers [5, 6], are widely used in electronics and computer-controlled systems today. When it comes to embedded monitoring and diagnostic systems, the RISC (Reduced Instruction Set Computer) processor is a strong instrument that offers extremely versatile and cost-effective solutions [7]. As a programmable device, the Embedded ARM controller may be customized to perform a wide variety of tasks. It's like the system's central processing unit. This controller is intended to serve as a general-purpose device with several inputs and outputs.

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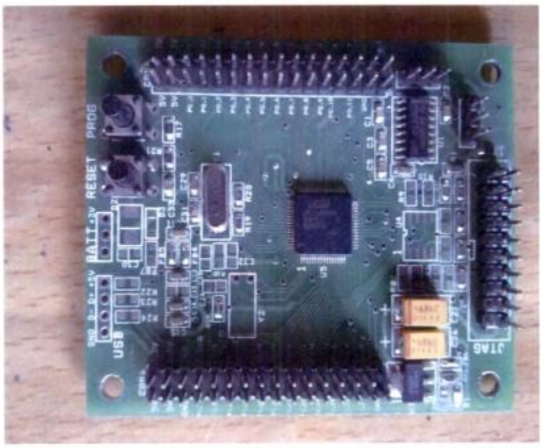

Figure 2.1: LPC2148 Board

The Embedded ARM controller used in the present work is LPC2148 ARM7TDMI-S processor and the LPC2148 board is shown in Figure 2.1. The details are discussed below.

III ARCHITECTURAL OVERVIEW

The LPC2148 has an ARM7TDMI-S emulation-capable CPU, the ARM7 Local Bus for connecting to the on-chip memory controllers, the AMBA Advanced High-performance Bus (AHB) for connecting to the interrupt controller, and the VLSI Peripheral Bus for connecting to the on-chip peripheral functions. Figures 2.2 and 2.3 depict the LPC2148's block diagram and pin layout, respectively. With the LPC2148, the ARM7TDMI-S CPU is set up for little-Indian byte order.

The uppermost 2 MB of the 4 GB of available ARM memory is reserved for AHB peripherals. Within the AHB address space, each peripheral receives 16 kilobytes. The VPB bus is used to link the peripherals of the LPC2148 (apart from the interrupt controller). Connecting the VPB bus to the AHB bus is the job of the AHB to VPB bridge. A 2 MB range of addresses commencing at the 3.5 GB address point has been set aside for VPB peripherals. Within the VPB address space, each peripheral receives 16 kilobytes.

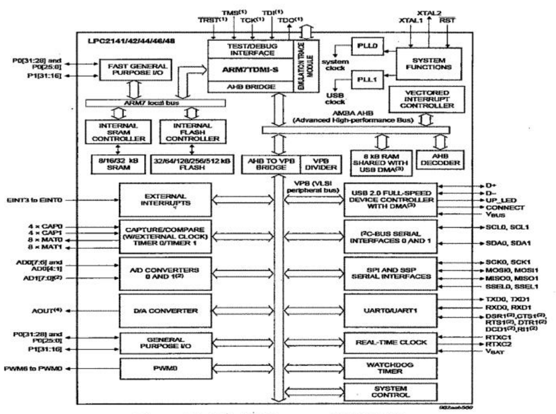

Figure 2.2: Block Diagram of LPC2148

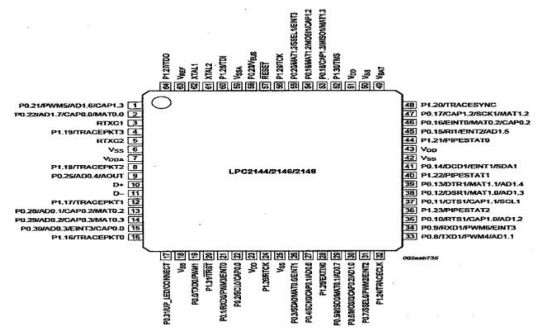

Figure 2.3: Plastic low profile quadraflat structure of LPC2148

A Pin Connect Block is responsible for managing the connections between on-chip peripherals and device pins. The functionality and placement of the peripheral pins and functions must be

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modified in software to meet the needs of a given application.

