НОВА ТЪКАЧНА КОНЦЕПЦИЯ: ПОДХОД НА СИСТЕМАТА ЗА КОНТРОЛ НА ЗАДВИЖВАНЕТО

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New Weaving Concept: Motion Control System Approach

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ABSTRACT

This paper deals with the design of a new weaving machine based on a specific motion control LMC058.This controller inserted in our control system which allows the synchronization between each slave axes on the textile machine and the master axis, according to a dynamic timing diagram. This configuration allows the modification of each mechanism parameters independently, and the quick change of the timing diagram. The control system structure is implemented with the help of "SoMachine" Software, dedicated for Original Equipment Manufacturers (OEM). The development of such a machine provides more flexibility to carry out new weaving functions in a very next future.

Keywords: *Weaving machine, controller, synchronization axis, CANOpen, electronic cam.*

Introduction

The world fibrous material consumption is strongly increasing particularly for industrial applications. As far as Europe is concerned, nowadays, 27% of fibres are dedicated to housing application, 34% for garment and more than, 38% for industrial applications.

This growth due to the very high mechanical performances of textiles fibres which are very thin and strong and which give very high ratio mass/performances. Based on these performances, a very large number of woven, knitted and non-woven fabrics are developed to fit with specific applications.

Since few years, many technical applications were developed with more and more complex textile structures far from traditional fabrics. The industrial demand asks for specific properties based on a combination of different textile structures which implies the evolution of classical structures towards more complexity i.e. the evolution of flat weaving to 3D in shape weaving.

Moreover, the introduction of the functionalization of these structures leads to develop hybrid textile structures combining textile and non-textile materials.

The weaving technology which is one of the oldest technologies which consists in interlacing two yarn networks, one in machine direction (x) and one in cross direction (y) is also one of the most versatile. In fact, the mechanical properties of fabrics can be adjusted as a function of (x) and (y) properties.

So that, the main function of a weaving machine is to interlace (x) direction yarns (warp) and (y) direction yarns (weft) respecting a given weave pattern [1].

There are three basic motions used to produce a fabric by ensuring the interlacing between warp and weft yarns. i.e. shedding, weft insertion and beat up.

During the weaving process, warp yarns have to be let-off and the produced fabric has to be taken-up. These necessary two motions are auxiliary movements that are warp let-off and fabric take-up[2][3].

In traditional weaving, in order to get different weave structures the movement of the warp yarns has to be controlled and changed before each weft insertion.

The running of the weaving machine requires a given sequence of movement to control its various weaving functions given by dedicates parts and all of these functions must be accurately timed and fixed to ensure a regular sequence [2].

Usually, these mechanisms are driven by one main motor[4] as shown in ***Figure 1***.

