Experimental Test of Digital Automated System for Dobby Based Fabric Structure

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Abstract- The ultimate goal of this research work is to provide an experimental test for a microcontroller based system to be embedded into weaving machine for monitoring and controlling the fabric design operation after the success of the simulation test. The proposed embedded system reads the design parameters entered by the designer using a keypad, calculates the color's repeating insertions, generate the design in sequences of binary digits and apply the design on the machine with machine status consideration. The peripheral Interface Controller (PIC) microcontroller, keypad, Liquid Cristal Display (LCD), relays, solenoids, sensors and power adapter are used for system design. In addition to that the MikroC editor is used for system programming in C language and uploaded to the internal memory of the microcontroller using the Wellon 490 universal programmer.

Index Terms- Digital System, Microcontroller, Experimental Test, Industrial Automation, Fabric Structure.

1. INTRODUCTION

The field of embedded systems has evolved continually in many different application domains. Driven by the ever improving price/performance ratio of microelectronic devices, many mechanical, hydraulic and electronic-analogue control systems have been replaced by embedded digital computer systems, resulting in control systems of lower cost, increased reliability and enhanced functionality [1].

Industrial automation (IA) is the vast area of embedded computing devoted to industrial applications. Apart from many tailored solutions (numerical controllers, hardware controllers, etc.) the scene is dominated by programmable logic controllers (PLCs), which represent the most wide-spread class of embedded computing platforms. In the past, the progress in embedded technologies has determined qualitative breakthroughs in the performance of automation systems, affordability and efficiency of their designs. Intelligent industrial automation (IIA) has appeared as a branch of research and development, answering the challenges of flexible and adaptive manufacturing, which require mass customization instead of mass production. It stipulates the use of information and communication technology (ICT) methods and tools for creating self-configurable or easily-reconfigurable control systems to automate manufacturing processes. [2].

Electronic-textile research is closely related to wearable computing research, but in many ways its own distinct field. Wearable computing explores technologies that are portable and attached to or carried on the body, but e-textile research has a slightly different focus: investigating electronic and computational technology that is imbedded into textiles [3].

The dobby based design method is completely depends on the design card and it's hole and non hole spaces which are used to control needles movement. The design plan will be represented on that created using punching machine to punch the card when the warp is overlap and to leave the card without punch when the weft is overlap, although the A computer based system in which the textile designer can create the design and save it on a floppy disk, Then this design can be applied on the textile machine through a suitable floppy disk driver attached to the machine or personal computer-textile machine direct interfacing are introduced [6].

In [4] a simple computer system with the capability to read the fabric design parameters for model, and to follow-up the design operation on the fabric structure according to entered parameters is successfully designed and simulated. Therefore, this research work goes continually to proved the system on test port and it's running in real world.

2. Material and Method

The proposed system which has been designed and tested in electronic simulation environment as illustrated in [4], composed of two main parts: the hardware and software. In the hardware, the rapier loom of Toyoda machine can be used in addition to a microcontroller, Keypad, liquid crystal display (LCD), power adapter, magnetic field and sensors. The central control unit (microcontroller) has to access the textile machine (rapier weaving loom) to obtain the design progress monitoring and control. Thus, one of the input/output ports of the Microcontroller with eight bits can be used for connecting the machine. Other input/output ports can be used for Keypad, LCD for user interface required for design creation and progress monitoring as illustrated in Figure 1.

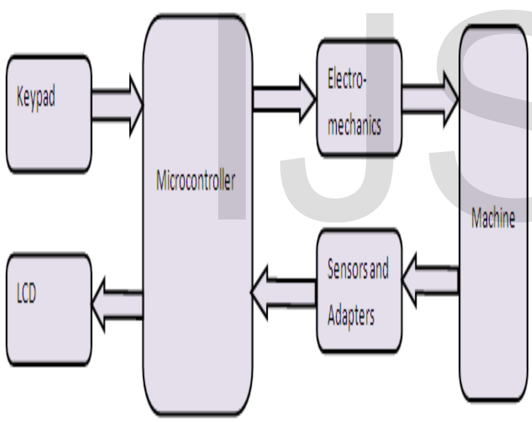

Fig 1 : System hardware

The keypad is used to enter the design parameters required for new design creation: four values for color length and the number of insertions / unit while the LCD is required for design progress and machine status monitoring: power status and progress percentage.

