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Digital Embedded Controller for Thermal Process

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Abstract: This paper presents a web architecture based low cost virtual instrumentation (VI) system to monitor and control the electrically heated water bath temperature. The PIC16F877 based digital microcontroller is used as thermostat which controls and monitors the temperature through internet-work model. The digital controller also allows the user to monitor the network status as well as sensor (PT100) calibration data values. The parallel port has been used to provide the control function and on-line display of measuring temperature, set point as well as the control function output plots through the parallel port. This bus interaction is realized in Visual Basic/Assembly Language and uses a 16 bit, 10 μs sampling analog-to-digital converter (ADS 7805) for monitoring and controlling the parameters of the temperature web enabled digital controller.

Keywords: Internet-work Model, Temperature Process, On-Off Controller, Embedded System.

INTRODUCTION

A large variety of data collection instruments designed specifically for computerized control and operation were developed and made available on the commercial market, creating the field now called "virtual instrumentation" (VI). Virtual instrumentation thus refers to the use of general purpose computers and workstations, in combination with data collection hardware devices, and virtual instrumentation software, to construct an integrated instrumentation system; in such a system the data collection hardware devices, which incorporate sensing elements for detecting changes in the conditions of test subjects, are intimately coupled to the computer, whereby the operations of the sensors are controlled by the computer software, and the output of the data collection devices is displayed on the computer screen, in a manner designed in software to be particularly useful to the user, for example by the use of displays simulating in appearance the physical dials, meters and other data visualization devices of traditional instruments.

The objective of this paper is to describe an embedded based digital controller to monitor and to control the electrically heated water bath temperature through internet architecture. The controller is built around the PIC16F877 on microcontroller board. The digital controller provides three primary functions: controlling locally the process functioning as thermostat, reading as well as displaying the digital temperature from the PT100 sensor and maintaining parallel communication with a computer. This system includes a cost effective design solution with minimum hardware and maximum support of software to achieve a user-friendly virtual instrumentation based programmable temperature controller, to control temperature range from -200° C to 850° C, with menu driven support for selection of the control functions. The advent of embedded based digital controller combined with user friendly software program assures desired performance, simplicity, flexibility and reliability for temperature monitor and control. The system includes both instrument server and internet server.

MATERIALS AND METHODS

The digital controller board consists of three modules. The first module PIC16F877 microcontroller is a high performance RISC CPU with low power consumption, 8k words Flash program memory, 368 bytes

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of data memory (RAM) and 256 bytes of EPROM data memory, Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation, three timers (two 8 bit and one 16 bit), Two Capture (16 bit, max. resolution is 12.5 ns) and Compare (16 bit, max. resolution is 200 ns), PWM modules and a Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection. The second module is Platinum Resistance Thermometers (PRTs) which offer excellent accuracy over a wide temperature range (from -200 to +850 °C). The principle of operation is to measure the resistance of a platinum element. The most common type (PT100) has a resistance of 100 ohms at 0 °C and 138.4 ohms at 100 °C. There are also PT1000 sensors that have a resistance of 25 ohms and 1000 ohms respectively at 0 °C and these sensors offer an accuracy of ±0.3 °C at 0°C. The microcontroller also reads the temperature binary from the sensor. The third module is parallel port transmission/reception, with ADS 7805 which is a 16-Bit 10μs sampling CMOS analog-to-digital converter. The digital controller is connected using parallel port to a personal computer on which the instrument application runs. Desired temperature (reference) is introduced using a computer keyboard locally. This value is transmitted using the parallel port from the computer to the digital controller. The source code for the microcontroller is written in assembly language and front panel is designed using Microsoft Visual basic. The photocopy of overall experimental system is shown in Fig. 1.

Fig. 1: Photocopy of experimental setup

RESULTS AND DISCUSSIONS

The instrument software application is written using visual basic that can run on Windows 98, 2000 and XP. The digital controller can be accessed directly by the instrument computer, which also has an active part in the control of the water bath temperature. A user friendly calibration of sensor system is also programmed within this digital controller. Thermal process can be monitored with or without the advent of personal computer system through offline measurement system. The offline system is also programmed within that of microcontroller. The instrument application is written in visual basic that has the features including, microcontroller board interfacing through parallel port, setting up the digital controller parameters and displaying and transmitting the state of the controller and the process parameters. The digital controller system is tested with electronic heated water bath temperature system. The Fig. 2 shows the automatic control scheme for the thermal process.