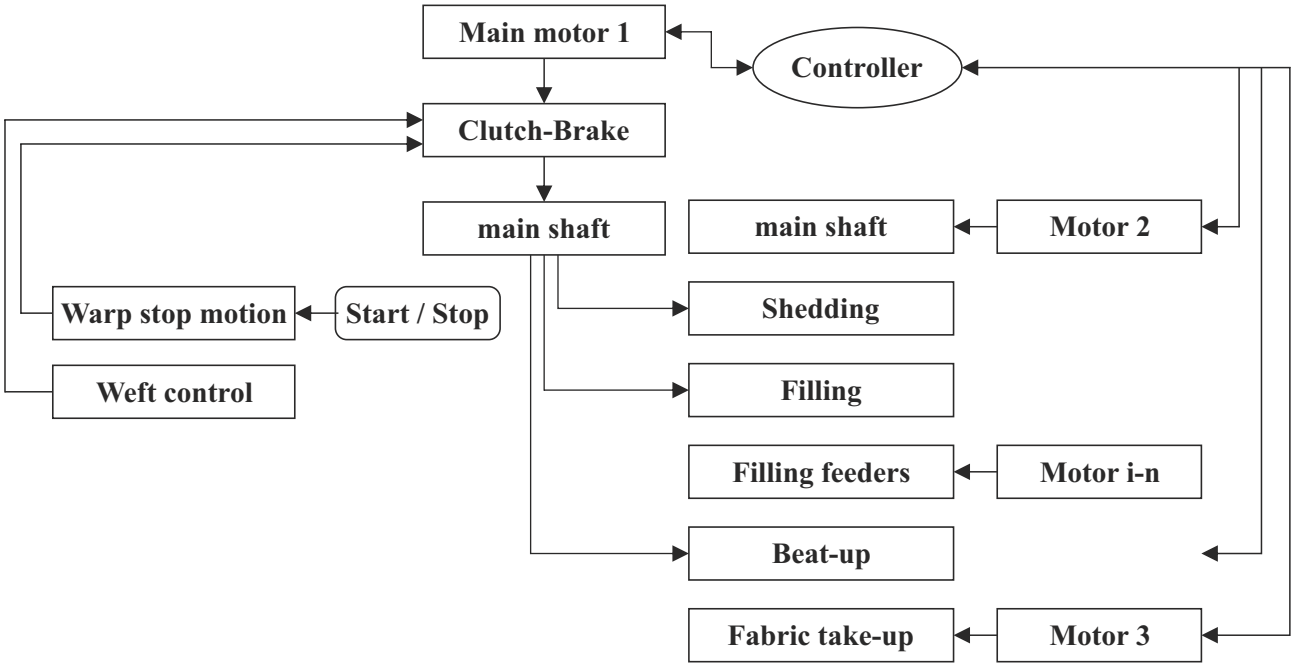

Figure 1 Conventional weaving machine design

The movement is distributed to the different functions with the help of shafts and gears [5]. So that, these functions are synchronized together, as shown on the loom timing diagram (***Figure 2***). It should be noted that the timing diagram can be different for each loom and fabric design. However, the five basic motions of a loom have to be completed in one pick that is 360°[2][6].

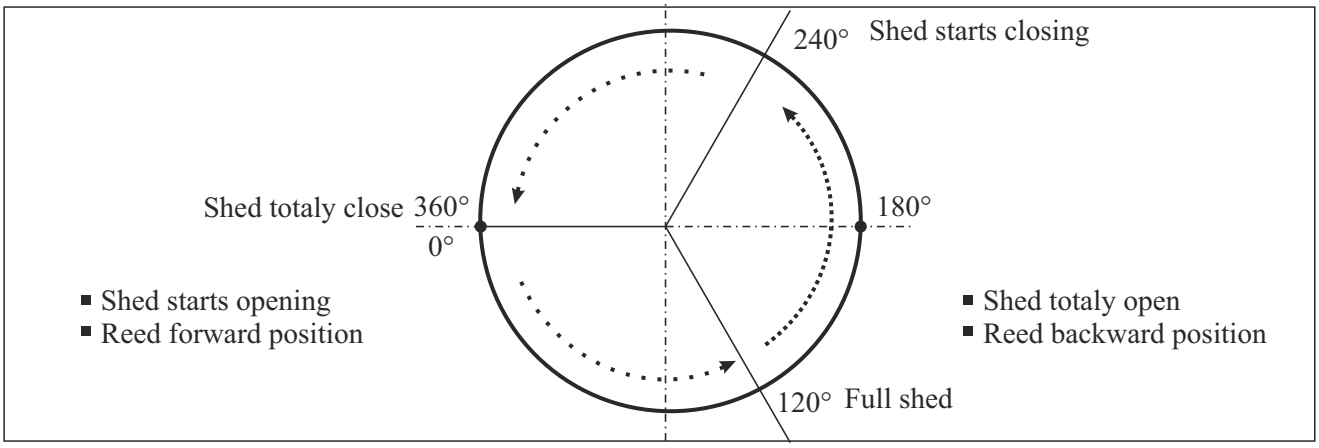

Figure 2 Typical timing diagram

Indeed, once and while the machine is running, the order of movements is fixed and the modification of parameters is strictly impossible during the weaving operation (shed height, harness speed, reed stroke and filling). Desig-ning new textile structures including both textile and non-textile structures requires the development of a new weaving machine based on a concept of fully independent movements unlinked to the main shaft, providing more flexibility.

Problematic

The synchronization between the five mechanisms on the conventional weaving machine must be done once before starting the machine.

To produce new woven hybrid structures, a new weaving machine concept is requires allowing quick setting as well as weaving parameters modification while the machine running. The ***Figure 3*** shows the control system design of the new weaving machine.

