TECHNICAL SCIENCES AND TECHNOLOGIES
UDC 004.4
DOI: 10.25140/2411-5363-2018-3(13)-219-224

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DIDACTIC MODEL OF LIFT

Urgency of the research. *Mechatronics products become more sophisticated and complicated. Mechatronic engineers should be prepared for this complex design process. Practical experimental model helps improve educational process as preparing for practice.*

Target setting. *Miniaturized model of the lift suitable for practical training on subjects focused to microcontrollers, sensors, actuators etc. Students have possibility to make practice on laboratory exercises, where they can verify theoretical knowledge obtained on lectures. The arrangement of the model has modular character, because of possibility to rearrange or adding of new function into model. The aim was to create minimized model of real lift with all functions and systems.*

Actual scientific researches and issues analysis. *Many universities are oriented only to finished robotic kits and do not support creativity of students. Open access and open structure model missing in this field. There is a need for fast prototyping model, which allows the creation of new design of product.*

Uninvestigated parts of general matters defining. *The question of the design of printed circuit board are uninvestigated, because they need more time than allows normal exercises.*

The research objective. *The main aim of educational process is to educate engineers with basic knowledge, skills and handicraft. Practical models help as support devices for fulfil of this aim. All mechatronic students can practice a training on these practical models. They become as more skilled and well-oriented engineers..*

The statement of basic materials. *Construction consist of upper and lower base plate connected with four pillars used as linear guide for moving of lift cage. Lower base plate includes base microcontrollers boards, resistor network, power transistor array board, power supply terminals, relay modules, PWM module and signals terminals. Upper base plate consist of DC motor with gearing and screw mechanism for moving the lift cage.*

Conclusions. *The model enables supports the creativity of the students. The starting point of the using of the model can be without any wired connections. Students should connect every part and try functionality of every function. The students receive the defined several problems and they have to analyze it and make any proposal for solution of defined problems.*

Keywords: *lift; controller; sensor; actuators; didactic.*

Fig.: 8. References: 17.

Introduction. Mechatronics as field is as synergistic combination of mechanics, electronics and also informatics. Beside these areas also other areas can be included in mechatronic product as hydraulics, pneumatics, optics etc. It means that mechatronic engineer should be expert in various scientific areas. The dominant role is to make sophisticated integration of all areas with aim to make the competitive product.

The main aim of educational process is to educate engineers with basic knowledge, skills and handicraft. Practical models help as support devices for fulfil of this aim. All mechatronic students can practice a training on these practical models. They become as more skilled and well-oriented engineers. This way also support the creativity of these students and improve the ability to solve also complicated engineering problems.

Paper describes the miniaturized model of the lift suitable for practical training on subjects focused to microcontrollers, sensors, actuators etc. The model has been created as result of master thesis.

Students have possibility to make practice on laboratory exercises, where they can verify theoretical knowledge obtained on lectures. The proposed didactic model supports educational concept with solving of problem situations. The concept uses the problem-explanation method, research-heuristic method.

Students received the practical experiences and extend their theoretical base. This approach also raises the motivation of these students, because they have realisation output of their work. The proposed problems can be solved as single student or as team of students. So they will experience with team working (fig. 1).

All problems in practical realisation cause many dilemmas, unsatisfying and new barriers. These factors are as impulse for motivation of students. They cannot solve these problems with actual knowledge, so they have to self-study and make new analysis, synthesis, experiments and new design. Students learn the mechatronic approach to design of products with higher added value. Their creativity and thinking rapidly raises up. Thus prepared graduated students are better prepared for industrial practice.

Fig. 1. Team working on didactic model

Concept of the model. The arrangement of the model has modular character, because of possibility to rearrange or adding of new function into model. The aim was to create minimized model of real lift with all functions and systems. Impact was also on safety as in real lift. First design has been made via using of virtual CAD model. The first idea was as two cabinet lift (twin concept) (fig. 2) with four floors.

