

## Woven design data transmission using TTL logic for 128 hooks electronic cardless jacquard

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A new electronic cardless handloom weaving apparatus which is an alternate to mechanical jacquard has been developed in order to improve the productivity and to reduce the occupational stress of the handloom weaver. The main objective of this development is to retain the features of the handloom with comfortable weaving and reduced laborious work. This development is based on embedded system to control the warp yarn vertical movement. The conventional punched cards are replaced by multimedia memory card file system. The shedding effect is programmatically controlled through miniature stepper motors. The new apparatus is found to be highly versatile for introducing variety of weaving patterns.

**Keywords:** Embedded system, Handloom weaving, Jacquard device, Punched cards, Multimedia memory card, RS485 serial bus, Transistor to transistor logic

Traditional handloom weaving of fabric has been declining over the years due to various factors such as obsolete weaving methodologies. It is an elaborate process involving many phases, like art work, transfer of outline of art work to design pattern, painting, draw weaves (ground and design), punch pattern cards (punched cards), lace the cards, stop the loom to set the pattern and weaving<sup>1</sup>.

Most of the marginal handloom weavers are not able to introduce new design for every fabric according to the need of the market or customer. When a new design is introduced the total set of cards of the Jacquard has to be replaced and this involves a lot of money. Due to these practical intricacies the weavers are less likely to introduce new designs with the increasing recurring cost. As a result, they will not compete in the market by having very few designs.

In the conventional system, the weaver has to exert maximum<sup>1</sup> physical strains by pulling the heald shaft

attached with the Jacquard system to shape the design. In course of time this will lead to serious health hazards ranging from chest related problems. Especially the women weavers and aged people are being affected. Due to the maximum effort, the weavers soon get fatigued and remain not in a position to work for long hours. Aged people are finding it increasingly difficult with their fragile health.

The younger generation of the weaving community have switched over to other jobs since they are unable to get lucrative income. Also this 128 hooks electronic jacquard may help textile students to understand the weaving concept easily and they could change the designs rapidly. In the woven design the ground weaves are very small and it has a repeating feature. The motifs are used in general for introducing ornamental effect on the fabric.

The woven design apparatus evolution has the following sequences like group of threads directly connected to warp threads, doobby and jacquard. The jacquard method generates the woven design without making changes on the loom setting. It requires only changing the perforated card which is known as punched cards. When the system needs controlling the entire warp threads by the jacquard device, the handloom weaver has to put more strain on his work. Hence, the handloom weaver health status will go in a declining stage.

In view of above, this study has been planned to improve the manufacturing of handloom fabric and to upgrade the socio economic status of handloom weavers group. A new electronic cardless handloom weaving apparatus which is an alternate to mechanical jacquard has been developed.

## 2 Experimental

### Existing Apparatus

The existing system is the mechanical jacquard along with punched cards in order to produce the woven designs. In the existing handloom the major difficulty is to form shedding by harnessing with the lingos (7-10 g weight connected to every warp thread through heald eye). The total weight of the lingos varies with respect to the width of the fabric.

A shedding device, i.e. weaving machine for textile industry, has individual thread controller, direct and permanent connection enabled between healds and lower and upper selecting and/or lifting elements without harnessing<sup>2</sup>.

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The loom control uses external memory card to monitor the data input from the computer<sup>3</sup>.

#### Proposed Apparatus

The developed apparatus is an alternate to the conventionally used mechanical jacquard. The new system has compact storage medium which is known as multimedia memory card in place of punch card. It is highly versatile, since its memory capacity (giga bytes) is very high.

An electronic jacquard mechanism uses electro-mechanical system to lift the warp threads found on the loom. As part of this product the woven design conversion tool is playing a vital role. Its primary job is to take universal image files and convert these images into raw binary format (RBF) which would be transferred to multimedia memory card at the end of the design conversion.

The product has no perforated cards for generating woven designs; instead raw binary information is read from the multimedia memory card, which causes appropriate warp lifting to generate the design in the handloom weaving. The weft thread insertion is done manually. The individual or group of threads connected together can be moved by this product. This product supports maximum hooks capacity up to 16384. The embedded system enabled client-server architecture is formed with a single server (master controller) and maximum of 256 numbers of RS485 clients. Every RS485 client is capable of controlling 64 hooks of the electronic jacquard for handloom. Based on this architecture the system could support up to 16384 hooks.