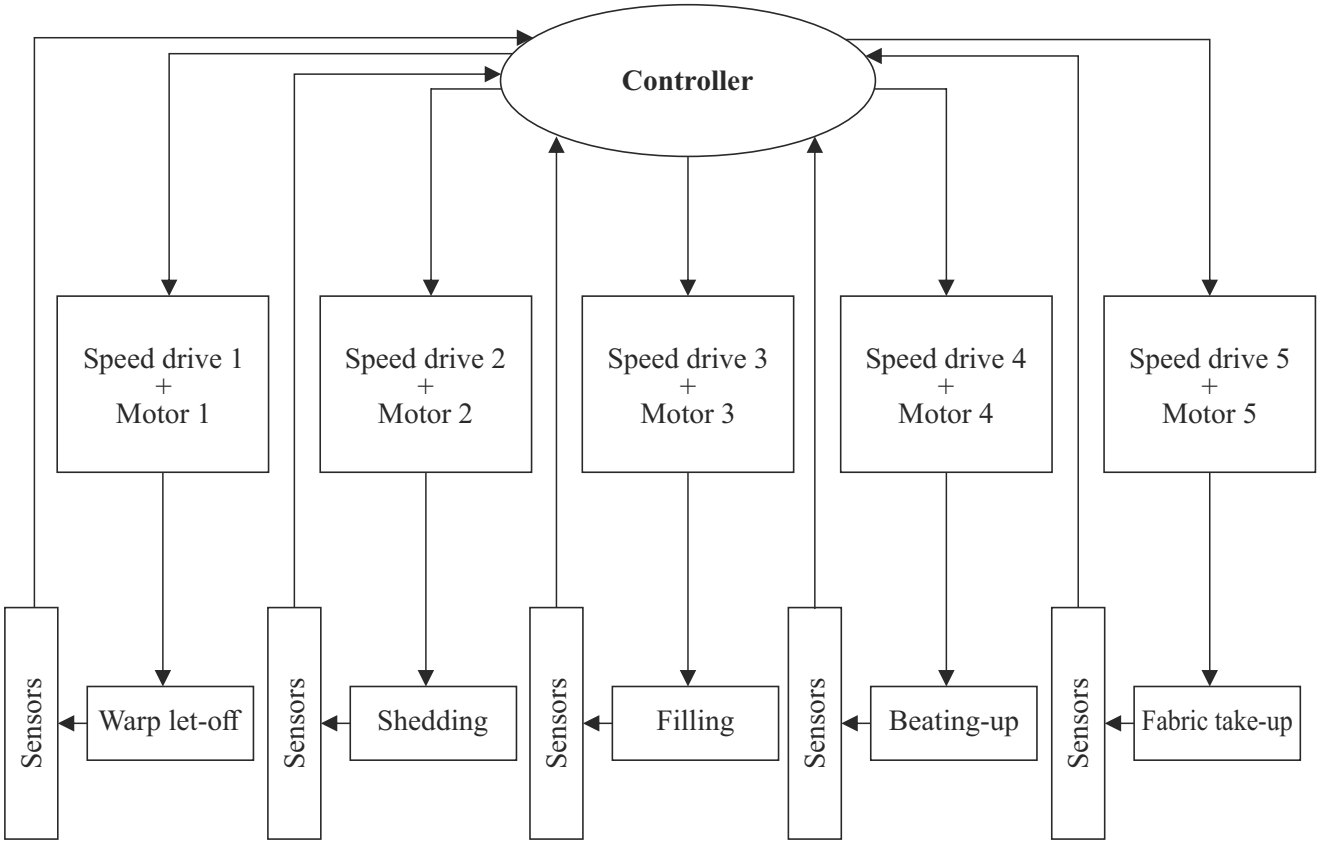

Figure 3 Control system design of the new machine

In order to develop each function on the machine, recent weaving machines are based on multi servomotors design, but the main functions of the machine are still the same as well as the movement synchronization. The following parameters: shed height, frame height, reed stroke, frame speed, insertion speed, let off motion velocity and take-up motion velocity are fixed.

The suggested new design allows controlling all these movements independently and to control and redesign the movement synchronization at each pick. These modifications allow to change various setting of the machine while it is running. The paragraph bellow describes this new concept and describes the development of this new weaving machine as well.

Design of the new weaving machine

The new prototype to produce specific hybrid fabrics is presented ***Figure 4***. The machine is 360 mm width, and 1 up to 8 picks can be inserted in the shed as well as different devices, equipped with 9 frames[7][8].