Therefore, the microcontroller has to read the design parameters entered by keypad input line, calculate the number of insertion for each color and the total number of insertions required for the design, read the machine status using the input lines connected to suitable sensors and adapters, send the sequence of binary digits represents the design to affect the machine using the output lines connected to suitable electro-mechanics systems (solenoids) for design creation and view the progress status using LCD.

Therefore, three 8-bit input/output ports are required for the microcontroller: a separate port for each keypad and LCD in addition to a machine-microcontroller communication port. The C/C++ language can be used successfully in low-end embedded programs which are not timing-critical. Low-end systems that need to work at high speeds or high efficiencies cannot use C/C++ because the compiler produces code which is far inferior to assembly language code. [5].

3. System Design

The hardware of the system is composed of a microcontroller, LCD, keypad, sensor, adapter, relays and solenoids. The microcontroller has to communicate with the machine through eight input/output lines: four of them connected to solenoids through relays to pull down one of the four needles used for color selection, two lines connected to solenoids to pull down one of the two groups of needles used for shafts setting, one line connected to the machine power source through an adapter and another one is used to detect the insertion rapier using photo sensor. The LCD and keypad are used for the user interface, also each requires eight input/output lines to communicate with the microcontroller. Figure 2 presents the diagram with pin connections for the proposed PIC 16f877A.

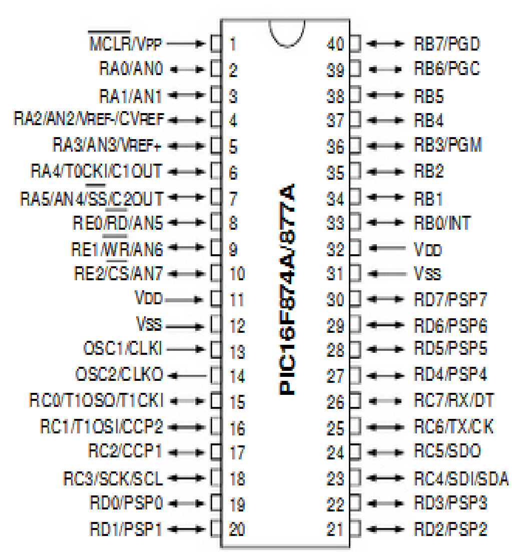

Figure 2: PIC 16f877A [data sheet]

This device consists of four programmable input / output ports: port b is used for LCD, port c is used for keypad and port d is used for machine connections.

As a complementary part for this hardware, integrated software has been developed in MikroC for PIC to: read the design parameters, check the machine status, calculate the real numbers of insertions, follow up the design progress and view the percentage. It is composed of the following parts:

- Global variables represent the variables used among the program.
- Global function as follows:
  - o Data read function: used to read color one, color two, color three, color four, number of insertion per unit and total product length from the keypad; therefore, it is used six times in function main.
  - o Color progress function: it has to read the number of insetion for each color and it's index when used to create this color on the fabric machine.
  - o Progress percentage view function: used to view the percentage of the progressed length out of 100.
- The main function:
  - o Declare and initiate the keypad.
  - o Declare and initiate the keypad.
  - o Identify the I/O port Function.
  - o Continually check the machine status.
  - o Sequential call for the Global Function

Before start writing the code for the above mentioned functions, the LCD and the Keypad should be defined then a mikroc code has been developed for the progress stage with the capability to read design parameters entered through the keypad: colors length, total product's length and number of insertion per unit which are used to calculate the number of insertions required for each color, unit length and the total number of insertion, then follow up the colors sequential progress goes according to the design requirements and view the progress percentage using the LCD. Sequential binary will be generated and applied through the microcontroller input/output port for connecting solenoids to pull down the dobby needles for color selection via pin 2, 3, 4 and 5 of port D and shafts setting via pin 6 and 7 instead of the punched and no punched spaces of the plastic card. Pin 0 and 1 used as input: 0 for the machine power source test via adapter and 1 for the insertion object position detecting via sensor.

Finally, the project has been compiled and converted to hexadecimal and loaded to the microcontroller internal memory.

4. Experimental Results.

For experimental system development, the system components installed on the test port as appeared in Figure 3.

