Design and Simulation of an Embedded Computer System for Fabric Structure

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ABSTRACT

The ultimate goal of this research work is to provide a simulation test for a microcontroller based system to be embedded into weaving machine for Monitoring and controlling the design operation. It will replace conventional mechanical methods as a forward step in embedded systems for industrial automation and mechatronics applications.

The proposed embedded system aimed to read the design parameters entered by the designer using keypad, calculate the colors repeats insertions, generate the design in sequences of binary digits and apply the design on the machine with machine status consideration. Peripheral Interface Controller (PIC) microcontroller, keypad, Liquid Cristal Display (LCD), relays, solenoids, sensors and switches are used for system design in addition to that the MikroC editor used for system programming in C language and Proteus electronics simulation environment.

Keywords

Embedded Systems, Microcontroller, Simulation, industrial automation, Fabric Structure.

1. INTRODUCTION

Microprocessors and microcontrollers have become the most powerful tools available to scientists and engineers. Microcontrollers have been embedded in so many products that it is easy to overlook the fact that they greatly outnumber personal computers (PCs). Millions of PCs are shipped each year, but billions of microcontrollers are shipped annually as microcontrollers to be used for embedded systems applications [2].Such systems achieved the time and efforts without human intervention and so, it proved a quite effective in terms, cost and efficiency in many applications.[3]

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 [4].

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.[6]

The electronic sewing kit includes the basic materials needed to begin embedding electrical components into fabric: conductive thread and a needle, a battery which can be either stitched or snapped onto a piece of fabric, LEDs which have been modified so that they can be sewn onto fabric like beads, and a soft fabric switch.

The objective of this research work is oriented to design and simulate 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.

2. Background

Generally, there are three devices are used to construct the fabrics known as Cam, Dobby and Jacquard, each device has the scope limit of design which is considered as a constraint. The Dobby device is widely used to construct fabrics design required not more than 24 shafts, but the dobby which controls the 24 shafts is commonly used. Recently, the mechanical dobby has been replaced with an electronic dobby and numerous patents of electronic dobbies are currently working in many countries [1].

The conventional woven design method is completely depends on the design card and it’s hole and non hole spaces which are used to control needles movements. 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 as shown in Figure 1[8].

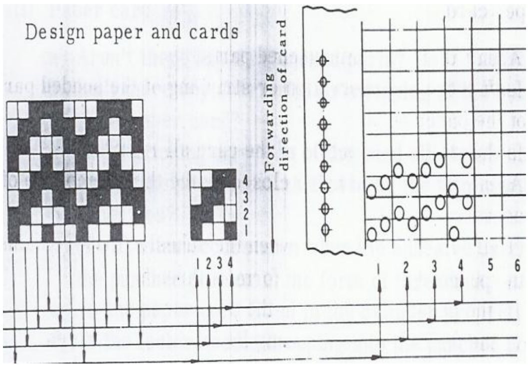

Fig 1 : The weft is overlap and design creation.

This card used by the fabric machine for the overlap control as in figure 2

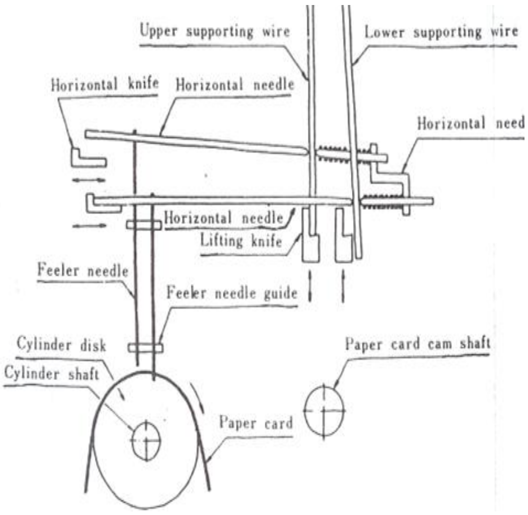

Fig. 2 weft overlaps control

A computer based system can be introduced in such a way that 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. A simple example of this mechanism is shown in Figure 3.

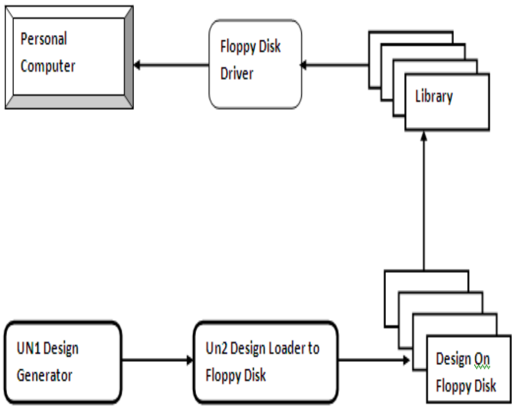

Fig 3 : A computerized design Mechanism.

