MATHEMATICAL MODELING OF PROCESSES AND SYSTEMS

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INTELLECTUAL METHOD OF ACTIVITY SUPPORT OF TELEVISION SYSTEM

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***Abstract*—*There are described the modern television systems and the device management. A method to support television system in an active state depending on the current performance of biometric parameters of the observer. The article examines the range of possible angles the user's face, which is near screen television system. Depending on the range of extreme values of the decision to intensify or hibernation television system.*

Index Terms—Television system; artificial intelligence; pattern recognition; identification of persons automatic control.

I. INTRODUCTION

The technique of television systems rapidly being replaced analog devices to digital. This process is not yet complete, but it is clear that in the near future in television should occur even more sweeping changes – making the transition from hardware to software, the replacement of the traditional production technology of television programs in information technology. The essence of this transition is the use of standard computer platforms and standard telecommunications components in conjunction with specialized software. Only the transition to information technology is able at this stage to make a high-quality digital television systems, rapid and cost-effective.

As a result of the introduction of information technology television system is transformed into an information system in which all production operations have data operations, and actuators are software and hardware components of computer platforms. Each function is realized in the traditional scheme of separate specialized technical device becomes just one of the functions that are performed by software and multi-purpose hardware-based systems for information technology.

Design and development of computer information systems, based on information technology, is more difficult and complex than the design and construction of traditional analog and digital production programs. Moreover, the design of computer information systems requires a fundamentally new approach that goes beyond the purely technical transformations. We need a new way of technical thinking, focused on recognition biometric user television system.

II. THE ANALYSIS OF THE LATEST RESEARCHES AND PUBLICATIONS

At present there are many methods of managing television systems, ranging from remote controls and ending gestures, voice commands and even facial movements. In [1]–[3] states that there multimodal interfaces for managing television (TV) systems. Multimodal interface includes a visual interaction between the user and the display system of your TV. With the help of a multi-modal interface, containing as system control your TV personal computer, a video camera and microphone, carried out to control the TV by a user's interaction with its display system. This algorithm detection and identification of the user, an algorithm for gesture recognition and voice recognition algorithm signals and dynamic range of data extrapolation of these algorithms on certain formulas. They are mathematically expressed by the dependence of the algorithms of these three modalities of interacting with a graphical menu multimodal interface is detected by a mathematical analysis of algorithms of three sets of signal commands control the TV, which are included in the database and the memory of a multimodal interface. As a result, it automatically identifies the individual for each user algorithms for three sets of signaling teams, interacting with its graphical menu, and carries with them to control the TV.

To date, there is a technology integration of the Internet and digital interactive services into modern television sets and set-top box, as well as in the technical symbiosis between computers and TV/digital TV receivers, previously referred to as the "Connected TV" Now it is called Smart TV. Currently, the technology is developing rapidly: according to experts, in 2010, features Smart TV was provided with 40 % of flat panel TVs, in 2011 – 90 % [3]. Although the concept of Smart TV is at an early stage, it is rapidly supplemented by software, such as Google TV and XBMC. Technology is widely covered in many literature [2]–[5], and also stimulates the equipment manufacturers, such as Samsung, Sony, LG and others to develop products with search functions, install applications, support for interactive

media, personalized communication and social media. The main problems to be solved manufacturers, it is easy to work with network resources using remote controls. To solve this problem developed special remote control that combines the functions of the actual TV remote and joystick / computer mouse, for example – Magic Remote from LG [4]. But not in the Smart TV or multimodal interface does not provide the possibility of switching the TV system in a low power mode, depending on the angle of the user's face. Also, there has not been solved and the problem of automatic exit from this mode, depending on the angle of the face.

III. TASK STATEMENT

Let us be a television system consisting of TV, camera and remote control (Fig. 1).