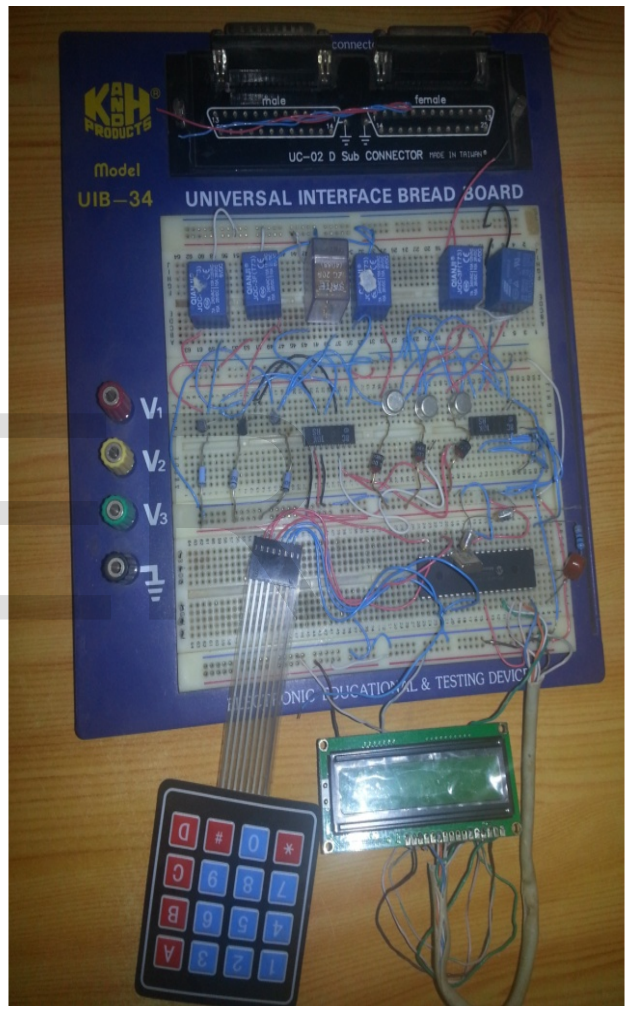

Figure 3: The system on test port

The light emitting diodes on the circuit were replaced by six 12 volt DC solenoids: four of them for color selection and two for shaft groups setting, as seen in Figure 4.

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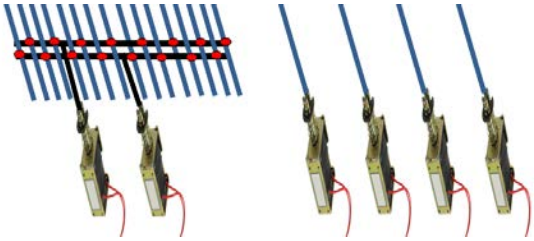

Figure 4: DC 12 Volts solenoid

Then the hexadecimal file uploaded to the microcontroller using the Wellon VP-490 universal programmer connected to the PC as shown in Figure 5. The driver software in Figure 6 was used to save the hexadecimal to the microcontroller internal memory.

Figure 5: Wellon VP-490 universal programmer

On the driver main widow, the microcontroller 16f877a is selected, the hexadecimal file selected and added then the programming stage started.

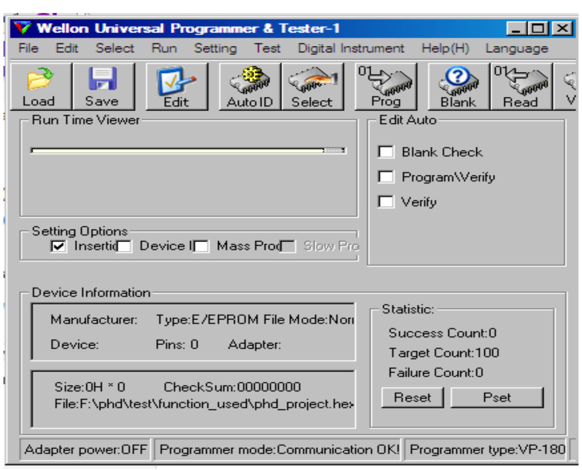

Figure 6: Driver software

When the system is run, considering the power source, the designer can use the keypad and the LCD on the front of the system case to enter the design parameters: four colors length, total product length and (n/u) "number of insertions per unit as shown in Figure 7.

Figure 7: Entering of design parameters via keypad

Then, if the design is set on the shafts needles as shown in Figure 8, the design progress will start applying via the solenoids with continually selection of the suitable group of needles to select the color and set the shafts.

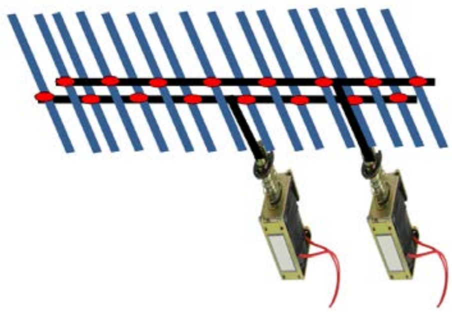

Figure 8: Shafts setting

Color one is enabled "pulled down the related needles" with one group then the other group, and so for color two, three and four sequentially as in figure 9. setting

The designer has to select the needles for each group according to the design requirements.