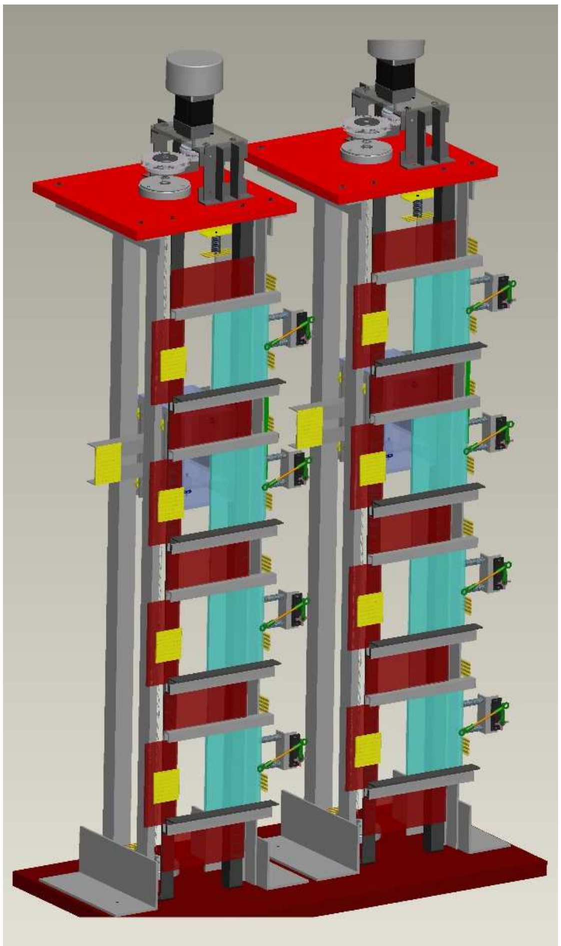

Fig. 2. CAD model of the lift

Functions of the model. The model has functions similar to real lift. The main aim is to make situation close to reality.

Detection of passengers inside the lift cage is needed for ensuring of higher priority of command inserted by passengers inside the lift cage (fig. 3). Also sensing of amount of passengers is necessary for protection against the weight overcome of overall weights in lift cage. Lighting inside the lift cage is also automatically activated only if any passenger is inside the cage. Passenger is represented by plastic green kinder egg with defined weight.

Sensing of lift cage position is also realized in lift model via using of infrared sensors (fig. 3). The position of lift cage is signalized on every floor and also on operator panel of the cage placed on left outside of cage. User can put any request also during the motion of the lift cage.

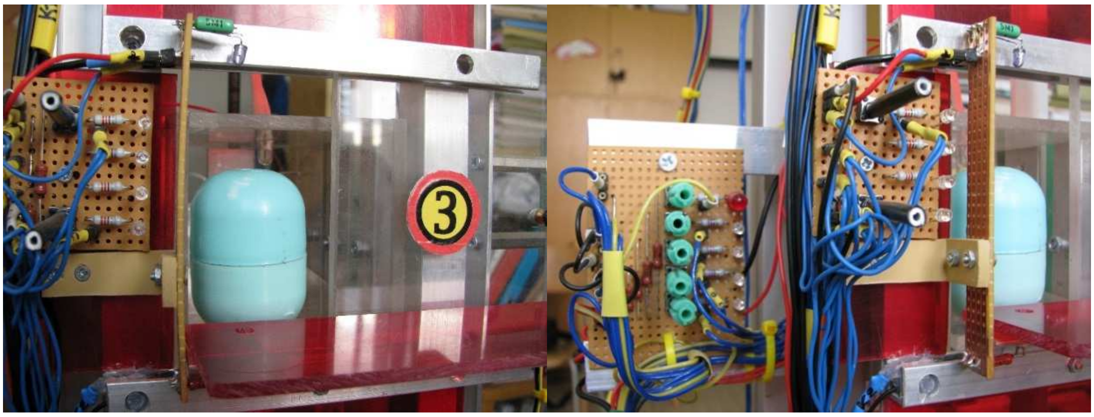

Fig. 3. Lift cage with passenger and operator panel

Sensing of cage position is also needed for controlling of cage moving. It continual accelerates on starting and it deaccelerates before target floor. Safety is very important and for this reason the passenger commands have higher priority than other commands. In case of emergency like fire or evacuation of building the control system should stop lift cage on closest floor.

