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Development of a Versatile Mathematical Routine Library with Microcontroller

P.B.Buchade

Abstract— A software tool for micro controller applications with assembly language programming for interfacing concepts having a multipurpose routine library is developed. This library is intended to solve different mathematical equations like linear equations, first polynomial, second polynomial etc encountered in data acquisition and analysis. Routines are also developed for proper formatted display on LCD. Some of the unique features of this method are highlighted. A multipurpose mathematical routine library which can be used as a easy tool in designing and implementation of microcontroller based instrumentation systems.

The analog voltage on a selected channel read from instrumentation is converted to digital form with ADC stored in internal memory..The subroutine programs for performing the mathematical operations like addition, subtraction, multiplication, division etc in 16 bit format are tested with Integrated Development Environment (IDE) simulator. This subroutine programs are then further used to solve the equations with asm51 cross assembler. The program can debug, erased and reprogrammed immediately and online tested. After assembly completion, error free program is downloaded with FLASH MAGIC in a microcontroller chip

Index Terms— Embedded, Microcontroller, Routine Library, software

I. INTRODUCTION

Micro controller have overcome the microprocessors especially, in areas where high integration and save of space is required. In recent time eight bit microcontrollers became the backbone for the solution of application of intermediate complexity[1]. A special application of microcontroller are well suited is for data logging as well as monitoring and recording the environmental, physical and chemical parameters. It is one of the powerful device, which can be used for the measurement and control applications in industry as well as in specific application. A special application of microcontroller are well suited is for data logging as well as monitoring and recording the environmental, physical and chemical parameters [2]-[4].The applicability of microcontroller for any given design is dependent on many interrelated factors that are not all of a technical nature. Economics most often plays an important, if not overriding, role in the design of a microcontroller in a product design. However there remains a task of creating the best design for the given specification[5]. A new software tool for micro-controller applications with assembly language programming for interfacing concepts with a multipurpose routine library is developed. The developed system is tested in laboratory.

II. THE CONCEPT OF ROUTINE LIBRARY

The system is designed with aims that it can be use by persons working with designing an instrumentation or maintaining embedded systems and having no prior detail technical skill or detail knowledge of writing a program for microcontrollers. With a hand on training and some instruction , they can use a routine library and can solve the simple to complicated mathematical equations in their control circuits, and display their result own.

A new software tool for micro controller applications with assembly language programming for interfacing concepts with a multipurpose routine library for 89c51RD2 is developed. Some of the unique features of this method are highlighted. The analog voltage on a selected channel read from instrumentation is converted to digital form with ADC stored in internal memory .The subroutine programs for performing the mathematical operations like addition, subtraction, multiplication, division etc in 16 bit format are tested with Integrated Development Environment(IDE)simulator. This subroutine programs are then further used to solve the equations with asm51 cross assembler. The program can debug, erased and reprogrammed immediately and online tested. After assembly completion, error free program is downloaded with FLASH MAGIC in a microcontroller chip. The results are displayed with LCD. The flexibility of this mode of programming may be used for pre-programmed production devices which requires to updates or modifications in the targeted application system. The developed system is a free standing piece incorporating its own power supply, keypad, LCD display, ADC. Connector is provided for the downloading from host computer where routine library is stored in different files on SIM 31and assembled on the same machine.

III. BLOCK DIAGRAM

It consist of different units like, Keyboard, Analog to Digital Converter, Liquid Crystal Display for the multi parameters measurement system. The device supports 6-clock /12-clock mode selection by programming a flash bit using parallel programming. This choice is available individually for each peripheral and is selected by bits in the CKCON register. This device is a Single-Chip 8-Bit Micro-controller manufactured in an advanced CMOS process and is a derivative of the 80C51 micro-controller family. Due to these immense features, the controller 89C51RD2 was chosen in the present design.[6]-[8].The block diagram of microcontroller interfacing is shown in Figure 1.

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***** Correspondence Author (s)
P.B.Buchade, Department of Electronic Science, Abasaheb Garware College, Pune 04, India.

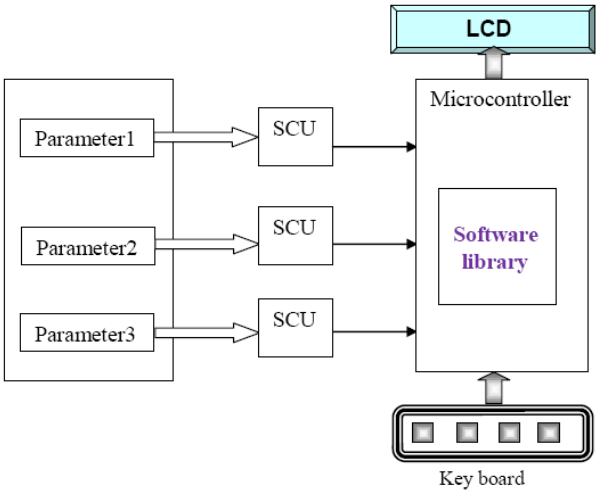

Figure 1. Block diagram of microcontroller interfacing system

IV. MICRO-CONTROLLER AND ITS PROGRAMMING

The package is designed to perform arithmetic operations we have called them as a "89c51 Calculator" it consist of following routine programs to solve the equations like

$Y= mX+C$, $A_1x+B_1y=C_1$ $A_2x+B_2y=C_2$

The tested programs available in a library are 32bit addition .multiplication and division of two 16 bit., Hexadecimal to Decimal conversion 24 bit. delays ranging from ms to sec etc. The 89c51RD2 has a total 128 bytes of RAM, out of which 38H to 4DH are fully utilized to store the data for the mathematical operation.