Resent study represents the warp overlap by logic (one) and weft overlap by logic (zero). Then the overall the design on the card is represented by sequences of zeros and ones. The suitable sequence of binary digits can be generated by a computer system according to the design requirements as presented in Figure 4.

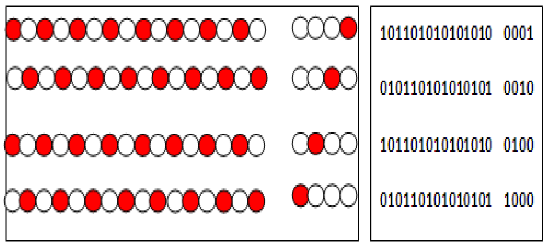

Fig 4 : Design representation

These sequences of binaries can make the same function using suitable magnetic fields. Thus the basic idea of the study idea is to implement the binary representation of this conventional method to create a simple computerized method.

3. Material and Method

The proposed system is 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 5.

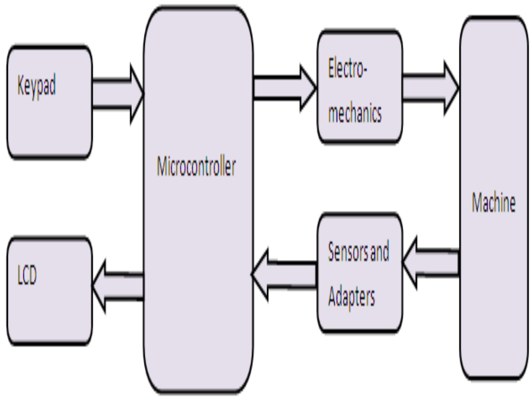

Fig 5 : System hardware

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. [7].

4. Design, Simulation and Results

The microcontroller has to communicate with the machine 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 adapter and another one used to detect the insertion rapier using photo sensor "but in this simulation study on/off switches were used instead of sensor and adapter"

As a complementary part for this hardware, integrated software has been developed in MikroC to handle these functions respectively. Figure 6 illustrates the design operations.

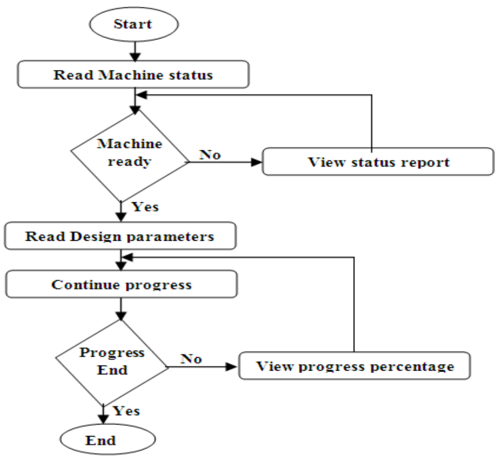

Fig 6: System operations flowchart

In the progress stage, the design parameter: colors length, total product's length and number of insertion per unit are used to calculate the number of insertions required for each color, unit length and the total number of insertion as follows:

The color's number of insertion= color length number of insertion per unit*

The unit = summation (color X length) when X=1- 4

*The total number of insertion = total product's length * number of insertion per unit*

total product's length mod unit length=0

Then the colors sequential progress goes according to the flowchart as shown in Figure 7 below.

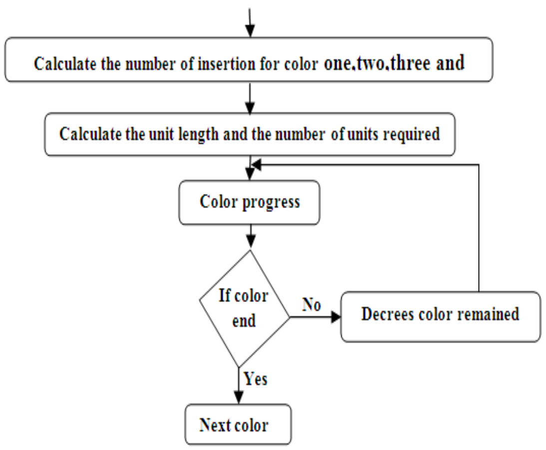

Fig 7 : Colors sequential progress

When all colors progressed, the number of units should be decreased. The unit progress will be repeated until the remaining number of units becomes zero. Sequential binary will be generated and applied through the microcontroller input/output port to connected solenoids to pull down the dobby needles for color selection and shafts setting instead of the punched and no punched spaces of the plastic card.