Smooth closing and opening of the door is also safety function and it is related to sensing of door space realised via using of infrared optocouplers. If anybody in door place, then lift wait. The smooth opening and closing influences the overall life of lift. Opening and closing is realized through the servo and crank mechanism (fig. 4).

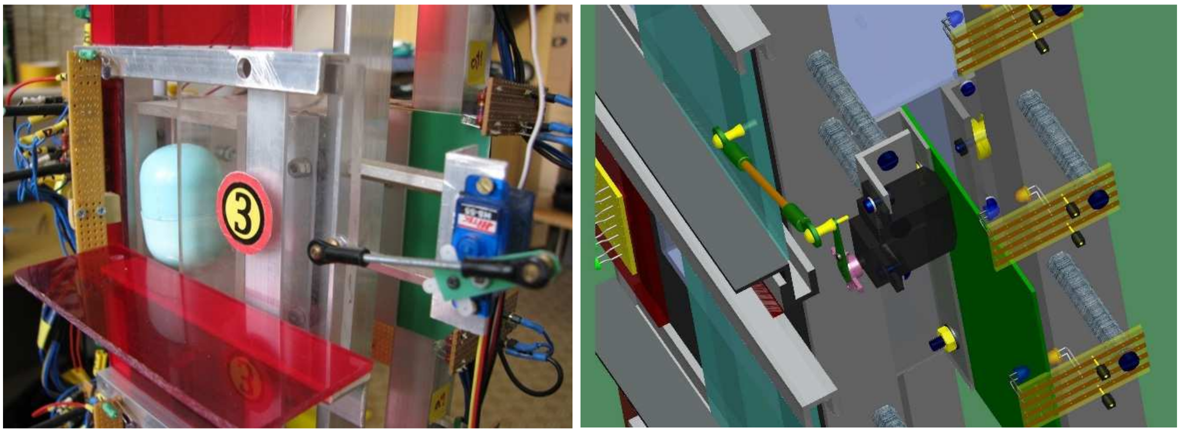

Fig. 4. Mechanism for opening and closing the door

Calling of the lift cage is possible on every floor through the buttons placed beside the door but still the commands received inside the cage have higher priority.

In case of any error the cage can crash into up or down limit barrier. For this purpose the limit end switches are installed and their function is independent on lift central control system. Also in case of wrong program it helps to prevent collision of cage at upper and lower limit.

Cage operator panel also includes the central stop button for emergency case and wrong program made by students.

Realization of the model. Model is 500mm high and weight is 1500g for easy manipulation. Construction consist of upper and lower base plate connected with four pillars used as linear guide for moving of lift cage (fig. 5).

Fig. 5. Linear guide for lift cage

Lower base plate includes base microcontrollers boards, resistor network, power transistor array board, power supply terminals, relay modules, PWM module and signals terminals (fig. 6).