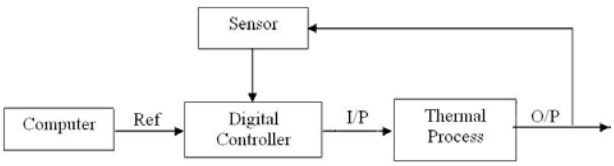

Fig. 2: Block diagram for thermal control process

The regulator is implemented in the digital controller which is a relay with non-linear characteristics. The relay outputs are on or off value by comparing the input (i.e.) error signal with the specified thresholds. The analog-to-digital conversion is done using a 16 bit, 10 μs ADC chip, the ADS7805. This chip is cost effective, works well, and has a 16 bit resolution if not 16 bit accuracy. The ADS7805 is a complete 16-bit sampling A/D using state-of-the art CMOS structures. It contains a complete 16-bit, capacitor-based, successive approximation register (SAR) A/D with S/H, reference, clock, interface for microprocessor use, and three-state output drivers. The ADS7805 is specified at a 100 kHz sampling rate, and guaranteed over the full temperature range. Laser trimmed scaling resistors provide an industry standard ±10V input range, while the innovative design allows operation from a single +5V supply, with power dissipation under 100mW. The 8-bit output from the ADS7805 is connected to the data lines of the parallel port. An external clock assesses data from the interface, which communicates without any external hardware for most digital signal processors, microcontrollers and personal computers. It reads the temperature data through the front-end hardware and sets the time triggering firing angle sequence through parallel port and controls the temperature as per the software application. The software front-panel consists of set temperature, temperature scale division, time scale division as well as on-off relay controller which are shown in Fig. 3 and 4. The high or low byte output from the ADC can be selected by the BYTE pin on the ADS7805 by the microcontroller.

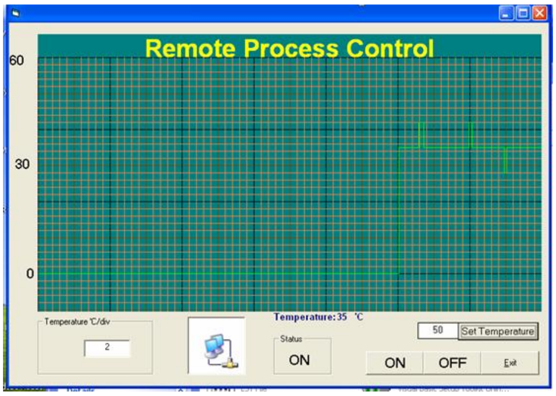

Fig. 3: Front-panel controls with online temperature graphical output

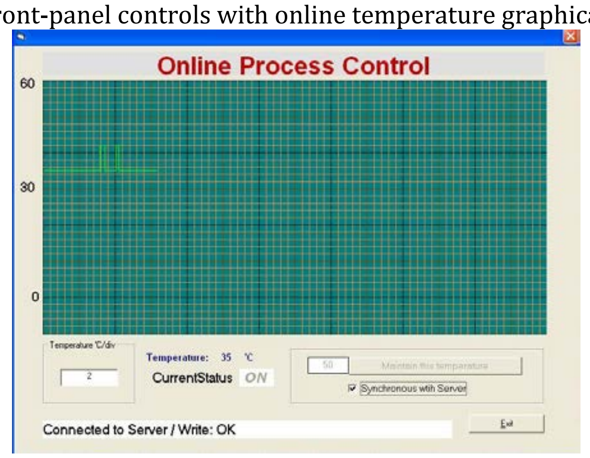

Fig. 4: Online temperature graphical output

The developed digital controller has the features such as, it has the provisions for set point tracking and monitoring of system parameters either by online and/or offline functions (i.e.) with and/or without the aid of personal computer and calibration of RT100 can be done at microcontroller itself instead of altering the application program code.

The local digital controller has built in 20&4 LCD display to monitor and control the temperature values.

CONCLUSIONS

Web architecture based low cost virtual instrumentation (VI) system to monitor and control the electrically heated water bath temperature has been described. The parallel port has been used to provide the control function and on-line display of measuring temperature, set point as well as the control function output plots through the parallel port. This bus interaction is realized in Visual Basic/Assembly Language and uses a 16 bit, 10 μs sampling analog-to-digital converter (ADS 7805) for monitoring and controlling the parameters of the temperature web enabled digital controller.