CORE PROCESSOR ARM7TDMI-S

The ARM7TDMI-S is a high-performance, low-power, 32-bit microprocessor suitable for a wide variety of applications. When compared to micro programmed Complex Instruction Set Computers, the ARM architecture's [10] instruction set and accompanying decoding process are much more straightforward. As a consequence of its straightforward design, the resulting tiny and cheap CPU core achieves a high instruction throughput and excellent real-time interrupt responsiveness.

The use of pipeline methods ensures that the processor and memory systems can function in a seamless manner. Three instructions are typically decoded and retrieved from memory in parallel while one is being executed.

The ARM7TDMI-S processor takes use of a novel architectural concept called THUMB, which makes it great for high-throughput applications with memory constraints or code density concerns.

Thumb's primary concept is that of a super-minimal instruction set.

The ARM7TDMI-S basically has two different sets of instructions:

A 16-bit THUMB instruction set; ® the normal 32-bit ARM instruction set.

When compared to a regular 16-bit processor with 16-bit registers, the THUMB set achieves almost double the density of normal ARM code thanks to its 16-bit instruction length. This is feasible since both THUMB and ARM programmed utilize the same 32-bit register set. Up to 65% of the code size of ARM may be provided by THUMB code, and speed is increased by 160% compared to a comparable ARM processor with a 16-bit memory architecture.

Detailed information on the ARM7TDMI-S processor may be found in the ARM7TDMI-S Data sheet.

The Pipeline The CPU at the heart of the LPC2000 family is an ARM7TDMI-S CPU. At the heart of the ARM7 CPU is the Instruction Pipeline. Pipe lining is employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. At the heart of the ARM7 CPU is the instruction

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pipeline. The pipeline is used to process instructions taken from the program store. On the ARM 7 a three-stage pipeline is used.

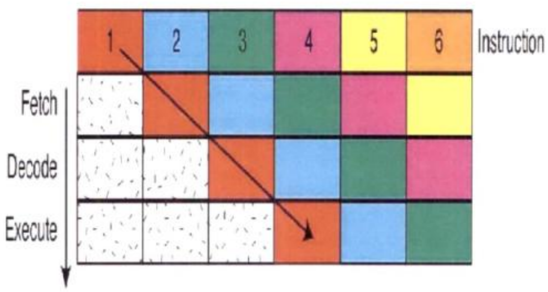

Figure 2.4: ARM7 Three Stage Pipeline Operation

ARM7 three-stage pipeline operation is shown in Figure 2.4. A three-stage pipeline is the simplest form of pipeline and does not suffer from the kind of hazards such as read-before- write seen in pipelines with more stages. The pipeline has hardware independent stages that execute one instruction while decoding a second and fetching a third. The pipeline speeds up the throughput of CPU instructions so effectively that most ARM instructions can be executed in a single cycle. The pipeline works most efficiently on linear code. As soon as a branch is encountered, the pipeline is flushed and must be refilled before full execution speed can be resumed.

IV MEASUREMENT PRINCIPLES & TECHNIQUES

Instrumental methods for determining the depth of a liquid or solid inside a container are collectively referred to as Level Measurement [4]. There are a number of 178 situations in which checking the amount of fluids in containers is necessary. Sometimes the issue at hand is as elementary as keeping an eye on the water level in a tank, in which case a float-based device will do the job. In some circumstances, though, the vessel may be sealed and the liquid may be flammable, making the task of monitoring more difficult.

The liquid level may be measured in a number of various ways, each of which has its own pros and cons depending on the circumstances.

Types include (a) float, (b) hydro static differential pressure gauge, (c) capacitance, (d) ultrasonic, and (e) radiation.

a. Type of Float

The easiest way to detect liquid level is through the float technique [5], which employs a float or displace as the main sensor device. The principle behind this technique is the buoyancy effect. A float in this setup follows the surface of the liquid. As the magnetic float goes up and down the stem of the instrument, it causes a

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change in the resistance housed there, which may be utilized to provide a quantitative analogue signal indicating the level to an observer. Floats, whether made of stainless steel or another material like plastic, Teflon, etc., may be used in liquids whose specific gravity is greater than that of the float. Both horizontal and vertical configurations of magnetic float type level switches [6] are readily accessible. Figure 6.1 displays the several varieties of magnetic floats that are available.