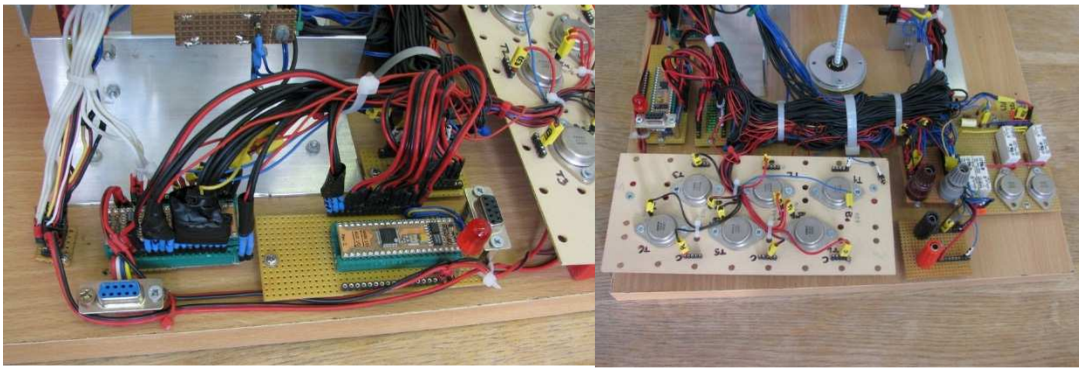

Fig. 6. Lower base plate

Upper base plate consist of DC motor with gearing and screw mechanism (motion screw and nut) for moving the lift cage. DC motor also includes optical encoder for measurement of velocity and angular position of rotor shaft. Screw mechanism transforms the rotation of DC motor to linear movement of lift cage (fig. 7).

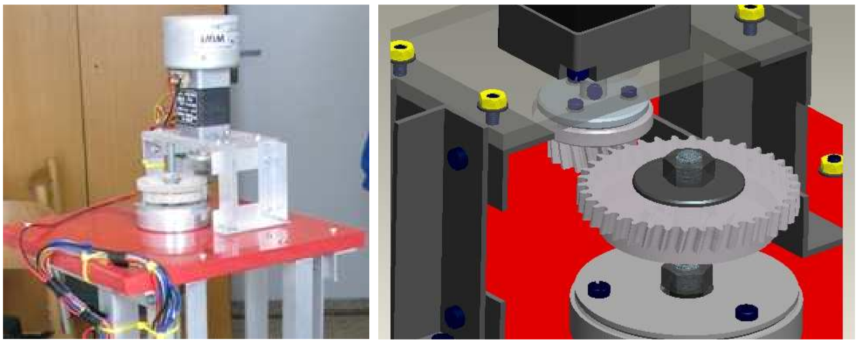

Fig. 7. Upper base plate

All electrical modules is connected with wired jumpers and it enables to rearrange electrical connections by students. Also they can add new modules. There are two microcontrollers as control system for all functions of the lift. The central power supply terminal needs only DC 12V power supply. It is selected because of safety of students during the experiments on this model. Overall model is compact device with easy manipulation. There are installed also safety shields and covers of moving parts as prevention of student's injuries. These covers are made from transparent materials for highly visibility of all components of the model. Electronic modules has short circuits protection and also reverse polarity of power supply. There are several master thesis has been done on this model and this model changes its appearance (fig. 8).

