PROGRAMMABLE AUTOMATIC SYSTEM OPERATED WEAVE PATTERNING OF POWER LOOMS

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Summary

At the conference 'Mechanical Engineering '98' the project entitled "Computerised system and databank for creating of weave patterns" managed by late Professor Miklós Jederán and supported by OTKA under TO14991 research number has been presented. As a follow up to this work, a free programmable automatic control system has been elaborated that manages the loom's weave patterning that is the healds by the pattern prepared by the pattern design system. The lecture presents the original operation of the opto-electronic power loom, the configuration principles and the objectives of the clearly electronic management and finally the materialised control system and software. Now the materialised system works in the Laboratory of the Dep. of Polymer Engineering and Textile Technology at the Budapest University of Technology and Economics. It is used for training. In case of appointment it can be previewed.

1 INTRODUCTION

At the conference 'Mechanical Engineering '98' the project entitled "Computerised system and databank for creating of weave patterns" managed by late Professor Miklós Jederán and supported by OTKA under TO14991 research number has been presented. As a follow up to this work, a free programmable automatic control system has been elaborated that manages the loom's weave patterning that is the healds by the pattern prepared by the pattern design system.

2 INTRODUCING THE ADAPTED POWER LOOM

The control system has been developed to the Müller made, electronic heald move narrow fabric loom owned by the Laboratory of the Dep. of Polymer Engineering and Textile Technology. The process of weaving is shown in fig. 1. Patterning during weaving is done by raising and lowering warps according to the pattern. One line of the fabric pattern contains the information which warps the power loom has to lower and to raise at the same time in a certain cycle. Warps moving the same way are needled in the same heald, so they are moved simultaneously according to the pattern determined raising and lowering of the heald. In the laboratory's loom there are 18 healds, their move up- or downward can be controlled independently in an electronic way. This makes it possible for the designer to operate 18 kinds of warps crossing in different ways. The loom was originally operated in an electro-mechanical way, that is mechanical organs were managed in an opto-electronic way, as shown

below. In front of a phototransistor line a holed paper card is proceeding according to the fabric pattern design.

One line of the paper card corresponds to one in the fabric pattern. The back of the paper card is illuminated by a lamp giving even light, so where there is a hole on the card light can contact phototransistors behind the card. The illuminated transistor switches then on an electric magnet through power stages, which lowers the connected heald. In case the transistor does not receive a light sign, healds remain unmoved (in upper position). In the perception line every transistor controls one corresponding heald, that is 18 transistors control the move of 18 heald frames.

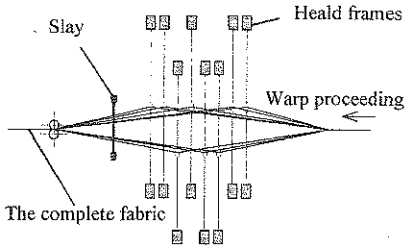

Figure 1. Drafted process of weaving

In case paper cards are used, every new pattern needs a new card, data storage is not possible. One part of such a card is shown in figure 2. Elaborating new cards takes a long time and includes the danger of mistakes, correction is difficult, the storage of the cards is not effective, and any mechanical damage may cause disfunction (damages can give way to light as holes, the loom may misinterpret them as pattern commands and execute them).

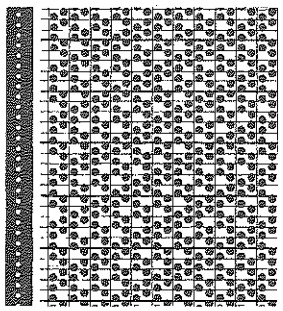

Figure 2. Part of a pattern card

3 PRINCIPLES AND GOALS OF CONFIGURATING ELECTRONIC CONTROL

The presented modern system controlled in a clearly electronic way has been developed to replace the traditional management system introduced in the last chapter. Pattern design procedures in the traditional and the computer-assisted ways are shown in figure 3.

Eliminating mechanical elements has reduced the possibility of damages and disfunctions. No need for paper cards, computer designed patterns can be woven or tested at once, disfunctions can be corrected easily.

Patterns can be stored in electronic format (traditional computer storage devices – disks, Winchester etc.), can be woven later, as well and can be easily redesigned. Storage for an

approximately big and complicated pattern is not more than some hundred bytes either. To put it in another way a traditional 3.5" 1.44 MB disk can store 2-3000 patterns.

When planning the controlling electronic part, optimal fitting to the original operation and loom's retooling to the new management with the least changes were a must. During development the loom has been handled as a black box, and considered as an optically perceiving tool. The managing electronic technique in this respect has to code optic signs. The loom did not have to be altered, only card operation tools had to be replaced by the new electronic management system.

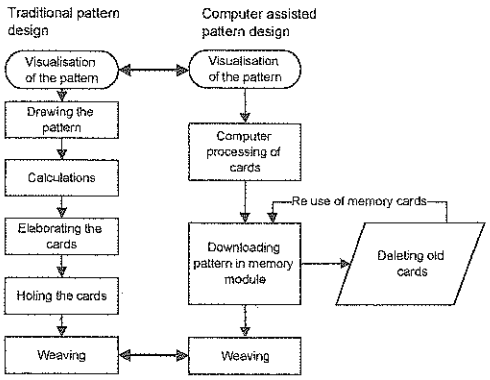

Figure 3. Comparison of pattern development methods

In the controlling module opposite each phototransistor one LED has been located, and controlling electronics switch these LED on or off according to the pattern. Phototransistors in the loom perceive light signs according to their original function, process them and then go on as originally.