After finishing the woven design for the fabric with the help of either graphics software or computer aided textile designing software, it is transferred into multimedia memory card in the form of raw binary format. All these works will be carried out with help of general purpose computers.

In Fig. 1, the typical system architecture of 128 hooks electronic jacquard is depicted.

This system has the facility to integrate micro controller with electronically forming the shedding effect. The warp controlling signals are available in the memory card which is the input source for the design and shedding information. The electronic jacquard mechanism sequentially expects the design data in a predefined sequence. Based on this sequence the electronic jacquard pattern operation is determined. The electronic system gets information for every warp thread in the binary form ( $1^s$  and  $0^s$ ).

With less time and effort any complex design can be prepared and it is transferred into loom apparatus. The system is implemented using 128 hooks module. This produces 27 inch fabric with 40 threads per inch. This system enables the handloom weaver to prepare the sample output very quickly.

#### Methodology (using TTL logic based Polling Method)

This development controls the warp threads by bottom-closed shed mechanism for generating the woven designs. The total capacity of the electronic card less jacquard is 128 hooks. This is a modular construction with 2 client controller modules. Every client controller has the capacity of 64 hooks which controls 64 stepper motors. This device operates with the help of client-server architecture. As per the system architecture depicted in Fig.1, the device is facilitated with the following features:

- (i) Control panel with memory card support – 1 No. (Server)
- (ii) TTL logic enabled RS485 clients with identification as 1 & 2 – 2 Nos.
- (iii) Frame rack arrangement for keeping 128 stepper motors -1 Nos.
- (iv) Frame rack arrangement for keeping RS485 clients with decoder logic and stepper motor interface electronics system – 1 Nos.
- (v) Border-tie harnessing system arrangement
- (vi) Frame loom setup without heald frames

The control panel performs its functions as a server in order to control the decoder logic based RS485 clients. Every decoder logic based RS485 client is configured

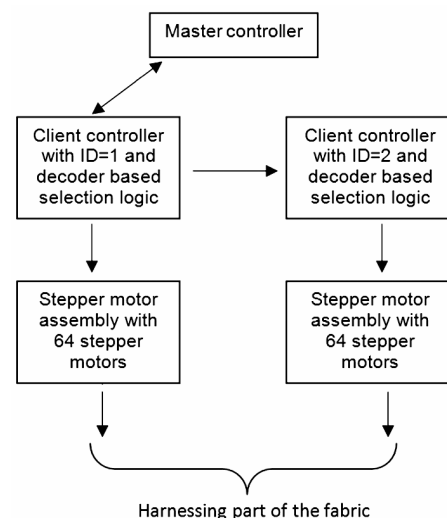


Fig. 1– System architecture

with its ID. While controlling the decoder logic based RS485 clients by the control panel (Server), it uses ID of the respective decoder logic based RS485 clients to transfer data and command. Once the decoder logic based RS485 client completes its operation, the acknowledgement is sent to the master controller. After receiving the acknowledgement by the server (control panel), it prepares itself for the next operation.

The design data transmission over decoder logic based RS485 client takes place in the following format to buffer the design pattern before execution:

CID Rotation D1 D2 D3 D4 D5 D6 D7 D8 PC  
(1-2) (F/R)

The description of the transmission format is given in Table 1. This table describes the parameters used to control the stepper motor movements for creating the shedding effect.

At the decoder logic based RS485 client end, the respective data is received and it uses TTL logic mechanism for transfer of the design data to the stepper motor using stepper motor driver logic. The design data transmission takes place for the entire decoder logic based RS485 client with IDs. Then control panel broadcasts signal E, which triggers the decoder logic based RS485 clients to execute buffered data according to format.

The simultaneous rotation effects of stepper motor is generated by sending either forward or reverse pulses to the latches of the stepper motor I/O interface using TTL method of data transfer. During this process no stepper movement starts. Finally, when a common latching signal E is transferred it enables the latch to send data to the respective stepper motor. The border-tie harnessing description for the real implementation is as follows: total number of hooks for border is 20, and total number of hooks for body is 108.

