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AMCD: Control and Monitor the Flow of Water Based on the Temperature

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Abstract— In any industry (e.g. manufacturing plant, process plant etc) majority of final control elements are control valves and motors. They are used indiscreetly in some or the other way. Whether you want to move something or control something they are only used. The controlling of such variables is done by PLC or through some other techniques that might be suitable to the industry. But the problem with these controlling parameters is that they are voluptuous and at instances can make a hole in your pocket. System-on-chip solutions based on ARM embedded processors address many different market segments including enterprise applications, automotive systems, home networking and wireless technologies. The ARM Cortex™ family of processors provides a standard architecture to address the broad performance spectrum required by these diverse technologies .SOC is where the world is headed. Creating a single hardware that is compatible with all software can be used for variety of application in much more reliable and cheaper way. The outcome is a hassle free easy atomization in industry with the use of tablet that can perform multitasking.

Index Terms— SOC, PLC, Embedded processor

1. The Concept of AMCD (AutoMatic Control Device)

Human progress from a primitive state to our present complex, technological world has been marked by learning new and improved methods to control the environment. At the heart of nearly all modern control systems is a computer-based controller. AMCD does the dedicated computer inputs measurement data from the plant, performs all the calculations for controller modes, and supplies the necessary output. Such an application is historically referred to as direct digital control (DDC). AMCD is similar to a microprocessor-based personal computer (PC) mounted in a rack or even on a desktop. So basically AMCD is a small printed-circuit board (SOC) mounted inside measurement equipment or even a large computer.

2. Operation Block Diagram of AMCD

The sequence of operation for the entire process is as follows:-
Any heat change in the environment will be detected by Temperature Sensor (LM 35).

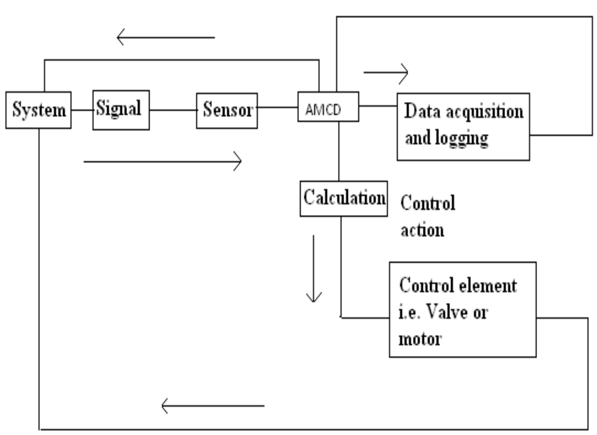

Fig.1 Application Block Diagram

This change is notified to the Development board through Signal Conditioning, amplification of input signal form sensor via DAC (The system has an onboard DAC).
The Controller on board performs necessary calculation and gives instructions/control signal in regard to those calculations on the basis of program encoded on the system.
The signal from controller is converted to output logic via ADC (The system has an onboard 10bit ADC).
The output signal received from the ADC is in the range of 0-3.3V respectively on the basis of temperature range.
The standard signal used in the industry is in the range of 4-20mA.

The output signal is thus converted from 0-3.3V to 4-20mA current signal. This conversion is done with the help of V-I converter using IC 741.
The generated 4-20mA current signal can be applied to Valve Positioner of Pneumatic or Motorised Valve.

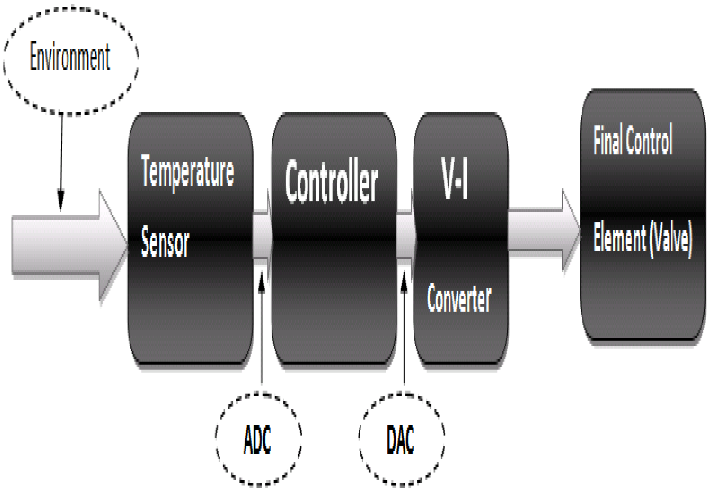

Fig. 2 Operation Block Diagram of Process

3. Hardware Configuration

AMCD has standard array of devices required for the application. ROM,RAM,ADCs and DACs as well as digital I/O channels. The final element is the network interface communication system. This provides for serial communication of the computer over a serial fieldbus or LAN (IEEE 802.3)