REFERENCES

[1] Krishnamoorthy P., & Jayalakshmi T. (2012). Preparation, characterization and synthesis of silver nanoparticles by using phyllanthusniruri for the antimicrobial activity and cytotoxic effects, *Journal of Chemical and Pharmaceutical Research, 4*(11), 4783-4794.

[2] Amir, M., Gungunes, H., Slimani, Y., Tashkandi, N., El Sayed, H.S., Aldakheel, F., Sertkol, M., Sozeri H., Manikandan A., Ercan, I., & Baykal, A. (2019). Mössbauer studies and magnetic properties of cubic CuFe 2 O 4 nanoparticles. *Journal of Superconductivity and Novel Magnetism*, *32*(3), 557-564.

[3] Raj M.S., Saravanan T., & Srinivasan V. (2014). A modified direct torque control of induction motor using space vector modulation technique. *Middle - East Journal of Scientific Research, 20*(11), 1572-1574.

[4] Khanaa, V., & Thooyamani, K.P. (2013). Using triangular shaped stepped impedance resonators design of compact microstrip quad-band. *Middle-East Journal of Scientific Research*, *18*(12), 1842-1844.

[5] Asiri S., Sertkol M., Güngüneş H., Amir M., Manikandan A., Ercan I., & Baykal A. (2018). The Temperature Effect on Magnetic Properties of NiFe 2 O 4 Nanoparticles. *Journal of Inorganic and Organometallic Polymers and Materials, 28*(4), 1587-1597.

[6] Thaya, R., Malaikozhundan, B., Vijayakumar, S., Sivakamavalli, J., Jeyasekar, R., Shanthi, S., Vaseeharan, B., Ramasamy, P., & Sonawane, A. (2016). Chitosan coated Ag/ZnO nanocomposite and their antibiofilm, antifungal and cytotoxic effects on murine macrophages. *Microbial pathogenesis*, *100*, 124-132.

[7] Kolanthai, E., Ganesan, K., Epple, M., & Kalkura, S.N. (2016). Synthesis of nanosized hydroxyapatite/agarose powders for bone filler and drug delivery application. *Materials Today Communications*, *8*, 31-40.

[8] Thilagavathi, P., Manikandan, A., Sujatha, S., Jaganathan, S.K., & Arul Antony, S. (2016). Sol–Gel Synthesis and Characterization Studies of NiMoO4 Nanostructures for Photocatalytic Degradation of Methylene Blue Dye. *Nanoscience and Nanotechnology Letters*, *8*(5), 438-443.

[9] Thamotharan C., Prabhakar S., Vanangamudi S., & Anbazhagan R. (2014). Anti-lock braking system in two wheelers. *Middle - East Journal of Scientific Research, 20*(12), 2274-2278.

[10] Thamotharan C., Prabhakar S., Vanangamudi S., Anbazhagan R., & Coomarasamy C. (2014). Hydraulic rear drum brake system in two wheeler. *Middle - East Journal of Scientific Research, 20*(12), 1826-1833.

[11] Vanangamudi S., Prabhakar S., Thamotharan C., & Anbazhagan R. (2014). Collision control system in cars. *Middle - East Journal of Scientific Research, 20*(12), 1799-1809.

[12] Vanangamudi S., Prabhakar S., Thamotharan C., & Anbazhagan R. (2014). Drive shaft mechanism in motor cycle. *Middle - East Journal of Scientific Research, 20*(12), 1810-1815.

[13] Anbazhagan R., Prabhakar S., Vanangamudi S., & Thamotharan C. (2014). Electromagnetic engine. *Middle - East Journal of Scientific Research, 20*(3), 385-387, 2014.

[14] Kalaiselvi, V.S., Prabhu, K., & Mani Ramesh, V.V. (2013). The association of serum osteocalcin with the bone mineral density in post-menopausal women. *Journal of clinical and diagnostic research: JCDR*, *7*(5), 814-816.

[15] Kalaiselvi, V.S., Saikumar, P., & Prabhu, K. (2012). The anti mullerian hormone-a novel marker for assessing the ovarian reserve in women with regular menstrual cycles. *Journal of clinical and diagnostic research: JCDR*, *6*(10), 1636-1639.

[16] Arul, K.T, Manikandan, E., Ladchumananandasivam, R., & Maaza, M. (2016). Novel polyvinyl alcohol polymer based nanostructure with ferrites co-doped with nickel and cobalt ions for magneto-sensor application. *Polymer International*, *65*(12), 1482-1485.