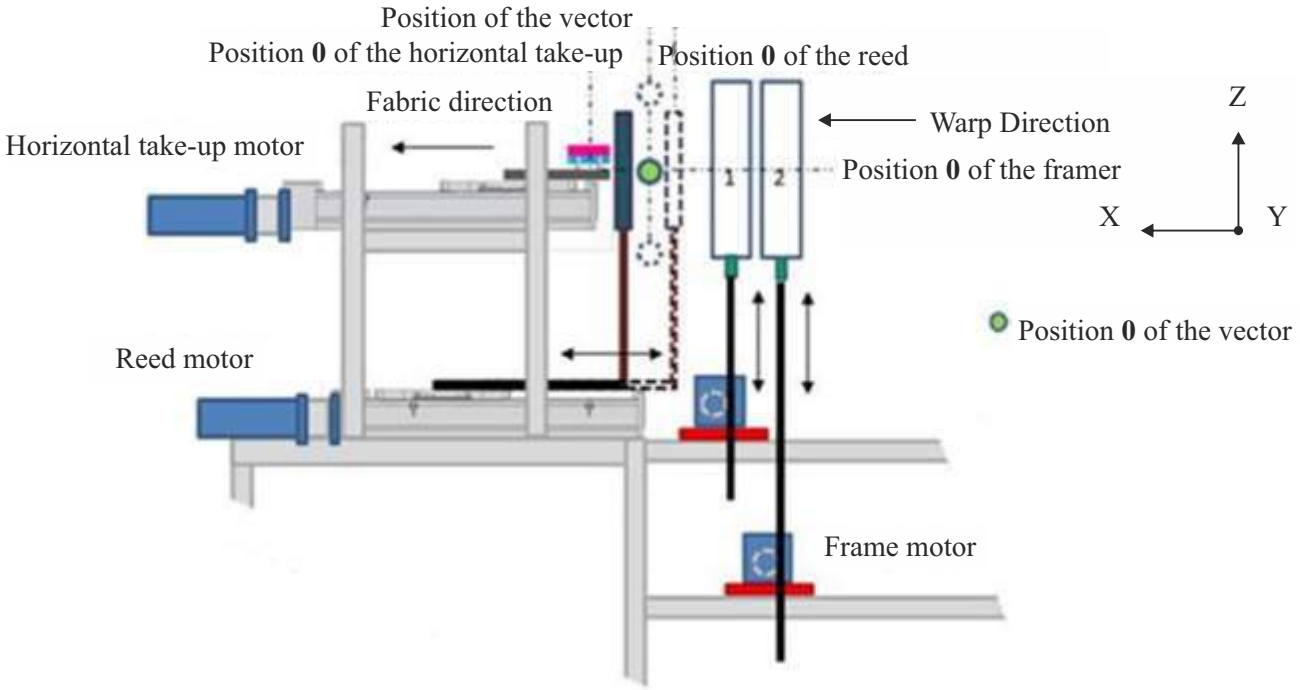

Figure 4 Partial view of the machine

Control system architecture

Servomotors associated with a speed drive (Lexium 32A), has been selected to provide the various movements on the machine. These products are marketed by Schneider Electric[9].

A LMC058 Controller has been used for keeping the synchronization of each moving axis on the machine. The controller permits to synchronise the various axes of the machine [9], with quick response times, via CANopen communication mode[10].

The LMC058 controller ensures the control of the machine via a Human Machine Interface (HMI), Ethernet protocol, and the synchronization of the various axes via Lexium 32 speed drive.