The Proteus has been used to create a system simulation environment for testing of the integrated embedded system test. It's rapid, flexible and parallel development of both the system hardware and software with a flexibility to make hardware or software upload and changes, in addition to the Mikroc editor which was used to create c project, compile, convert to hexadecimal and upload to microcontroller internal memory.

When system run, it has to check the machine power source then read the design parameters: four colors length, total product length and (n/u) "number of insertions per unit as shown in Figure 8.

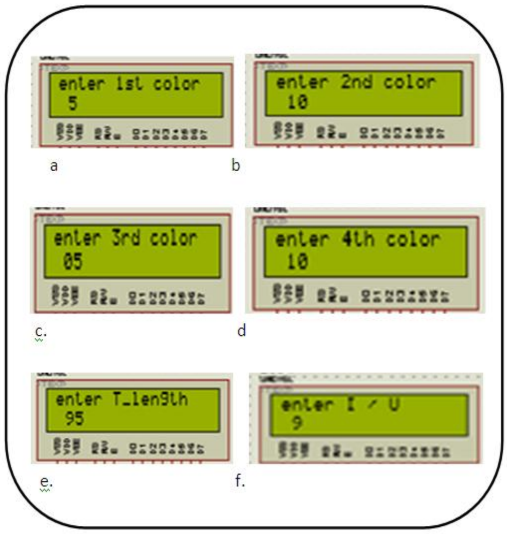

Fig 8: Reading of design parameters

Then calculate the number of insertions required for each color, the number of insertions required for the total production, generate and apply the design binary representation on the machine to pull down/up the needles according to the product characteristics through the solenoids connected to the relays.

Then, progress percentage message continuously viewed until 100% when completed as demonstrated by Figure 9.

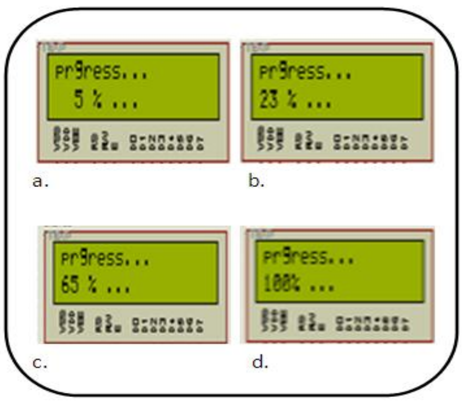

Fig 9 : Design progress

During the progress, the required color should be selected and the shafts should be at the suitable position according to the design. Light Emitting Diodes used for simulation as shown in Figure 10.

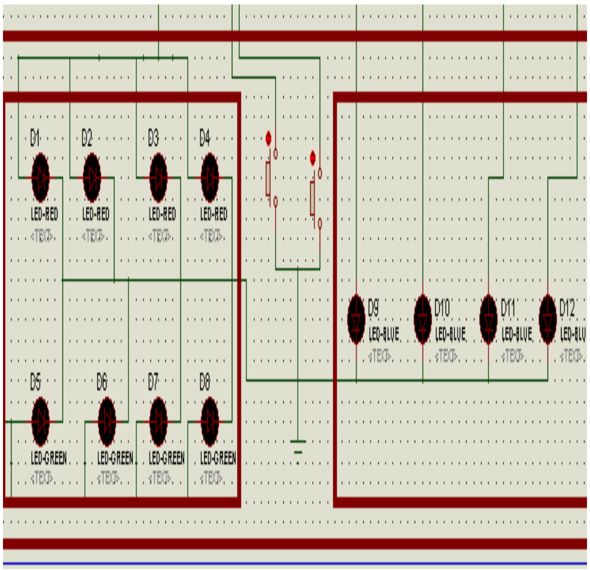

Fig 10: Color selection and shafts setting

5. Conclusion

This study addresses the problems of conventional mechanical methods implemented in fabric machines. In particular, a simple, flexible extendable easy and to be used system is has been designed and tested with the avoidance of design card and punching machine. In addition to it is compatible with heterogeneous machines while dobby is used. therfore, the proposed system can be considered as a base to standardize computerize methods for fabric structure design as an embedded systems application.

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