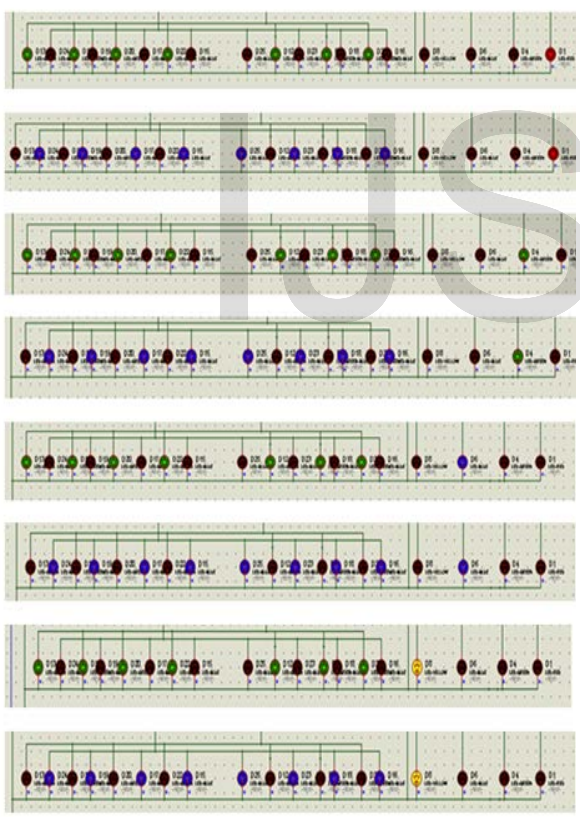

Figure 9. the sequential color selection and needles selection

. Instead of the punched and no punched spaces on the plastic card it's now simpler to create design, enter design parameter using key pad and set the shafts groups required for the design without plastic card and punching machine. Then the solenoids and the relays handled the pulling down function. The solenoids represented by light emitting diodes(LED) for test as in figure 10.

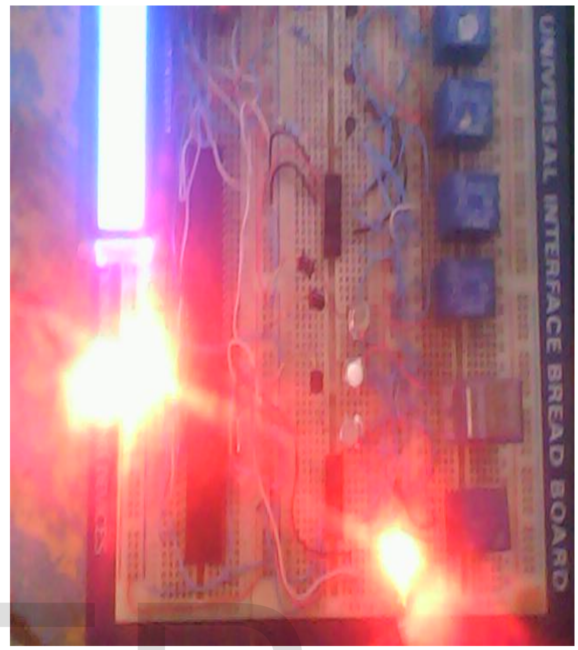

Figure 10: system running using LED

5. CONCLUSION

By the end, a simple, flexible and easy to use system is successfully designed and tested. For the user "fabric designer" there is no need for plastic cards and the high proficiency required for design on the punching machine where the designer can easily set the suitable grouping required for the needles and enter the design parameters using the keypad with capability to correct and restart for error avoidance. About the cost, the embedded system's cost is: Unit cost which refer to the monetary cost of manufacturing each copy of the system excluding NRE cost and the Non-Recurring Engineering cost (NRE) cost is The one-time monetary cost of designing the system; overall the system billed of available and low cost components for the fabric manufacturers compared with the current tools. The system flexibility can be viewed via two main visions: the system developers vision and fabric designers vision; for the system developer, there is an unlimited band of choices to create new copy or partially replace of system hardware concatenated with the system reprogram ability for software upgrade and repair; for the fabric designer, the system provides an unlimited color and product length with all the available of needles settings.

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