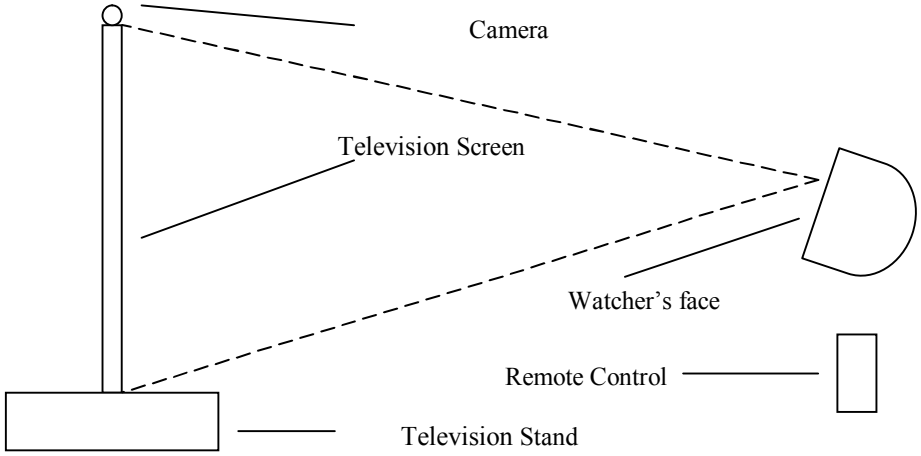

Fig. 1. Television system with TV camera to track the observer's attention (side view)

Figure 2 shows the same thing, only the front view.

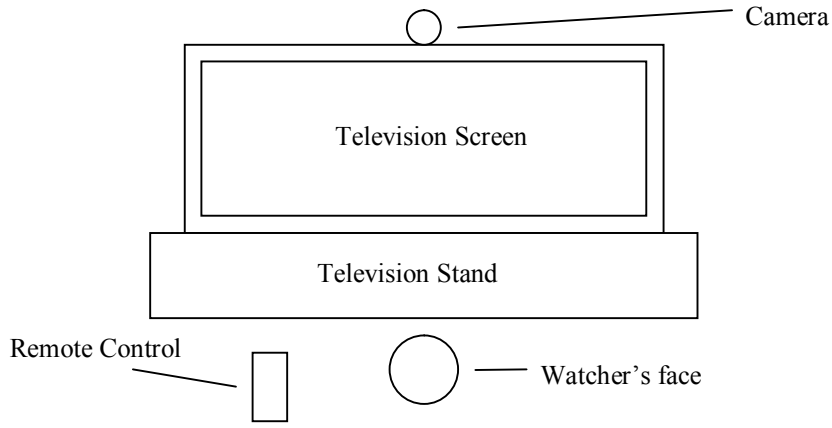

Fig. 2. Television system with TV camera to track the observer's attention (front view)

Need to find a range of possible angles of the face of the observer in depth and on the basis of this range to translate the TV system in sleep mode and back.

IV. TASK SOLUTION

Determining the range of possible angles face based on geometric structural features of the human face. As a priori information can be used About face anchor points, such as the centers of the pupils, nose, extreme left and right border of the face, lips center, the lower point of the face, etc. Automatically retrieve the location of control points by using the algorithm using elastic graph, and control points listed this algorithm finds the first few iterations [2]. Knowing the coordinates of the anchor points on the facial image, we can use this information to find the range of possible angles face, allowing television system to make decisions on the transition to sleep mode or vice versa. In order to develop an algorithm for automatic determination of the range of angles on his face image is proposed using ratios based on geometric features of a human face. You can use the following reference points (Fig. 3):

1. The center of the pupil of the left eye.
2. The center of the pupil of the right eye.
3. Nose.
4. The center of the lips.
5. Point lower face.

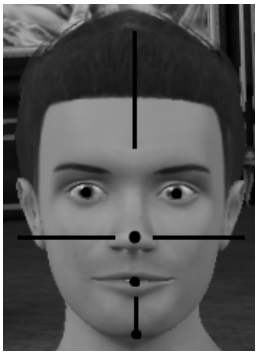

Fig. 3. Anchor points for determining bevel face

Since the image is two-dimensional human face, to determine the range of angles is mainly used methods used in geometry in the plane. However, one should take into account the spatial geometry of the human face, especially that nose has some height above the plane passing through the other control points (centers of the pupils of eyes, the center of the lips, face lower point), which can prevent the proper solution of the problem. So you need to choose a triangle, the plane which would be parallel to the plane of the face and the height of the triangle took its maximum value in frontal face position.

Since the point at the end of the nose and on the mid-point of the lips slightly protruding over the whole face, the remaining points on the pupil of the eyes and the lower point of the face, ie, *A*, *B*, *E* (Fig. 4). Chin can also act on the face, but the lower point of the face is not the end of the chin and the bottom, so the position of the frontal face it lies approximately at eye level.