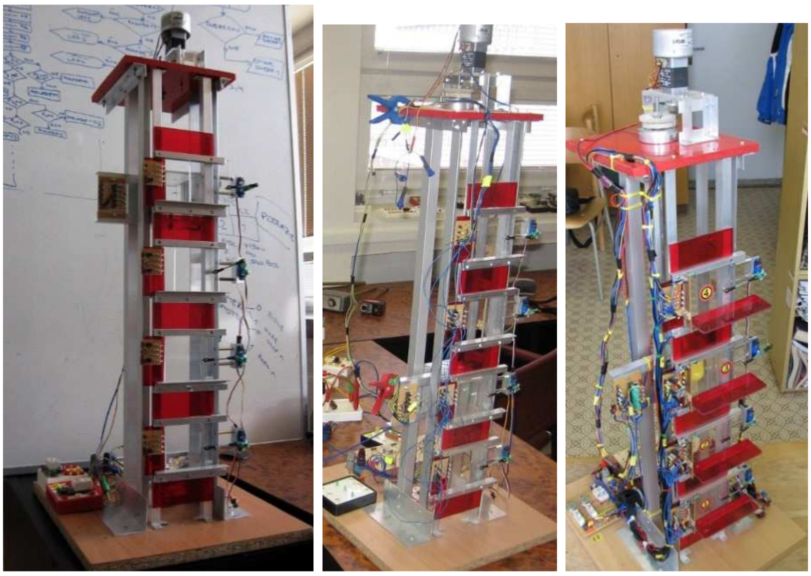

Fig. 8. Developing of the model – change of appearance

Conclusion. The model enables supports the creativity of the students. The starting point of the using of the model can be without any wired connections. Students should connect every part and try functionality of every function.

The students receive the defined several problems and they have to analyse it and make any proposal for solution of defined problems. Teacher only defines the problems and specifies the input restrictions. Then students have to study and make synthesis of knowledge for building the subsystems. This heuristic approach is perfect way for motivation of students. These students works in team and very often they use a brainstorming and other devices of team work [1-17].

Acknowledgement. *The authors would like to thank to Slovak Grant Agency – project KEGA 018TUKE-4/2018, and FGV/2016 supported by Faculty of Mech. Eng. at Technical University of Kosice.*

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УДК 004.4

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ДИДАКТИЧНА МОДЕЛЬ ЛІФТА

Актуальність теми дослідження. *Мехатронні вироби стають все більш складними. Інженери мехатроніки повинні бути готові до складності процесу проектування. Практична експериментальна модель допомагає поліпшити навчальний процес при підготовці до практичної діяльності.*

Постановка проблеми. *Мініатюрна модель ліфта, підходяща для практичного вивчення предметів, орієнтована на мікроконтролери, датчики, приводи і т. ін. У студентів є можливість практикувати лабораторні заняття, де вони можуть перевіряти теоретичні знання, отримані на лекціях. Будова моделі має модульний характер, що дає можливість перегрупування або додавання нової функції в модель. Мета полягала в створенні мініатюрної моделі реального ліфта з усіма функціями і системами.*

Аналіз останніх досліджень і публікацій.. *Багато університетів орієнтовані тільки на готові роботизовані комплекти і не підтримують творчість студентів. У цьому полі відсутня модель відкритого доступу і відкритої структури. Існує необхідність в швидкій моделі прототипування, яка дозволяє створювати новий дизайн продукту.*

Виділення недосліджених раніше частин загальної проблеми. *Питання про дизайн друкованої плати не досліджено, тому що йому потрібно більше часу, ніж дозволяють звичайні дії.*

Постановка завдання. *Основною метою навчального процесу є навчання інженерів базових знань, навичок і умінь. Практичні моделі допомагають в якості допоміжних пристроїв для досягнення цієї мети. Всі студенти-мехатроніки можуть практикуватися на цих практичних моделях. Вони стають більш кваліфікованими і добре орієнтованими інженерами.*

Викладення основного матеріалу. *Конструкція складається з верхньої і нижньої опорної плити, пов'язаної з чотирма колонами, які використовуються в якості лінійної напрямної для переміщення підйомної клітки. Нижня опорна плита включає в себе базові плати мікроконтролерів, резисторну мережу, плату з масивом силових транзисторів, клеми джерела живлення, модулі реле, модуль PWM і термінали сигналів. Верхня опорна плита складається з двигуна постійного струму з зубчастим зачепленням і гвинтового механізму для переміщення підйомної клітки.*

Висновки. *Модель дозволяє підтримувати творчий потенціал студентів. З'єднання з точкою управління моделлю може бути безпровідним. Студенти повинні підключити кожну частину і спробувати можливості кожної функції. Студенти отримують певні завдання, їм доводиться аналізувати їх і робити будь-які пропозиції для вирішення певних проблем.*

Ключові слова*: ліфт, контролер, датчик, приводи, дидактика.*

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Miková, L. (2018). Didactic model of lift. *Technical sciences and technologies*, *3* (13), 219–224.