Table 1 — Design data transmission format

CID (1-2)	Maximum 2 Nos. of clients
Rotation (F/R)	F denotes forward rotation R denotes reverse rotation
D1	Least significant byte – Byte 1
D2	Byte 2
D3	Byte 3
D4	Byte 4
D5	Byte 5
D6	Byte 6
D7	Byte 7
D8	Most significant byte – Byte 8
PC	Pulse count for the direction (forward or reverse)

The first 20 hooks are used to construct mirrored repeat harnessing in the border area. For the double side border from each side one inch area is allocated on the fabric. From each side 40 threads are allocated. Hence, totally 80 threads are used to construct tiny border.

From 21<sup>st</sup> to 128 hooks the border area harnessing can be done in straight repeat mode. Out of 27 inch fabric 25 inch area is allocated for the fabric body area. Hence, totally 1000 threads are being used in the body area of the fabric. No. of body repeat is 9.2 repeats

#### Working Principle (using TTL logic based Polling Method)

After converting the woven design, the raw binary format of the woven design is transferred to the multimedia memory card. Before starting the weaving process, the multimedia memory card needs to be placed in the control panel (server). When the control panel with multimedia memory card is turned ON, the following actions are performed:

- Initialize Real Time Clock functionality
- Initialize Liquid Crystal Display functionality
- Initialize Multi Media Memory Card functionality
- Initialize UART Serial communication interface

The control panel with memory card support is facilitated with the following options (i) – (viii):

- (i) Initialise option moves the design location to the starting of the design from the current location and resets the various flag variables associated in the master controller operating environment. The following procedure is implemented:

```
Set VBFlag to 1; // Very Beginning Flag
Set PFlag to 'F'; // Pending Flag
Set crow to 1; // Current Row
Set StepValue to 1; // StepValue
```

- (ii) Reverse navigation option navigates design row from N<sup>th</sup> row to 1<sup>st</sup> row by block read operation on the multimedia memory card and it updates the current row. The implemented logic code segment is shown below:

```
if (crow <= StepValue)
    crow = nor;
else
    crow = crow - StepValue
set PFlag to 'F'
```

- (iii) Forward navigation option navigates design row from 1<sup>st</sup> row to N<sup>th</sup> row by block read operation on the multimedia memory card and

it updates the current row. The implemented logic code segment is shown below:

```

if (crow <= nor)
{
    crow = crow + StepValue;
    if(crow > nor) crow=1;
}
else
    crow = 1;

```

set PFlag to 'F'

- (iv) Play option reads from multimedia memory card for the current row. First it restores the harnessing threads for the last row and then generates the patterns for the current row. The implemented logic code segment is show below:

```

if (VBFlag == '1')
{
    Call Lift routine with crow
    Reset VBFlag to 0
    Set PFlag to 'R'
}
else if(PFlag=='R')
{
    Call UnLift routine with crow
    Set PFlag to 'F'
    if(crow > nor)
        Set crow to 1;
    else
        Set crow = crow + 1;
    If(crow > nor) crow=1;
    Call Lift routine with crow;
    Set PFlag to 'R';
}
else if(PFlag=='F')
{
    Call Lift routine with crow
    Set PFlag to 'R'
}

```

- (v) Increment/decrement option is used to adjust the navigation step value. The implemented logic code segment is shown below:

```

If (StepValue == 128)
    StepValue=1;
else
    StepValue = StepValue * 2;

```

- (vi) Restore the recently executed design row option restores the recently executed design row if

power failure occurs when pending movement is started. The implemented logic code segment is shown below:

Call Unlift routine with crow and Varying PulseCount

- (vii) Reset the direction flag option toggles the direction flag between 'F' and 'R'  
 (viii) Vary the PulseCount option increments the VaryingPulseCount in a wraparound mode.

Figure 2 shows the typical harnessing view of the loom setup.

### Results and Discussion

This electronic cardless jacquard equipment for handloom contains 128 hooks, which is suited for both silk and cotton. The utilization of this device creates highly skilled weavers for modernized handloom. Aged people and women weaver would find it more comfortable with their fragile health and new machine is less time consuming process. The handloom weavers are getting migration to next generation technology.

