На даний момент проведено аналіз задач, які необхідно вирішити в ході розробки, і виконано моделювання векторної системи керування індукційним двигуном у спеціалізованому пакеті САПР PSIM. Подальші дослідження будуть стосуватися безпосередньої розробки апаратних складових контролера індукційного двигуна, а також проведення реального експерименту. Планується розробка алгоритму опису (на мові опису апаратури) та імплементації ПІ-регулятора в ПЛІС; спостерігачів ковзання, потокозчеплення ротора і моменту; реалізація апаратних блоків прямого та інверсного перетворень Парка та Кларк; розробка детермінованого цифрового автомату для керування блоком просторово-векторної модуляції із можливістю завдання "мертвого часу".

Список використаних джерел

1. Induction motor [Електронний ресурс]. – Режим доступу: https://en.wikipedia.org/wiki/Induction_motor.
2. Усольцев А.А. Частотное управление асинхронными двигателями / Учебное пособие. СПб: СПбГУ ИТМО, 2006, – 94 с.
3. Tesla Inc. [Електронний ресурс]. – Режим доступу: https://www.tesla.com.
4. Спільне українсько-німецьке підприємство «Електронтранс» [Електронний ресурс]. – Режим доступу: http://eltrans.electron.ua.
5. Park, Inverse Park and Clarke, Inverse Clarke Transformations MSS Software Implementation. User guide. [Електронний ресурс]. – Режим доступу: https://www.microsemi.com/document-portal/doc_view/132799-park-inverse-park-and-clarke-inverse-clarke-transformations-mss-software-implementation-user-guide.
6. Jean-Gabriel Mailloux, Stephane Simard, Rachid Beguenane, "FPGA implementation of Induction Motor Vector Control using Xilinx System Generator", 6th WSEAS International Conference on CIRCUITS, SYSTEMS, ELECTRONICS,CONTROL & SIGNAL PROCESSING, Cairo, Egypt, Dec 29-31, 2007, pp. 252 – 257.
7. C. Kowalski, J. Lis, and T.O Kowalska, "FPGA implementation of DTC control method for the induction motor drive," Int. Conference on Computer as a Tool (EUROCON), 2007.

PECULIARITIES OF USING THE SURF-METHOD OF DETECTING OBJECTS IN ROBOTICS

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To date, advances in the field of electronic technology allow you to robotize many industries and areas of people's activities. Reasonable introduction of robots in the field of medicine, space, industry, security systems, and entertainment allows people to feel more comfortable and harmonious. The variety of human interests generates, respectively, a variety of robot models that cover one particular direction or aggregate of several directions in the design. One of the design directions, which will be discussed further, is the machine vision, which is used mainly in the industry, in particular - it's autonomous robots and visual inspection and measurement systems.

Machine vision uses a system for collecting and analyzing visual information, and then performs the actions based on the received data. Machine vision is used to detect objects with which you need to interact or obstacles that the robot must bypass; checking the quality of parts; observation of the terrain and many other tasks. In the robotic assembly, the visual pattern recognition system is designed to simulate human vision. It must be able to perceive and detect the individual parts of the object as possible closer to human vision. To achieve this ability by choosing the optimal method of object recognition based on machine vision. The review of existing methods allows determining their main advantages and disadvantages. One method that has the most acceptable characteristics for object recognition is the SURF method.

The purpose of this work is to determine the feasibility of using this method to implement autonomous object detection systems. The solution to this problem could have broad applications.

SURF (Speeded-Up Robust Features) is a method that allows recognizing the object using the selected singular points of the original object and its descriptors. The main feature of this method is that the scale of the image and its rotation to an arbitrary angle does not affect the ability to detect the object.

A singular point is a location in the image where there is a change of the brightness gradient and descriptors represent the area around a singular point and showing the fluctuation of the gradient. Search for singular points is performed by using the Hessian matrix, and the determinant of this matrix (the Hessian) reaches an extremum at the points of maximum change of the gradient of brightness. Representation of the Hessian matrix [1]:

$$H(f(x,y)) = \begin{bmatrix} \frac{\partial^2 f}{\partial x^2} & \frac{\partial^2 f}{\partial x \partial y} \\ \frac{\partial^2 f}{\partial x \partial y} & \frac{\partial^2 f}{\partial y^2} \end{bmatrix}$$

$$det(H) = \frac{\partial^2 f}{\partial x^2}\frac{\partial^2 f}{\partial y^2} - \left(\frac{\partial^2 f}{\partial x \partial y}\right)^2$$

where $f(x,y)$ – brightness change function.

In the calculation method SURF used another representation of the computation of the determinant:

$$det(H) = D_{xx}D_{yy} - (0.9D_{xy})^2$$

where D_{xx}, D_{yy}, D_{xy} – convolution of the filters shown in fig. 1. The factor of 0.9 has theoretical justification, and adjusts the approximate character of the calculations.

