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ELEVATOR WITH THE POSSIBILTY OF CONTROL BY MOBILE PHONE

Abstract:

The electro - pneumatic model with the possibility of being controlled by a mobile phone was designed and constructed on the Department of Applied Cybernetics by the diplomats Přemysl Matoušek and Tomáš Kvapil. This electro - pneumatic model serves for education of the students of this department, it enables the students to practice STL language, programming of microprocessors and it also helps to acquaint the students with pneumatic components and also with sensors in practice. The module for remote control of PLC by means of SMSs was projected for the application of electro - pneumatic elevator, but it can be also used in practice to control or signal the state of technological process or the machine.

Keywords:

mobile phone, electro - pneumatic model, electro - pneumatic elevator

INTRODUCTION

The model of electro - pneumatic elevator is a laboratory model of elevator that combines the pneumatic and electronic components. This model can be controlled manually by the buttons or by a mobile phone by means of SMSs. The central operating unit consists of a PLC that controls the air flow rate into central non - piston unit, which carries the cabin of the elevator, and into eight valves controlling the floor doors. The buttons that are attached to the PLC serve for calling the cabin into appropriate floor. An SMS card, also attached to the PLC, enables the communication not only with the PLC, but also with the mobile phone. This SMS card receives the commands from the PLC and sends them in short SMSs to the receiver. The card also receives the SMSs from the mobile phone, transforms them and then sends the commands that were sent by SMS, to the PLC. Consecutively, the PLC switches proper pneumatic units in such way, so that the required position of the cabin could be reached.

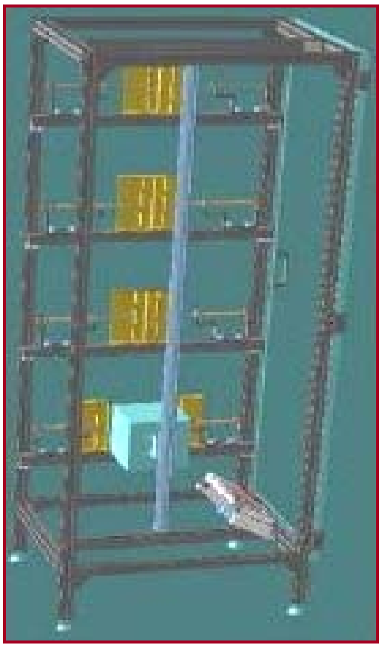

Figure 1: Project of elevator model construction

Figure 2: Final construction of elevator model

CONSTRUCTION

The project of the construction was designed in CAD software VariCAD. The frame of the model was made of aluminous profiles, whereas the basic proportions come from the chosen non - piston unit fasten to the bottom and the top part of the frame. The front side is separated into four floors by the aluminous profiles that carry the door pistons. Highs carrying the elevator door are fastening to the right side of the frame. The door is filled with blue plexiglass, the rest sides are properly modified and made from black boards of polymer.

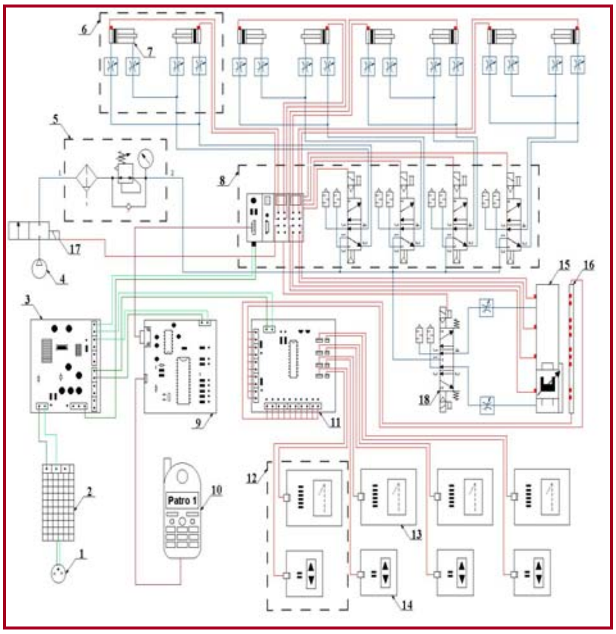

Figure 3: Scheme of controlling the elevator model (Legend: red – electrical signals, blue – pneumatic signals brown – RS - 232, green – power supply)

The elevator cage is welded from stainless metal plates and directly attached to the non - piston unit. An arm with a magnet, also fixed to the cage, is placed. There in order to control the motion of the elevator cage. The printed circuits (SMS card, supply card, operating display card), distributor plinth and the mobile phone are attached to the back side of the frame.