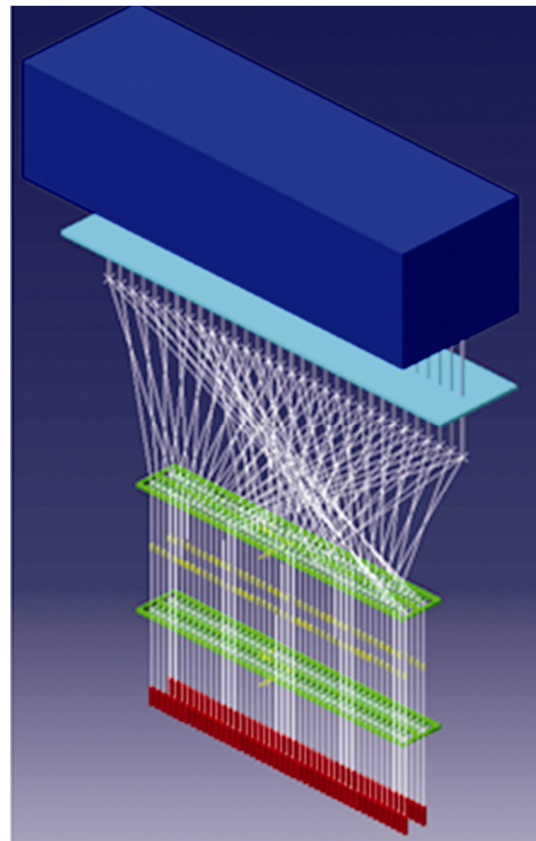


Fig. 2 — Isometric view of harnessing view

Table 2 – Design for 120 Hooks jacquard card punching  
(2.50 Rs/Card) cost economics

Loom	Card qty.	Costing, Rs.
Existing jacquard loom	1000	2500
Electronic card less jacquard for handloom	1000	200-300 to sketch the computer aided textile design



Fig. 3— 128 hooks electronic jacquard loom

Frequent design changing is possible which leads to very good marketing competency. The sample economics of the new electronic card less handloom along with the existing handloom is given in Table 2.

Figure 3 shows the complete view of the electronic card less jacquard for handloom weaving having the 128 hooks capacity.

During the new design implementation the recurring cost involved is negligible (only multimedia memory card needs to be fixed with new RBF type file copying). The input design image used for the fabric (border and body) weaving is given in Fig. 4(a). This system accepts maximum of 128 pixels width designs and no restriction on the design height.

The entire shedding movement is controlled by electronic jacquard system. Figure 4(b) shows the woven output for the given input as depicted in Fig.4 (a).

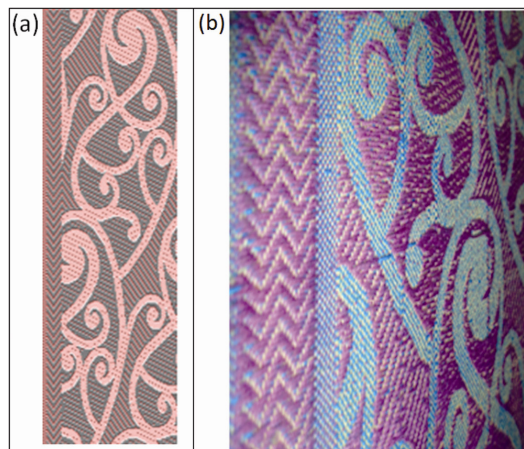


Fig. 4—(a) Input design image and (b) woven output

The development of electronic jacquard based handloom using embedded technology for cotton/silk yarn weaving with border-tie harnessing has 128 hooks capacity. The new system is highly versatile for introducing varieties of weaving patterns. The salient features of this apparatus are summarized as follows:

- Indigenous development
- Generate frequent fabric samples
- Data transferred in TTL Logic, it is quite easy for hardware interfacing
- Easy to educate the weaving community
- Weavers health hazardous problems are nullified

By adapting this technology the electronic jacquard with the size of 256, 384, 512 hooks capacity shall be constructed to improve the ornamental effect on the handloom fabric.

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