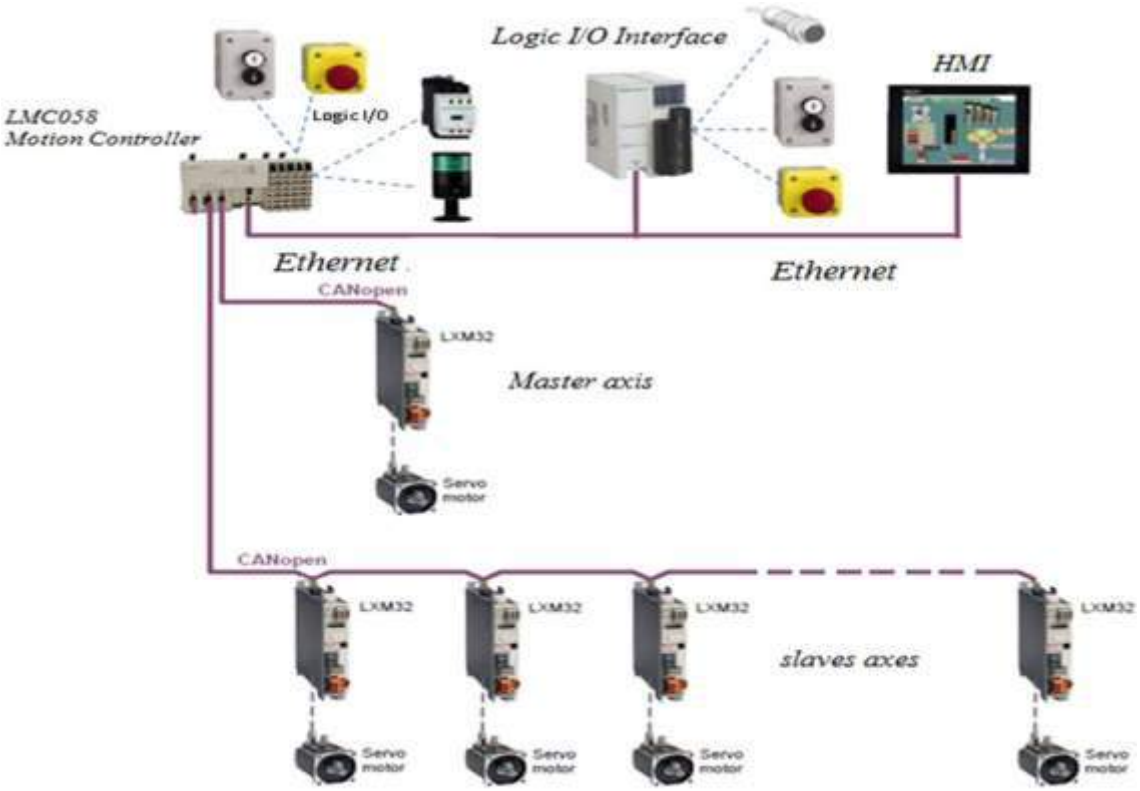

Figure 5 Control structure of the new machine

Figure 5 shows the design implemented in the weaving machine prototype, where each axis is synchronized to the master axis motion (the reed).

The control program is associated with "SoMachine" Software. The architecture of this software is the standard CoDeSys (Controller Development System). This standard uses programming languages according to IEC 61131-3 [11]. This program allows to develop the dialogues by HMI, regulates the speed drive parameters (acceleration, deceleration, PID, etc…), supervision, communication by network and ensures the security of machine.

A program depending on a digital cam profile has been done by using the LMC058 controller. From this cam profile, the "SoMachine" Software allowed us to generate the master cam profile which corresponds to a virtual axis, which control slave axes (for example: reed axis, heddle frame axes .etc.…). Based on this virtual axis, the timing diagram has been defined.

All parameters of each moving axis can be changed very quickly at each pick during the weaving by using this type of cam

Figure 6 and *7* show respectively an electronic cam defined for the reed and for the heddle frame movement.

