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A Mechatronical System for Research of a New Knitting Method

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Introduction

The scientific research about the subject of this paper is a development of a new knitting method based on a BG patent No 62816B1 – "Method and device for cross knitting" [1]. The essence of the method is a parallel and synchronous control of a large number of needles with modern computer systems. Combined with good actuators dynamics, this solution gives a high speed, reliability and quality. The investigations have been made during the phases of the NSF-MinEdu Grant No НПР-1/2003.

Types of yarn

The yarn is an essential limiting factor for the speed of a loop-formation. It is stretched all the way from the bobbin to the needle, passing through numerous yarn carriers and tensioners, it is corrugated and is rubbed in numerous needles, as well as in itself, and as a result it cannot stand a high speed of loop-formation because of its limited strength. There are different types of yarn [2].

Single, or *one-ply yarns* are single strands composed of fibers held together by at least a small amount of twist, or of filaments grouped together, etc. *Ply*, *plied*, or *folded* yarns are composed of two, three or more single yarns twisted together. *Cord yarns* are produced by twisting ply yarns together, with the final twist usually applied in the opposite direction of the ply twist. *Novelty yarns* include a wide variety of yarns made with such special effects as slubs, produced by intentionally including small lumps in the yarn structure. *Textured yarns* are man-made continuous filaments, modified to impart special texture and appearance. *Stretch yarns* are frequently continuous-filament, man-made yarns that are very tightly twisted, heat-set, then untwisted and producing a spiral crimp giving a springy character. *Metallic yarns* are usually made from strips of a synthetic film, such as polyester, coated with metallic particles.

Linear actuators

The idea of the new method is the introduction of individual actuation and control of each and every knitting needle. The direct control (selection and actuation) of each individual needle along the length of the reed (needle bed) is a new, radically different approach in machine knitting [3]. In this way the revolutionary boost of performance parameters will be achieved. The individual actuation of each knitting needle requires the implementation of special kind of linear actuators possessing specific features – Fig. 1.

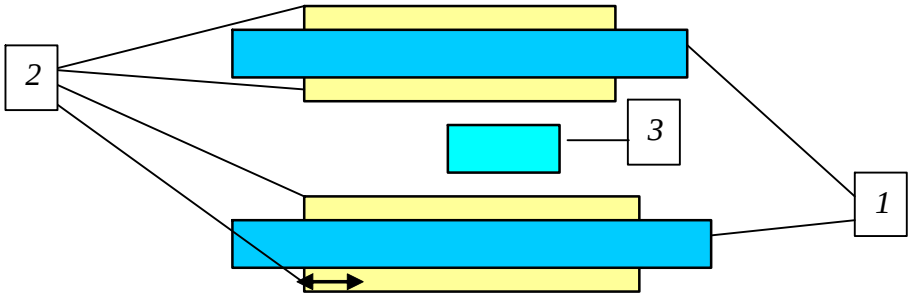
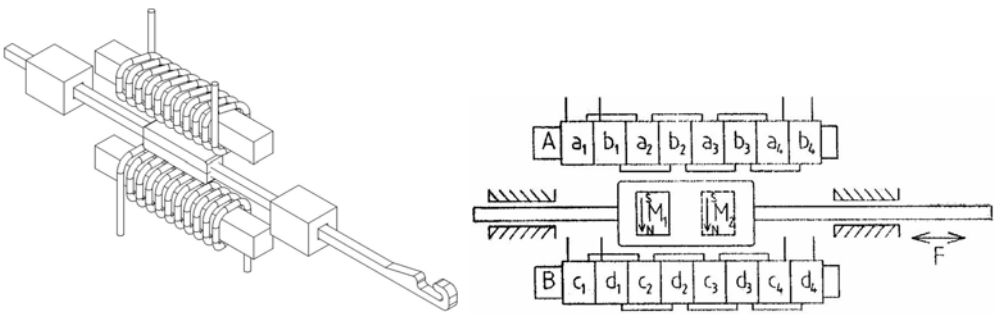


Fig. 1. A linear actuator:
1 – feromagnetic kernels, *2* – coils, *3* – permanent magnet

The direct actuation of each needle does not solve automatically the problems associated with the effective loop-formation process. To a great extent this is due to the classical method of loop-formation, which has reached it saturation phase and cannot be developed any further.

The different types of linear motors were investigated – high-speed linear pneumo actuators, linear electromagnetic actuators with moving magnet and with moving coil. Two points and multipoints linear actuators designed as consecutive sections have been tested (Fig. 2). The problems related to the control of the servounit both in perallel and synchronous real-time control of multiple actuators have been solved [4].



a) b)