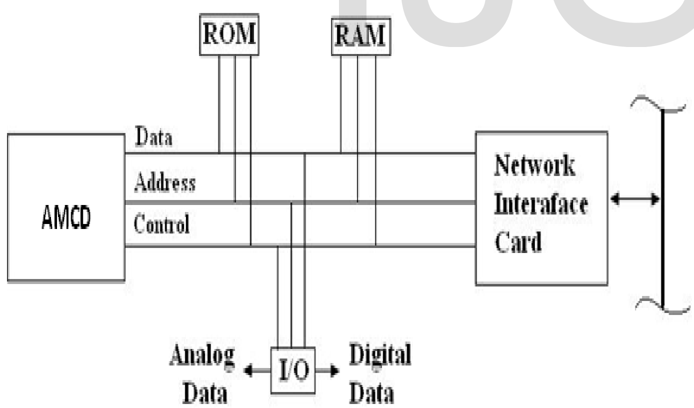

Fig. 3 Basic Structure of AMCD for the application

3.1 Realization of the Final Variable

The project revolves around three main pillars i.e. Three Function Blocks that helps in implementing the application

1.) The Cortex M3 controller
2.) The Development Board along with peripherals
3.) The Most Important Part aka The Programming
4.)The communication channel i.e Netwoking
5.)The final Control Element

Which in some or the other way has analogy with the human body i.e the heart and brain, bones & muscles, the blood , nervous system.

Cortex M3 controller (The Heart & Brain)
Use of the word heart and brain itself implies the importance that cortex m3 controller has in our project. The Cortex-M3 processor is a high performance 32-bit processor designed for the microcontroller market.The Development Board along with peripherals (The muscle and bones)The muscle and bones required for this paper is the general purpose development with peripherals acting as limbs. For us Landtiger i.e lpc1768 serves the above purpose [1].

The most important part Programming: (The blood)
Having a processor alone will not guarantee anything. As blood is the life force for human body similarly programming is the life source for the controller. The main components of blood are RBC, WBC etc. in same way the main components for Programming is IDE(for our project Kielµ vision) along with programmer that acts as WBC.

The communication channel/Networking (The Nervous system)
As nervous system is the structure for communication in the human body similarly the network communication(i.e IEEE 802.3)is used for communication between different segments of the system.

The final Control Element
The work done by human body is to control the environment surrounding it similarly work done by AMCD is to control a system. That control element can be a valve or motor, depending on the type of controlling action required.

3.1 Circuit Realization (Circuit Wiring diagram)

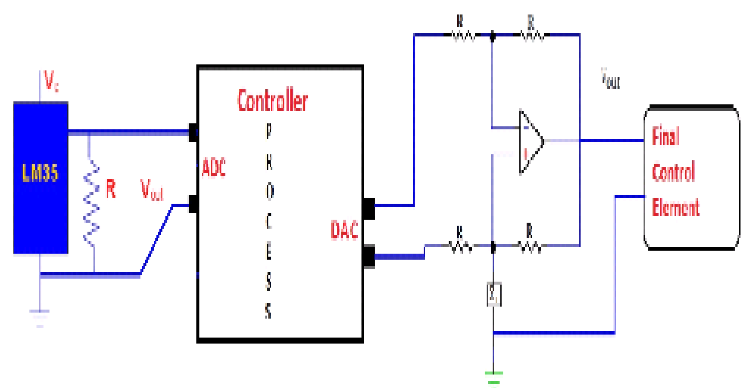

Fig. 4 Electrical Circuit Diagram

The input voltage to this circuit is assumed to be coming from some type of physical transducer/amplifier arrangement,

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caliAMCDed to produce 1 volt at 0 percent of physical measurement, and 5 volts at 100 percent of physical measurement. The standard analog current signal range is 4 mA to 20 mA, signifying 0% to 100% of measurement range, respectively. At 5 volts input, the 250 Ω (precision) resistor will have 5 volts applied across it, resulting in 20 mA of current in the large loop circuit (with Rload). It does not matter what resistance value Rload is, or how much wire resistance is present in that large loop, so long as the op-amp has a high enough power supply voltage to output the voltage necessary to get 20 mA flowing through Rload. The 250 Ω resistors establishes the relationship between input voltage and output current, in this case creating the equivalence of 1-5 V in / 4-20 mA out [3].

4. Programming an Embedded System

Program is about TCP/IP implementation. This is the method to define ip address, subnet mask, gateway ip address, time out, refresh rate, Ethernet network layer implementation, frame types, ipv4 layer implementation [2].