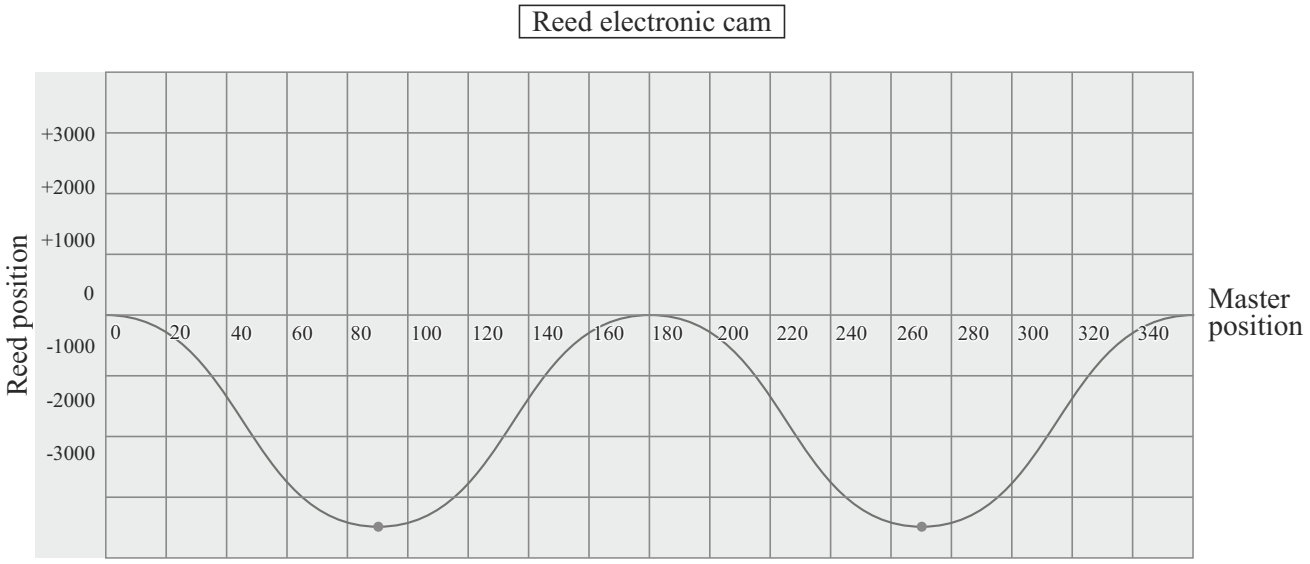

Figure 6 Reed electronic cam

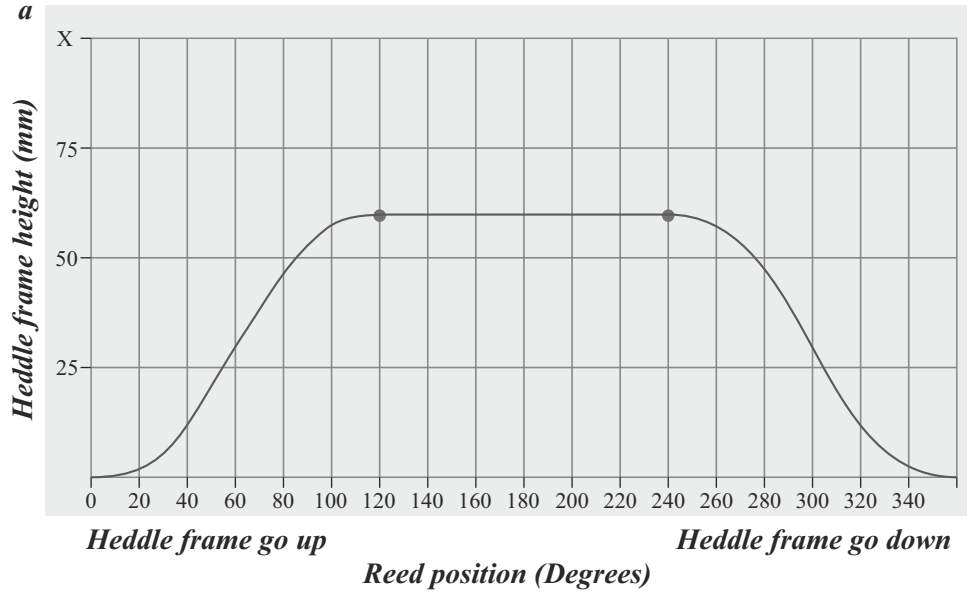

Figure 7 Heddle frame profile programmed on "SoMachine" **a**

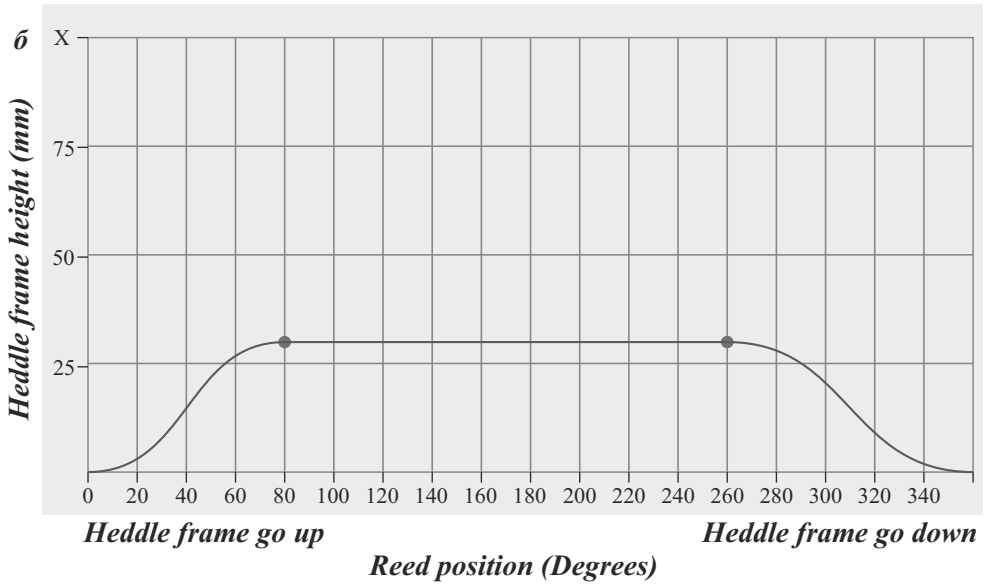

Figure 7 Heddle frame profile programmed on "SoMachine" **б**

With such a design the timing diagram can be modified to perform any new design i.e. during one timing diagram of 360°, one cycle of the Mast axis has been done whereas two cycles of reed axis were done.

On the other hand, while the cams running, it is possible to carrying out other movement synchronized with the axes movement by using "markers", (i.e. we can control the movement of the take-off motion at any time of the timing diagram).

Therefore, changing the cam profile to modify the shed height, harness speed, reed stroke, and the time of weaving fabrication, is easy and quick as well.