At the beginning of developing process the following objectives were set:

- Loom has to be PC on-line,
- Pattern management of loom should work off-line as well,
- Independent function must be controllable by PC software,
- Managing system should be suitable to process patterns made by other pattern designing systems.

For the configuration the simplest hardware tools have been preferred, so that it can be adaptable as widely as possible and it can be fit in a possible functioning patterning system as easily as possible.

Considering the above mentioned objectives and principles, an independent but PC controllable *Flash memory micro-controller unit* has been selected. Micro-controller include integrated in one chip everything, that is needed for a normal computer (CPU, RAM/ROM, On/off perifery control). Micro-controller adaptation is supported by Flash memory, which is cheap and can be programmed on the circuit battery's work voltage (+5V) and deleted by a simple electronic impulse.

During development Microchip's second widest spread brand, PIC 16F84 has been selected. Selection has also been influenced by the fact that to this controlling unit there are lots of, free of charge programming tools, model adaptations and adequate documentation available. What's more the controlling unit has a so called reduced instruction set (RISC), which simplifies timing calculation and essentially improves the execution speed of a microprocessor.

4 MATERIALISED CONTROLLING SYSTEM AND CONTROLLING SOFTWARE

The development of the loom's control unit has been carried on in two simultaneous ways:

- a micro-control unit with an independent memory that can communicate on the computer's serial interface (RS 232), and
- development of a PC-based communication programme.

The system's elements:

1. WW2 control unit + external memory card & Connecting cable
2. IBM compatible PC/DOS operation system & Communication and controlling software

4.1 The loom's control system

To develop the loom's control system Microchip's PIC 16F84 Flash memory micro-controller has been selected. The control system's scheme is shown on figure 4.

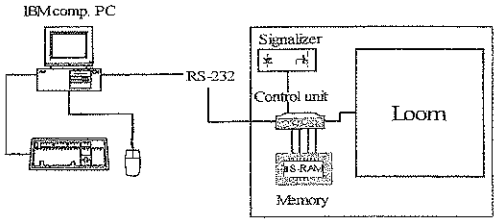

Figure 4.: The loom's managing system

An independent memory is necessary in order that the control unit can control weaving without computer. This requirement is met by an external Flash memory located in the micro-controller unit. This external program storage is appropriate because each of the complete patterns can be stored in a memory chip and by a manual swap pattern change can be solved without computer skills. Memory module is a 24LCxx Flash memory, which excepts any variant from 32 kbit to 256 kbit to be a control module. The memory chip is located on a simple circuit panel, so it can be easily swapped. To make programming of chips easy the loom's control unit can not only fulfil control tasks, but also can programme the memory unit.

In the original equipment paper cards were moved by a forwarding tool in accordance with the mechanical elements of the loom. In this way cards always gave light impulses in adequate timing. In the new system LED line always has to give raising commands to the healds in the right minute.

This accordance is guaranteed in the new control system by an electronic feedback sign. This electronic feedback sign is given by an opto-electronic signalizer, which analyses the location of the mechanical element on the main axe. When the cover sheet connected to the main axe reaches the optical element's slot, it hides the photodiode's light. As a result of this the signalizer gives the managing unit an impulse that straight away changes the state of the LED line, jumps to the next line of the pattern, pretending this way the proceeding move of the paper cards. The cover sheet can be accurately located, so electronic control can correspond to the slay's move.

4.2 The controlling programme

Nowadays the selected DOS is said to be obsolete, but it needs a simple HW platform, at present any computer has got the necessary resource to run it, so under small-scale

conditions it does not need any extra investment.

Controlling the micro-control unit has been materialised by a PC-based terminal-emulator named WW Terminal (WWTERM.EXE).

Outlook of the software is typically Borland-type. The opening screen consists of 3 parts:

- On the top of the screen the *menu-structure*. The software takes commands through activating menu elements.
- In the middle of the screen there is an *editing window* working as a simple terminal. Both micro-control-unit and the software can write messages onto the screen.
- On the bottom of the screen there are codes for *accelerator keys*. They help to activate some of the more important menu-points (e.g. download pattern).

In the following part optional functions from the *software's menu structure* are presented:

- *File menu*: Storage and move functions for patterns such as saving, downloading and listing pattern files. The results of listing function are shown in figure 5.

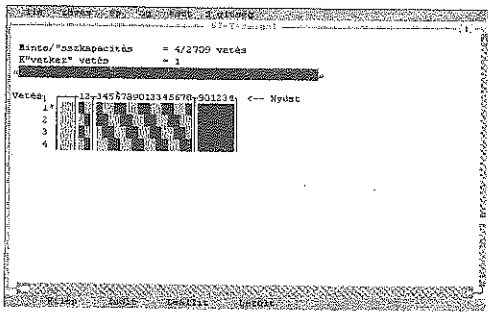

Figure 5. The results of listing function

- *Memory menu* controls memory-card based functions (e.g. deleting all information in cards, formatting the memory chip and etc...).
- *Weaving menu* starts and stops weaving procedures.
- *Machine menu* is primarily for service staff. When activated all healds or a certain heald can be contacted for raising or lowering.
- *Log menu* is an output of the screen to a file, in order e.g. to save a pattern to a disk or print it.
- *Help menu* informs about the author and the software's registration.

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