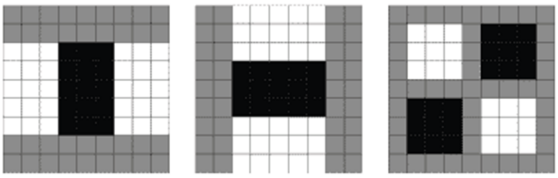

Fig. 1. Convolution filters used to find the Hessian matrix [1]

The white regions have brightness values +1, gray 0, and black for the first two filters -2 (and for the third filter black regions have brightness values -1).

As already mentioned, the change of scale has no effect on the detection of the SURF-method however, calculation of the determinant of the Hessian matrix depends on the image scale. Therefore, in order to neutralize this factor, when calculating the determinant of the matrix on a certain scale, the filters that are divided into octaves, 4 in each filter (Fig. 2).

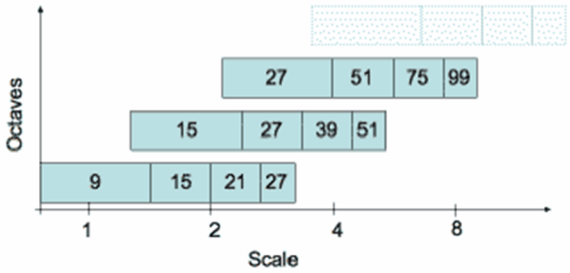

Fig. 2 - Illustration of filter sizes for the first three octaves [2]

The calculation of the determinant is applied on a scale of 1 to 10. A further increase in scale will not give any results, because in this case dramatically reduces the number of detected singular points in the image (fig. 3).

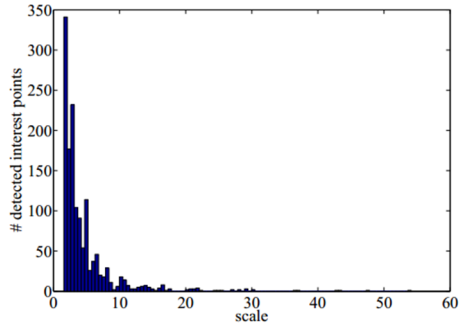

Fig. 3 – The dependence of the number of detected singular points of scale [2]

To compute the image descriptors using Haar filters, presented in fig. 4.

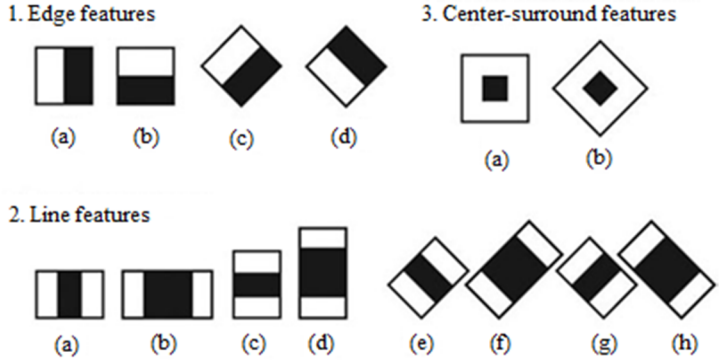

Fig. 4 - Haar filters. Black regions have the values -1, white +1 [3]

Further studies are planned to be performed in two stages:

1) simulation of the process of solving the recognition problem considered method using the MatLab package, in which there is the possibility of working with object detection systems, in particular, - there is an example of a solution for the SURF method;

2) physical modeling using the hardware of a personal computer and a video camera to test the method with the subsequent transition to embedded microcontrollers for the realization of a given goal.

Experimental researches are designed to solve the following problems:

– assess the correctness of the system operation by finding the probability and the accuracy of determining the given object;

– determine the high-speed performance of the system;

– determine the range of possible improvement of the above characteristics.

References

1. А. В. Головко. Поиск объектов интереса по устойчивым признакам на изображении / А. В. Головко, В. Р. Ягьяев // Збірник наукових праць НУК – 2011. – №6. – с. 34-40.
2. H. Bay, et al., Speeded-Up Robust Features (SURF), Computer Vision and Image Understanding, 2008, pp. 346-359
3. D. Volz, J. DeVito, Algorithms, OpenStax, 2012, pp. 1-5
4. N. Herakovic, Robot Vision in Industrial Assembly and Quality Control Processes, Robot Vision, 2010, 624 p.
5. R. Verschae, Ruiz-del-Solar J. Object Detection: Current and Future Directions, Front. Robot, AI, 19 November, 2015.
6. A. Xu, G. Namit, SURF: Speeded-Up Robust Features, Ph.D. thesis, McGill University, 2008, pp. 1-30