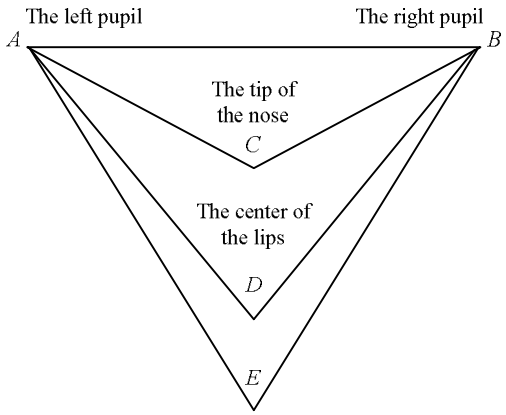

Fig. 4. Triangle formed by face anchor points

With gradual tilting face, as shown in Fig. 5, the projection area of the triangle formed by the points of the pupils of the eyes and lower face which decreases, and decreases the projection height of the triangle.

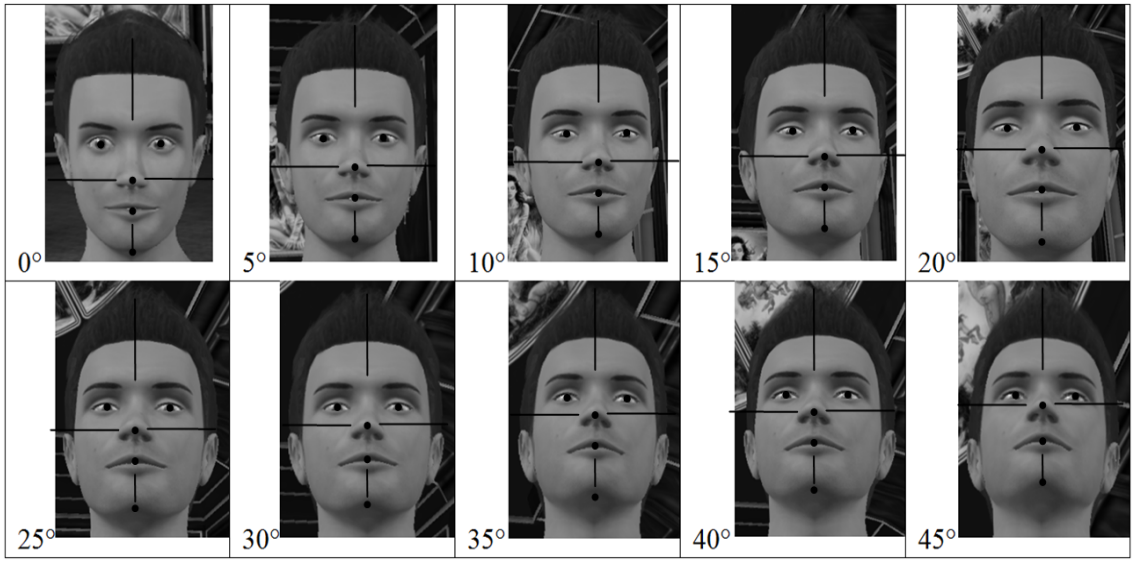

Fig. 5. Face at different angles ascending

Let the height of the triangle ABE is equal to *h*, and projection – *p* (Fig. 6). They will correlate with each other as $h = p\cos\alpha$, where α is the real value of the angle of inclination of the face.

In Fig. 6 shows the projection of the triangle ABE, and the projection of the height *EP*. Since *AP* = *BP*, it is easy to find the coordinates of the point *P*, which will be equal $\left(\frac{x_1+x_2}{2};\frac{y_1+y_2}{2}\right)$. The length of the projection of the *EP* will be equal

$$p = EP = \sqrt{\left(x_5 - \frac{x_1+x_2}{2}\right)^2 + \left(y_5 - \frac{y_1+y_2}{2}\right)^2}$$

$$= \sqrt{\left(\frac{2x_5 - x_1 - x_2}{2}\right)^2 + \left(\frac{2y_5 - y_1 - y_2}{2}\right)^2}$$

$$= \frac{1}{2}\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}.$$

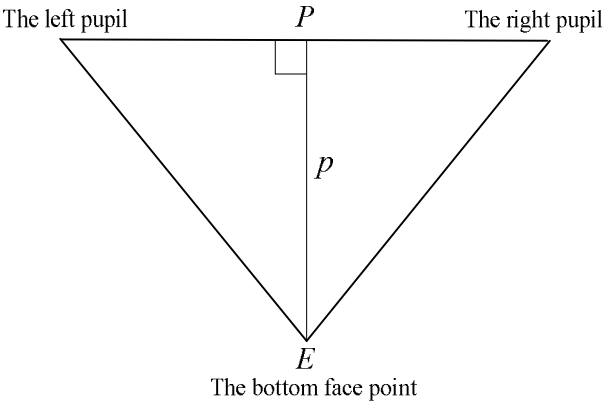

Fig. 6. The height of the triangle ABE, EP = *p*

In source [3] states that the ratio of the distance between the pupils perpendicular to the face of a man held in the lowest point of the chin (*PE* – Fig. 6) lies in the range 0,4…0,7, i.e.