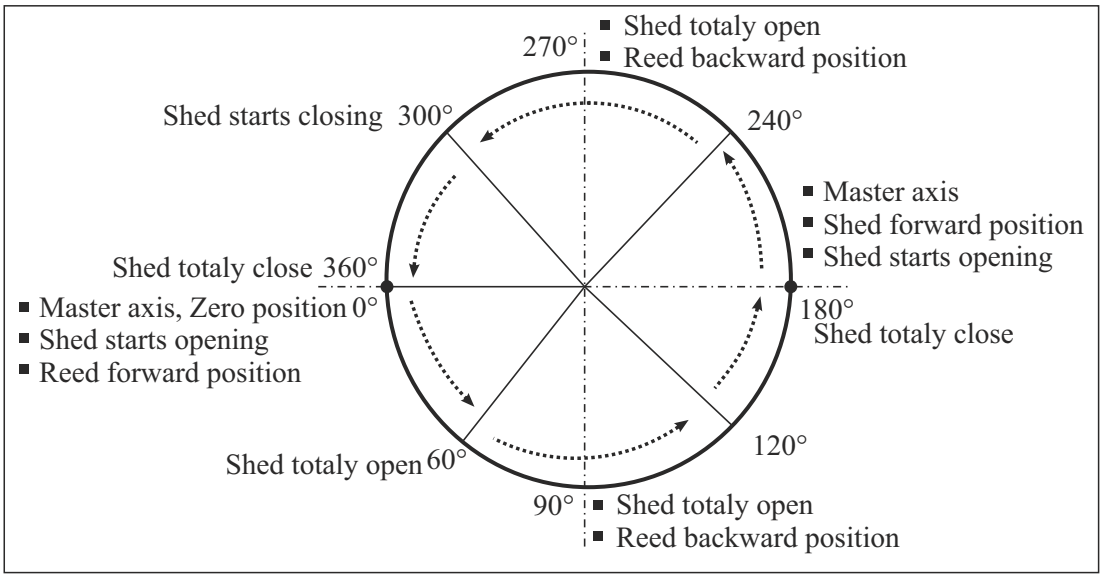

Figure 8 New timing diagram

Conclusions

The development of the machine control program ensures the synchronization of the various axes on the machine with carrying out the safety of their axes. By using this system, a large number of parameters can be quickly modified which allow more flexibility on the weaving process.

By implementing the LMC058 controller, various settings of the machine can change independently while it is running. Such a system permits fast multi axis synchronization with precision and increased reliability. In a next future, the flexibility of the system, LMC Controller will simplify the integration of new devices in our weaving machine.

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