[17] Das, M.P., & Kumar, S. (2015). An approach to low-density polyethylene biodegradation by Bacillus amyloliquefaciens. *3 Biotech*, *5*(1), 81-86.

[18] Vanangamudi S., Prabhakar S., Thamotharan C., & Anbazhagan R. (2014). Turbo charger in two wheeler engine. *Middle - East Journal of Scientific Research, 20*(12), 1841-1847.

[19] Vanangamudi S., Prabhakar S., Thamotharan C., & Anbazhagan R. (2014). Design and calculation with fabrication of an aero hydraulwicclutch. *Middle - East Journal of Scientific Research, 20*(12), 1796-1798, 2014.

[20] Saravanan, T., Raj, M.S., & Gopalakrishnan, K. (2014). VLSI based 1-D ICT processor for image coding. *Middle-East Journal of Scientific Research*, *20*(11), 1511-1516.

[21] Ajona, M., & Kaviya, B. (2014). An environmental friendly self-healing microbial concrete. *International Journal of Applied Engineering Research*, *9*(22), 5457-5462.

[22] Hemalatha, R., & Anbuselvi, S. (2013). Physicochemical constituents of pineapple pulp and waste. *Journal of Chemical and Pharmaceutical Research*, *5*(2), 240-242.

[23] Langeswaran, K., Revathy, R., Kumar, S.G., Vijayaprakash, S., & Balasubramanian, M.P. (2012). Kaempferol ameliorates aflatoxin B1 (AFB1) induced hepatocellular carcinoma through modifying metabolizing enzymes, membrane bound ATPases and mitochondrial TCA cycle enzymes. *Asian Pacific Journal of Tropical Biomedicine*, *2*(3), S1653-S1659.

[24] Masthan, K.M.K., Babu, N.A., Dash, K.C., & Elumalai, M. (2012). Advanced diagnostic aids in oral cancer. *Asian Pacific Journal of Cancer Prevention*, *13*(8), 3573-3576.

[25] Asiri S., Güner S., Demir A., Yildiz A., Manikandan A., & Baykal A. (2018). Synthesis and Magnetic Characterization of Cu Substituted Barium Hexaferrites. *Journal of Inorganic and Organometallic Polymers and Materials,* 28(3), 1065-1071.

[26] Vellayappan, M.V., Jaganathan, S.K., & Manikandan, A. (2016). Nanomaterials as a game changer in the management and treatment of diabetic foot ulcers. *RSC Advances*, *6*(115), 114859-114878.

[27] Vellayappan, M.V., Venugopal, J.R., Ramakrishna, S., Ray, S., Ismail, A.F., Mandal, M., Manikandan, A., Seal, S., & Jaganathan, S.K. (2016). Electrospinning applications from diagnosis to treatment of diabetes. *RSC Advances*, *6*(87), 83638-83655.

[28] Bavitra, K., Sinthuja, S., Manoharan, N., & Rajesh, S. (2015). The high efficiency renewable PV inverter topology. *Indian Journal of Science and Technology*, *8*(14), 1.

[29] Vanangamudi, S., Prabhakar, S., Thamotharan, C., & Anbazhagan, R. (2014). Design and fabrication of dual clutch. *Middle-East Journal of Scientific Research*, *20*(12), 1816-1818.

[30] Sandhiya, K., & Kaviya, B. Safe bus stop location in Trichy city by using gis. *International Journal of Applied Engineering Research*, *9*(22), 5686-5691.

[31] Selva Kumar, S., Ram Krishna Rao, M., Deepak Kumar, R., Panwar, S., & Prasad, C.S. (2013). Biocontrol by plant growth promoting rhizobacteria against black scurf and stem canker disease of potato caused by Rhizoctonia solani. *Archives of Phytopathology and Plant Protection*, *46*(4), 487-502.

[32] Sharmila, S., & Jeyanthi Rebecca, L. (2012). GC-MS Analysis of esters of fatty acid present in biodiesel produced from Cladophora vagabunda. *Journal of Chemical and Pharmaceutical Research*, *4*(11), 4883-4887.

[33] Ramkumar, M., Rajasankar, S., Gobi, V.V., Dhanalakshmi, C., Manivasagam, T., Thenmozhi, A.J., Essa, M.M., Kalandar, A., & Chidambaram, R. (2017). Neuro protective effect of Demethoxycurcumin, a natural derivative of Curcumin on rotenone induced neurotoxicity in SH-SY 5Y Neuroblastoma cells. *BMC complementary and alternative medicine*, *17*(1), 217.