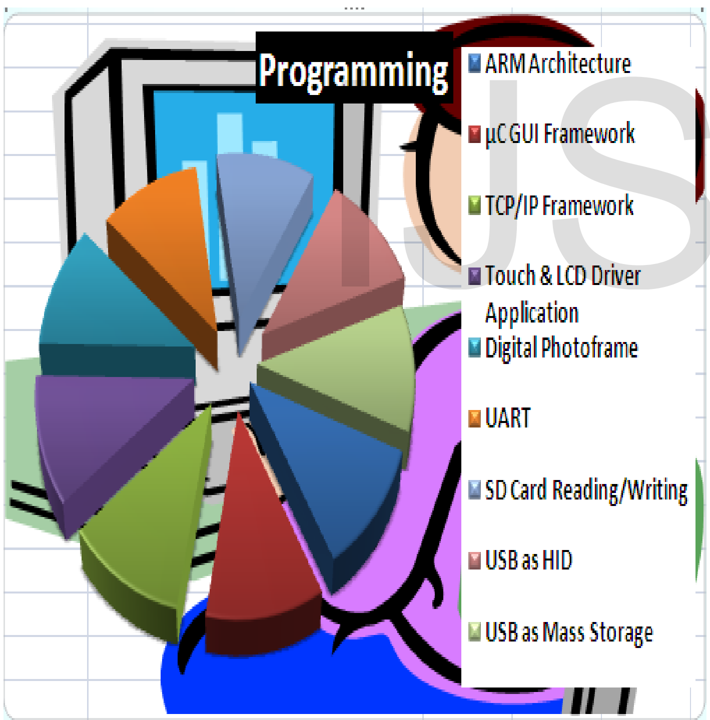

Fig.5 Programming Partition Pie chart

5. The Hardware Description

The Hardware has been broadly divided into three Modules [9].

1.) Input Module: - Input Part includes the sensor that relays information about particular environment to the controller. The input module receives signal from input device convert higher level input to Controller level.
2.) The Land Tiger Board: - The Land Tiger Board includes Cortex M3 Controller which is s the heart of system. It receives instructions from the memory and generates commands to the output modules.
3.) Output Module: - Output module receive command from the controller and converts the controller logic into high level signal to operate contactors, solenoids, valves, heaters etc.

Fig. 6 Hardware Setup of Complete Process

6. The Complete Process

Fig shown below depicts implementation of AMCD in a particular loop of operation.

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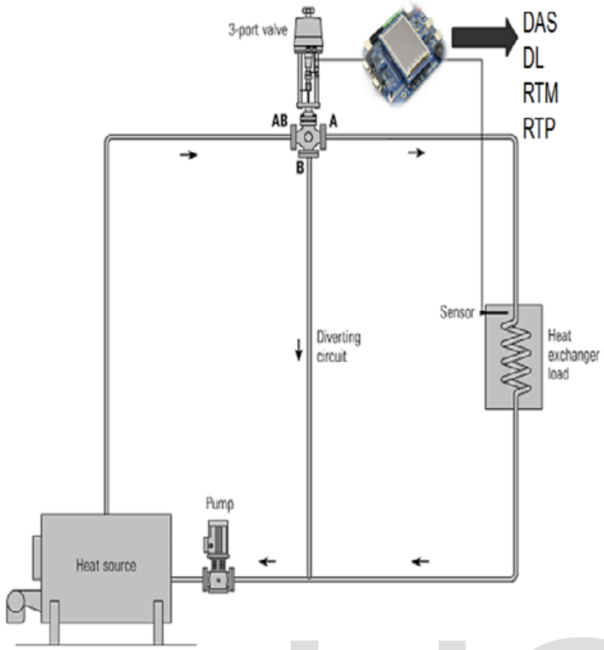
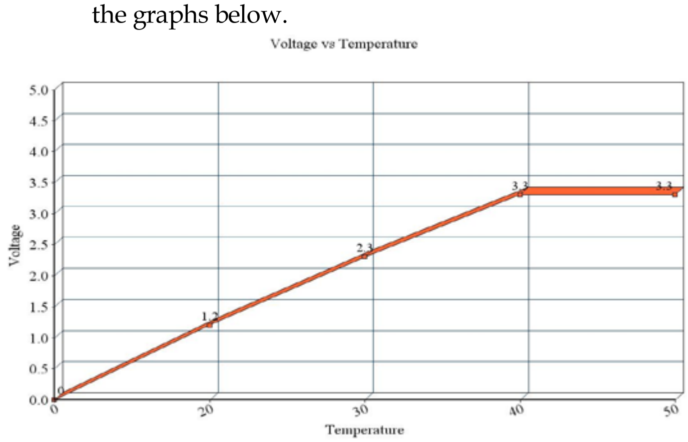
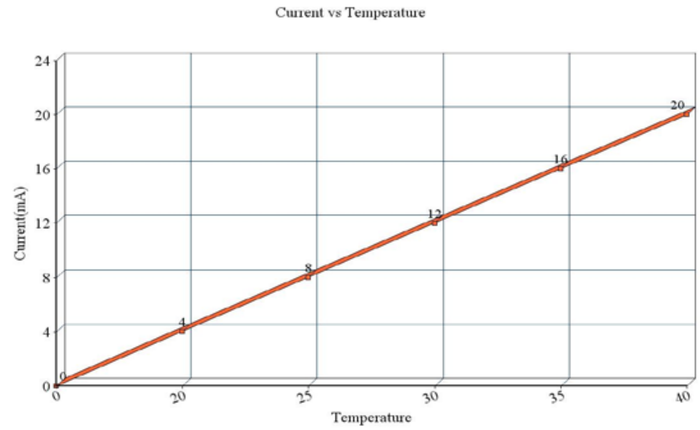