In the present study, to program 89C51RD2 a special board was prepared. The developed board was also used for experimentation in the laboratory. It has DB9 male right angle connector to connect to the COM port of PC. IC MAX 232 is used to convert RS232 signal to TTL signal. The board is outfitted with 40-pin socket to place the controller and a switch to change the logic level of $\overline{PSEN}$ pin. The developed target board is shown in Fig. 2 and the flow diagram is shown in Fig. 3.

Figure 2.Downloading Program into a target board

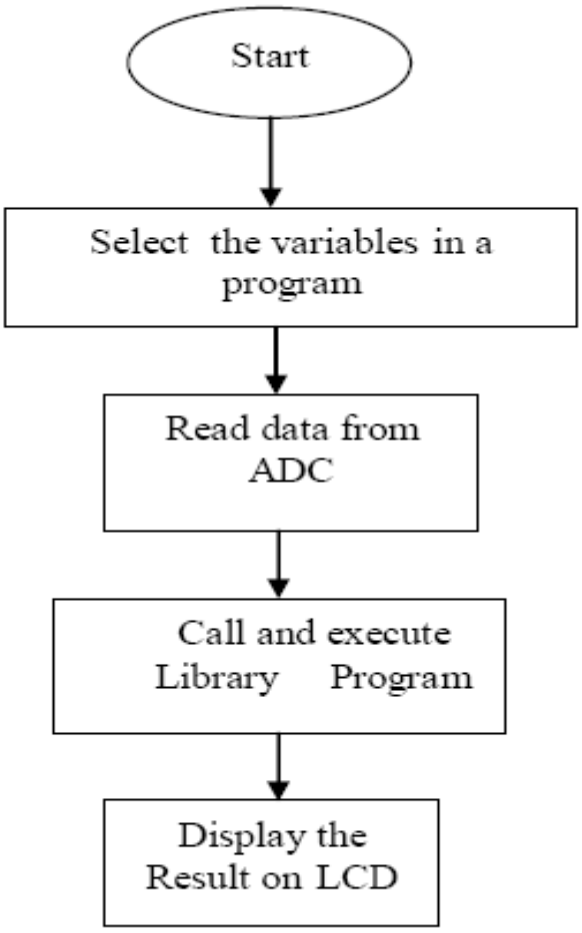

Figure 3.Flow diagram for system routine

V. INTEGRATED TESTING

After each development, the graphs were plotted. According to behavior of variables and nature of plot, equation was derived. e.g. The dummy graph is plotted for elucidation.

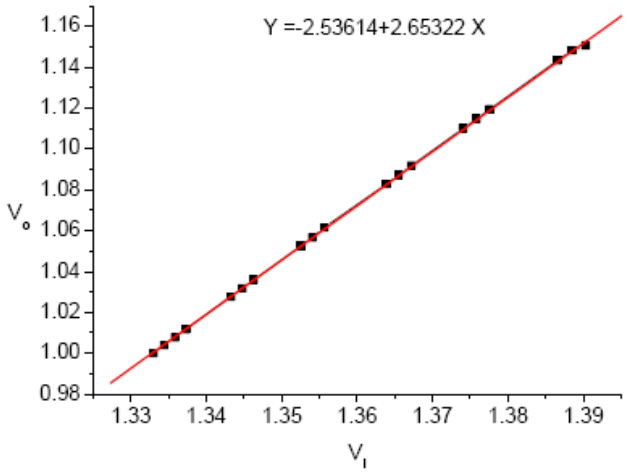

Figure 4. Graph showing linear relationship between V_i and V_{out}

Equation from the graph obtained is

$$V_i = -2.5361+2.65322 * V_o,$$

where slope = 2.65322 and C=-2.5361, V_i and V_o are the input and output variables. The analog signal from transducer or sensor through signal conditioning changes from (0-5V).

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By rearranging the above equation, we have

$$V_o = [(V_i + 2.5361)/2.65322]$$

To solve this equation if both numerator and denominator are multiplied by 100D, It becomes

$$V_o = (100\ V_i + 253)/265$$

VI. DISCUSSION AND CONCLUSIONS

Microcontroller exhibited different arithmetic precision for floating point operation in different ranges of numerical values. This problem was removed by scaling these numbers by constant factor 19, which is the step voltage of 8 bit ADC, and by checking the minimum threshold. This method greatly improved accuracy. With this specific routine library, it is possible to use microcontroller as a tool for the interdisciplinary field in a basic sciences, biotech, and engineering.

The system is designed with an aim that it can be used by persons working on designing instrumentation or maintaining embedded systems and having no prior detail technical skill or detail knowledge of writing a program for microcontrollers. With hands on training and knowledge of some instructions, they can use a routine library and can solve the simple to complicated mathematical equations in their control circuits, and display their own results.

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