CONTROLLING OF THE PNEUMATIC COMPONENTS

The regulation of the air piped from the compressor 4 (Figure 3) ensures the regulation set. This set is composed of an transforming valve and an electrically controlled throttle - valve that is joined on air filter, 17 (Figure 3). This regulation set is placed in the bottom part of the frame together with the PLC. Another part of the PLC is the valve terminal 8 (Figure 3) .This valve terminals is made of four two - way valves, where each of them controlls the motion of the two pistons carrying the floor door of the elevator mode 6 (Figure3, Figure 4). Motion of these eight door pistons 7 (Figure 3) and the central non - piston unit 15 (Figure 3) is scanned by the reed contacts attached to the PLC. A three - way valve 18 (Figure 3), also fixed to the PLC, serves for the control of the central non - piston unit motion.

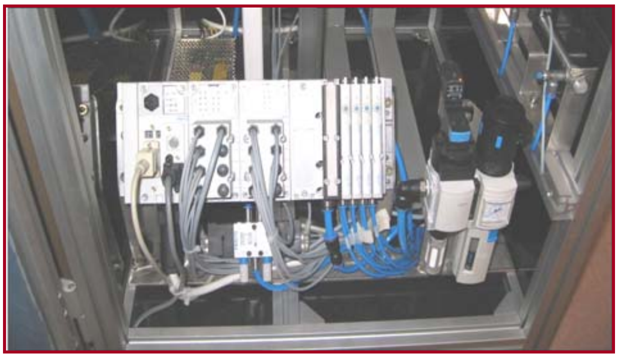

Figure 4: Central controlling complement of the model

Figure 5: Fixation of door pistons

The valve terminal is programmed by the program in STL (language) and communicates with the series line RS - 232 and SMS card. The motion of the elevator can also be controlled manually by means of the buttons placed in each floor of the model. Structure of controlling of the pneumatic components is represented in Figure 5.

THE POWER SUPPLY OF ELEVATOR MODEL

In the model it is necessary to feed the PLC, integrated circuits, displays etc. whereas the supply voltage of PLC is 24V and of the integrated circuits 5V. From this reason, the power supply of the model is ensured by the switch - mode supply 2 (Figure 3) and to its input the line voltage is brought 1 (Figure 3).

Figure 6: Realization of power supply of the elevator

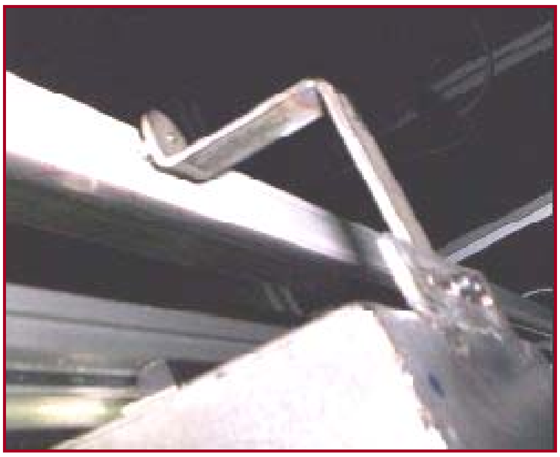

Figure 7: Scanning of the position of elevator cabin with means of a magnet moving along the sensor plinth

An output voltage of this supply is 24V and the supply is fixed to the bottom plastic board of the model. The output voltage is conducted to the input of the supply card 3 (Figure 3) that distributes the 24V voltage, protects PLC against high currents and also stabilizes the led voltage to 5V. The PLC is connected to the supply card. The supply card contains different components, where the most important part is a switched stabilizer LM2576 that implements the fore mentioned voltage stabilization.

CONTROL OF SIGNALIZATION

Position of the elevator cabin is scanned by reed contacts that are a part of sensor - plinth 16 (Figure 3) fixed to the frame behind the central non - piston unit. The plinth is connected to the operating display card 11 (Figure3). This card processes the signals coming from the reed contacts and on the basis of results the operating display card controls the seven - segment displays 13 (Figure 3) and display representing the direction of elevator cabin motion 14 (Figure 3). Each of this display is a part of printed circuits board together with components that ensure their correct operation and this circuit is connected to the operating display card. The couple of displays (seven - segment display and a display representing the direction of cabin motion) are placed in each floor 11 (Figure 3). The reed contacts are switched by a magnet that is attached to the elevator cabin.

A sensor plinth is mainly composed of reed contacts, LEDs and is attached to the operating display card. The reed contacts in the sensor plinth are placed in such a way, so that the position where the cabin stops can be scanned and it is also possible to detect the direction of the motion. If the cabin starts to move in one of the two directions, it is immediately after going on from the stop position, switches the reed contact that is placed above the stop position. This operation causes that the signal to the operating display card is led. The card evaluates the signal and switches an appropriate display arrow. The sensors placed in the stop position are used for displaying the floor numbers, where the cabin stops. Switching of one of the contacts is also signalized by the LED.