Figure 6.1: Various Types of Magnetic Floats

Hydro static Differential Pressure type The hydro static pressure [7] developed at the bottom of a tank is given by: P=h p g where h is the height of the liquid level and p is the density of the liquid. So by putting two pressure taping, one at the bottom and the other at the top of the tank, we can measure the differential pressure, which can be calibrated in terms of the liquid level. Such a schematic arrangement is shown in Figure 6.2.The drum level of a boiler is normally measured using this basic principle. However proper care should be taken in the measurement compensate for variation of density of water with temperature and pressure.

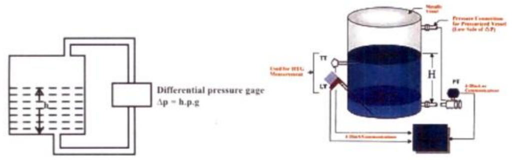

Figure 6.2: Level measurement using hydrostatic differential pressure

V RESULTS AND DISCUSSIONS

The aim and objective of the present work is to develop an integrated wireless RMACS for monitoring, controlling and accessing the performance of remotely situated parameters such as temperature, pressure, humidity and level on real time basis. Hence an attempt has been made by the author to develop a GSM based RMACS for level as a part of integrated wireless RMACS using an advanced processor ARMISTICE-S LPC2148 which is tiny, rugged, low cost and low power consumption ideally suited for industrial control systems. The system is tested with the standard set point and also with different set point values as level as a process parameter in the present study. The results are presented in Table 6.3.

Table 6.3: Results ofthe system

Liquid Level ml	Buzzer Status	SMS status	SMS Message
100	OFF	NO	-------
250	OFF	NO	-------
400	OFF	NO	-------
525	OFF	NO	-------
690	ON	YES	Liquid level crossing limit
700	ON	YES	Liquid level crossed limit

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The above results confirm that the monitoring and control device is always with the user(s) and also it is possible to read the data from any remote place. If the input value is near or more than the threshold limit then the processor will sends an SMS as "Liquid Level crossing limit" or "Liquid Level crossed limit" to a user(s) mobile phone through GSM MODEM. The user(s) concerned to the plant can control the set point by changing the input value or can switch ON the Buzzer as an indication to the operator in the plant by sending AT commands to GSM MODEM, which will be directed to the processor. The user(s) can also monitor the status of the liquid level remotely by issuing a string of commands to GSM modem and in turn to the processor. The measured values are stored in personal computer for further analysis to download the reports and graphs. The graphical representation of process parameters, log data, current data values and high limit values of sensors, status of the parameters in the mobile phone are discussed in detail in chapter 7. The system was tested by measuring liquid level up to 1500ml (1.5 liters) and the results are in good agreement with experimental values. In RMACS if there is any deviation observed in the measured value the remote user can change the set point value with his mobile phone by sending command " SET LEVE XXXX ml " where XXXX indicates the value. The designed RMACS tested with remote user mobile phone for different set points along with measured values of water level with real time is shown in Figure 6.17.

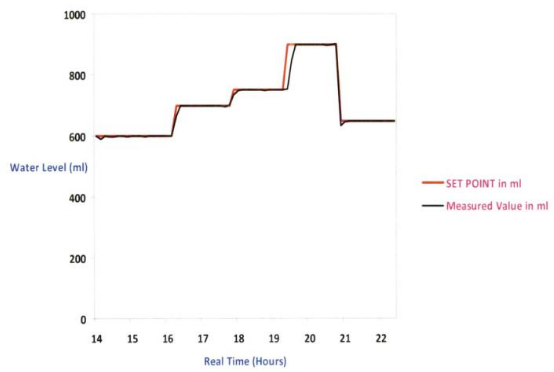

Figure 6.17: Graphical Representation of Water Level with different set point values

V Conclusion

Instrumentation system employed for the measurement of process parameters needs systematic calibration. The calibration process involves study of influence of various parameters on the final measurement systems. Malfunctioning and bad calibration of the system leads to wrong diagnosis leading to catastrophic results. Hence the calibration regarding the process parameters need vast studies and precautions. Calibration of a given pressure is important to ensure reliable measurement. In the present work the calibration is done by using a standard beaker. To carry out this place float sensor inside a beaker with markings on it. Pour some water on a beaker note the readings on RMACS and on beaker. It is observed that the readings are well matched and found with good repeatability for humidity measurement purpose as shown in Table 6.2. The calibrated values are in good agreement with measured values.

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