Fig. 6 AMCD in Industrial Loop of Operation

6.1 Specification

The industrial environment has diversified range of operation. For the application purpose it has been limited to a particular range. This can be stated from the graphs below.





7. Real Time Orientations

Real time Orientation refers to systems that are subjected to a "real-time constraint"— e.g. operational deadlines from event to system response. Real-time programs must guarantee response within strict time constraints. Often real-time response times are understood to be in the order of milliseconds and sometimes microseconds.

Or it can be referred to as multitasking operating system intended for applications with defined completion time and latency requirements.

Similarly the AMCD has been incorporated with three such orientations i.e.

Real Time Programming

Real Time Monitoring

Real Time Graph Generation

7.1 Real Time Programming

A system having different applications for different control signals is subjected to Real Programming. The program which executes the process can be changed depending on the application remotely, real time [6].

It contain following steps.

1. Programming For Application Configure
2. Programming For Creation of Task i.e. GUI
3. Programming For Creation of Task i.e. Touch Panel
4. Programming For Creation of Task i.e. Real Time

7.2 Real Time Monitoring

In Real Time Monitoring the system is under constant scrutiny for system stability and improvement.

It contain following steps.

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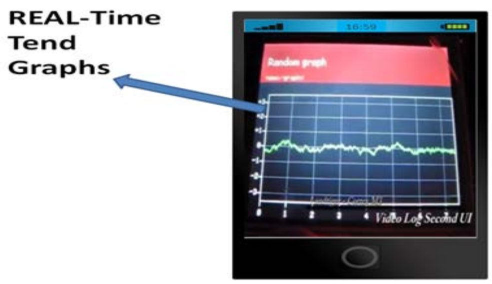
1. Programming For System Reinitiating
2. Programming For ADC Value
3. Programming For DAC Value

7.3 Real Time Graph Generation

The system generates Real time graphs of signal Applied to the controller.



8. CONCLUSION

System-on-chip solutions based on ARM embedded processors address many different market segments including enterprise applications, automotive systems, home networking and wireless technologies. The ARM Cortex™ family of processors provides a standard architecture to address the broad performance spectrum required by these diverse technologies. SOC is where the world is headed. Creating a single hardware that is compatible with all software can be used for variety of application in much more reliable and cheaper way.

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9. RECOMMENDATION FOR FUTURE WORK

A lot can be done using the concept. Control and real time transmission is just scratching the surface. Better controllers can add low scale image processing and can be used to implement augmented reality which is a brilliantly genius concept and altogether a complicated implementation.

For Undergraduates who might wish to work on this concept can improvise by optimizing AMCD for different industrial loop applications including different sensors/transducers and final control element.

AMCD if harnessed properly can become the future for Industrial Automation.

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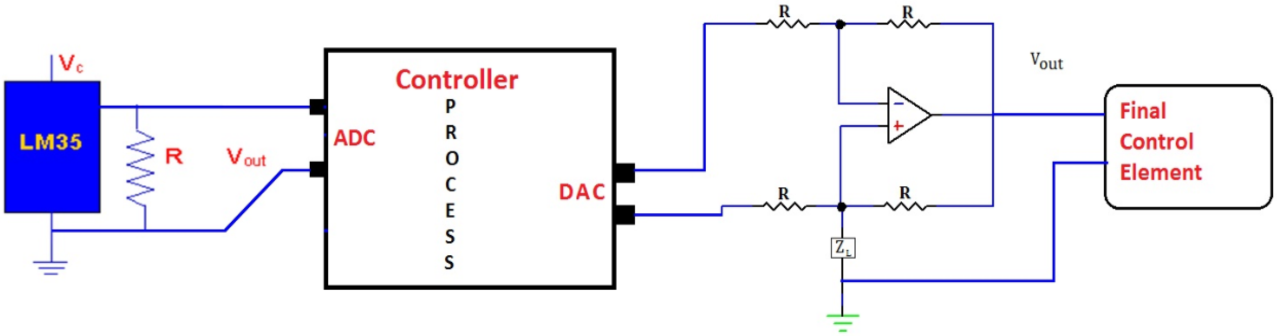
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LM35
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ADC
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Vout
Final
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