[34] Selvi, S.A., & Sundararajan, M. (2016). A Combined Framework for Routing and Channel Allocation for Dynamic Spectrum Sharing using Cognitive Radio. *International Journal of Applied Engineering Research*, *11*(7), 4951-4953.

[35] Krupaa R.J., Sankari S.L., Masthan K.M.K., & Rajesh E. (2015). Oral lichen planus: An overview. *Journal of Pharmacy and Bioallied Sciences, 7,* S158-S161.

[36] Srividya, T., & Saritha, B. (2014). Strengthening on RC beam elements with GFRP under flexure. *International Journal of Applied Engineering Research*, *9*(22), 5443-5446.

[37] Kumar, J., Sathish Kumar, K., & Dayakar, P. (2014). Effect of microsilica on high strength concrete. *International Journal of Applied Engineering Research*, *9*(22), 5427-5432.

[38] Saraswathy, R., & Saritha, B. (2014). Planning of integrated satellite township at Thirumazhisai. *International Journal of Applied Engineering Research*, *9*(22), 5558-5560.

[39] Saritha, B., Ilayaraja, K., & Eqyaabal, Z. (2014). Geo textiles and geo synthetics for soil reinforcement. *International Journal of Applied Engineering Research*, *9*(22), 5533-5536.

[40] Iyappan, L., & Dayakar, P. (2014). Identification of landslide prone zone for coonoor taluk using spatial technology. *International Journal of Applied Engineering Research*, *9*(22), 5724-5732.

[41] Alageswari, P., and Nandhakumar, S.K. (2016). Design of SM Controller Technique for Photo Voltaic System with DC-DC Converter. *International Journal of System Design and Information Processing, 3*(1), 1-5.

[42] Dr.Mummoorthy, A., Bhasker, B., & Jagadish Kumar, T. (2018). Using of Bellman Fords Algorithm in WSN to Identify the Shortest Path and Improve the Battery Power & Control the DDOS Attackers and Monitor the System Environment. *Bonfring International Journal of Networking Technologies and Applications, 5*(1), 9-11.

[43] Andrea, and Matthew. (2017). FlybackSnubber to Recycle the Absorbed Energy in the Clamping Capacitor for Isolated Bidirectional Full Bridge DC-DC Converter. *Bonfring International Journal of Power Systems and Integrated Circuits, 7*(1), 19-25.

[44] Neenu Preetam, I., & Gupta, H. (2014). Cardless Cash Access using Biometric ATM Security System. *International Scientific Journal on Science Engineering & Technology, 17*(10), 893-897.

[45] Jha, H.R., & Singh, S.N. (2015). Study of Scattering Parameters and Gain of two Longitudinal Slots of Same Electrical Lengths Milled on two Waveguides for Series and Shunt Slot Array Planar Antenna. *Bonfring International Journal of Research in Communication Engineering, 5*(3), 12-21.

[46] Mandal, S., Saha, G., & Pal, R.K. (2014). A Comparative Study on Disease Classification using Different Soft Computing Techniques. *The SIJ Transactions on Computer Science Engineering & its Applications, 2*(4), 1-29.

[47] Gopalakrishnan, C., & Iyapparaja, M. (2019). Detection of Polycystic Ovary Syndrome from Ultrasound Images using SIFT Descriptors. *Bonfring International Journal of Software Engineering and Soft Computing, 9*(2), 26-30.

[48] Sivasankari, M., & Dr.Velmani, P.& Dr.ArokiaJansi Rani, P. (2018). Multilingual Off-line Handwriting Recognition in Real-World Images Using Deep Neural Network (DNN) Classifier*. Journal of Computational Information Systems, 14*(4), 164 - 175.

[49] Dr.Berin Jones, C. (2018). Text Segmentation and Recognition in Natural Scene Images Using MSER*. Journal of Computational Information Systems, 14*(5), 1 - 8.

[50] Preethi, S., & Leelavathi, B. (2018). Adaptive Firefly Algorithm (AFA) based Feature Selection and Unsupervised Fuzzy Extreme Learning Machine (USUFELM) with Network-based Intrusion Detection and Prevention System*. Journal of Computational Information Systems, 14*(5), 34 - 44.