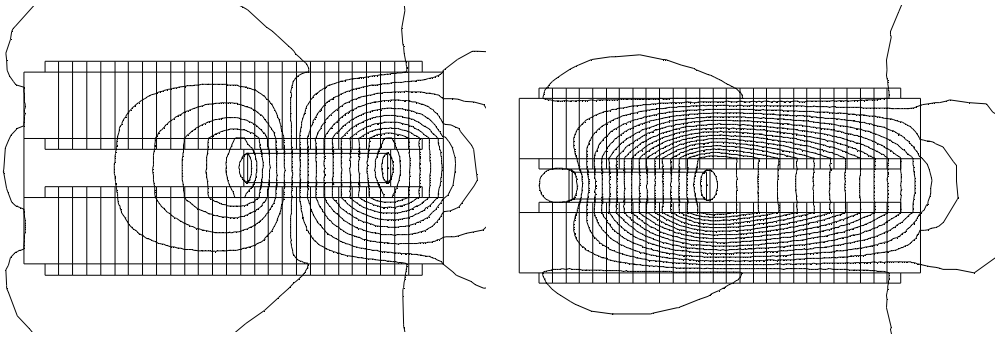
Fig. 2. Linear needle-shotting mechanisms: a – two-points; b – multi-points

Magnetic fields

The main features of the two-dimensional and three-dimensional magnetic fields as well as the electromagnetic force have been investigated. Several geometric models have been prepared.

For flat/parallel field is investigated a base mechanical variant (Fig. 3). There is not air-interspace, all the sections for both coils are supplied, all the sections in each layer have identical polarity. This coils supply is named “entire coil”.

The investigation of the three-dimensional magnetic field requires a lot of time for the preparing of the geometric model. A basic design of a construction, consisting of the kernels with rectangular section have been adopted. Windings are mounted over the kernels. The permanent magnet moves in parallel between the kernels – (Fig. 4).



a) b)

Fig. 3. Basic two-dimensional fields picture: a – home – 0 mm; b – end – 24 mm

Fig. 4. The construction with the set of the end-element

Hardware and software

The research hardware is a single-board PLC DEKA with the following parameters (Fig. 5):

CPU	– Motorola 68HC11G5
RAM	– 2 kB
EEPROM	– 512 B
EPROM	– up to 32 kB
Digital Inputs	– 16
Relay Outputs	– 12
Analog Inputs	– 8, 10 bits
Analog Outputs	– 2, 12 bits
Impulse Inputs	– 4

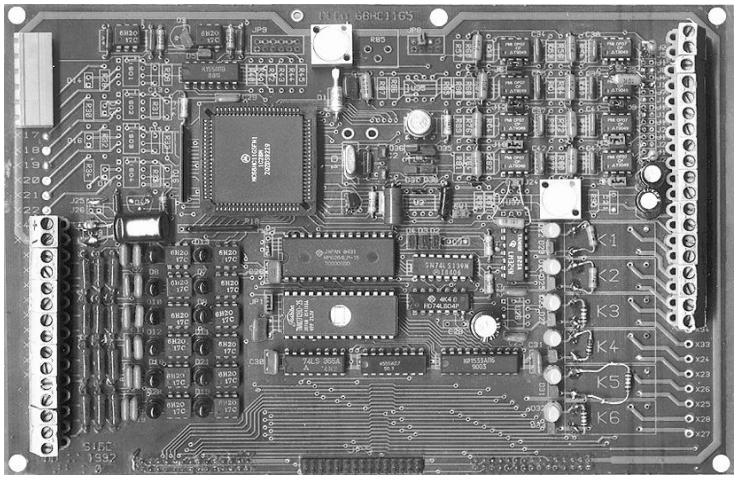


Fig. 5. The PLC DEKA

It is possible to add to the PLC DEKA up to 8 input/output modules with up to 512 inputs/outputs – both digital and analog.

For the research needs the real-time multi-tasking operating system is used [5]. It dispatches up to 256 applied programms with up to 256 different priorityes (Fig. 6). The communication between the programms is realized with mail boxes and semaphors.

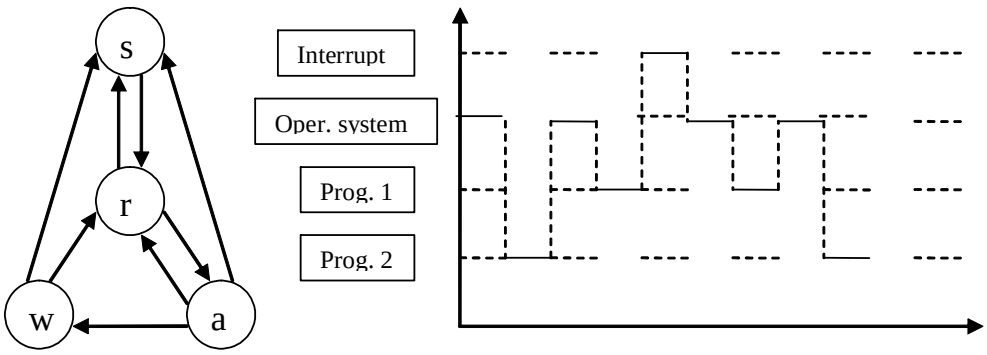


Fig. 6. State and priority of the programms

Conclusion

The method of a cross-knitting with parallel and synchronous individual control of a large number of needles with modern computer systems gives a lot of advantages and new ways of knitting.

References

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Мехатронная система для исследования нового метода вязания

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(Резюме)

Тема доклада – развитие нового метода вязания на основе болгарского патента № 62816B1 – "Метод и устройство поперечного вязания". Представлены исследования в области линейных двигателей, магнитного поля, петли-образования и пряже-ведения. Описана μP информационно-управляющая система на основе одноплатового контроллера и многозадачная операционная система реального времени.