Processing of the signals led from the sensor plinth is done by the operating display card. The main unit of this card is made of AVR ATmega8 *microprocessor by ATMEL Company. The card is further filled with components that ensure the connection of reed contacts from the plinth, their voltage transformation, and with components for connecting the cards with the floor display and an arrow displays that are placed in each floor of the model. The microprocessor ATmega8 is programmed by the control algorithm written in language C.*

Figure 8: Connection of particular floors

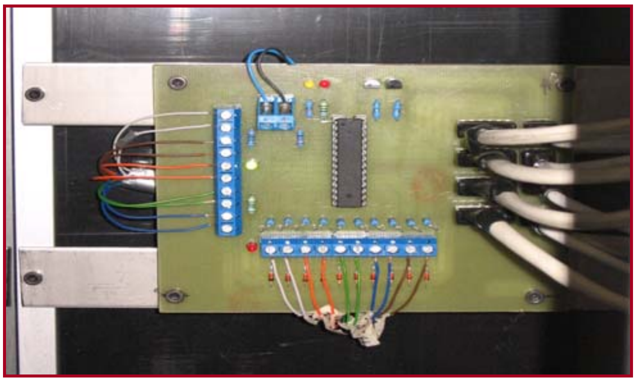

Figure 9: Control display card

CONTROLLING THE ELEVATOR BY MEANS OF MOBILE PHONE

The electro - pneumatic model is controlled by means of SMSs through the SMS card 9 (Figure 3) to which the PLC and the mobile phone Siemens C35i are connected 10 (Figure 3). Both of these two devices are connected to the SMS card by the series link RS – 232. Their communication is done through a non-synchronous way. The basic components of the SMS card are the microprocessor ATmega 162 by the ATMEL Company, the components for voltage values transformation and components that signal the operation of SMS card.

SMS card communicates with the mobile phone by means of AT commands. In the case, that a new SMS with a valid command was received by the mobile phone, a AT command is sent by SMS card to the mobile phone. On the basis of this command the phone sends back a PDU datagram. This PDU datagram consists of many information, for example the telephone number of the receiver, the telephone number of the sender, the date of receiving the SMSs, etc. The most important part of the datagram is a coded text. This text must be decoded in a seven - bit way. If the decoded text contains a valid command, it is sent to the PLC that switches appropriate valves so that the required position of the elevator cabin is achieved. In the opposite case, if the cabin reaches required position, the PLC generates the command and then sends it to the SMS card. The SMS card encodes the received command in a seven - bit way and a new made PDU datagram is sent to the mobile phone. During this actions the receiver gets the SMS in which is informed about the reaching of the required position of the cabin. The SMS card pursues also several other actions, for example erasing the SMSs according to the need of the mobile phone, dialing the phone numbers, ending the phone calls, etc. The controlling algorithm is also written in C language.

***Figure 9:** The placement of the SMS card with the attached mobile phone in the model of the elevator.*

THE PROBLEMS

The main problem of this model is the inaccuracy in positioning the elevator cabin, that always over or under passes the required floor. This problem is caused by the compressibility of the air and mainly by the passive resistances. In the model there are reed constants that scan reaching the floor.

Figure 10: The placement of the SMS card with the attached mobile phone in the model of the elevator

Figure 11: A view into the interior of the final of solution of the model

In each floor there is one reed contact that signals reaching the floor. If the magnet, that is a part of the elevator cabin, switches the reed contact on, the air supply is switched off and the cabin is deflected from the floor (both during the motion up and down) owing to the compressibility and the passive resistances. This phenomenon cannot be eliminated for example, by back-pressure braking hence it has to be solved by means of self-adapting control, because this system is non-linear. This is the reason why I am dealing with the project of an adaptive LQ controller. This adaptive LQ controller should solve the problems with the positioning and it also should be transmittable for various pneumatic operating mechanisms. This adaptive controller is developed on the system prototype with the use of real time system (PXI 1042Q) and LabView software by NI.

RESULT

The electro - pneumatic model of the elevator was made for an educational purpose and during its construction many theoretic knowledge from various fields were applied. The pneumatic components that are used in the model are by Festo S.R.O. Company that, by its support, enabled the realization of this project. The other components of the model are made in laboratories of the Department of Applied Cybernetics TUL inclusive of the desks of the printed circuits. More detailed information about the procedure of the construction is available on the websites of the department, www.kky.tul.cz/elevator.

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