$$0,4 \le \frac{AB}{h} \le 0,7 \Rightarrow \frac{10}{7} \le \frac{h}{AB} \le \frac{10}{4},$$

or

$$\frac{10}{7} AB \le h \le \frac{10}{4} AB.$$

Since $h = p\cos\alpha$, then

$$\frac{10}{7} AB \le p\cos\alpha \le \frac{10}{4} AB \Rightarrow \frac{10AB}{7p} \le \cos\alpha \le \frac{10AB}{4p}.$$

In turn, $|AB| = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$, we will get

$$\frac{20\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{7\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}} \le \cos\alpha \le \frac{5\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}},$$

from what we get the next inequality

$$\arccos\frac{20\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{7\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}} \le \alpha \le \arccos\frac{5\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}}.$$

Denote the smallest possible angle for α_{min}, but biggest – for α_{max}, i.e.

$$\alpha_{min} = \arccos\frac{20\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{7\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}};$$

$$\alpha_{max} = \arccos\frac{5\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}{\sqrt{(2x_5 - x_1 - x_2)^2 + (2y_5 - y_1 - y_2)^2}}.$$

We assume that if the average value of the angle of the range of possible angles face more than 45°, then the observer attention is reduced or absent and television system may go into low power mode. That is:

$$If \quad \frac{\alpha_{min} + \alpha_{max}}{2} > 45^\circ \quad \Rightarrow \quad \text{hibernation;}$$

$$If \quad \frac{\alpha_{min} + \alpha_{max}}{2} \le 45^\circ \quad \Rightarrow \quad \text{activation.}$$

V. CONCLUSIONS

So, in this article described the existing technology and developments in the field of television systems and methods of management. Was proposed algorithm for determining the range of possible angles face too deep. Information about them will build a TV system with elements of artificial intelligence. Television system based on this information, make decisions about moving in low power mode – if it reduces attention of the observer or vice versa will be activated at elevated his attention.

The paper discusses and analyzes the conditions of formation and detection zones of probable aircraft icing.

Detailed consideration of these conditions, it is clear that the condition of a clear division of hydrometeors, depending on their phase state (ice or water droplets), which is required for correct operation of the algorithm Shupyatskogo-Yanovsky [3], [5] is not always satisfied. Namely, this condition is satisfied only in stratiform icing scenario. To verify the correctness of the algorithm and evaluate its reliability in other scenarios further investigations required, since these scenarios allow for the simultaneous presence of crystals and drops in a resolution volume.

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Д. М. Федоров. Інтелектуальний метод підтримки активності телевізійної системи

Розглянуто сучасні телевізійні системи та пристрої управління ними. Запропоновано метод, який дозволяє підтримувати телевізійну систему в активному стані в залежності від поточних показників біометричних параметрів спостерігача. Проаналізовано діапазон можливих кутів нахилу обличчя користувача, який знаходиться біля екрану телевізійної системи. В залежності від крайніх значень діапазону приймається рішення про активізацію чи гібернацію телевізійної системи.

Ключові слова: телевізійна система; штучний інтелект; розпізнавання зображень; ідентифікація особи; автоматичне управління.

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Д. М. Фёдоров. Интеллектуальный метод поддержки активности телевизионной системы

Рассмотрены современные телевизионные системы и устройства управления ними. Предложен метод, который позволяет поддерживать телевизионную систему в активном состоянии в зависимости от текущих показателей биометрических параметров наблюдателя. Проанализирован диапазон возможных углов наклона лица пользователя, который находится у экрана телевизионной системы. В зависимости от крайних значений диапазона принимается решение об активизации или гибернации телевизионной системы.

Ключевые слова: телевизионная система; искусственный интеллект; распознавание изображений; идентификация лица; автоматическое управление.

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