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Eye tracking in urban visual environment

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ABSTRACT

Visual environment pollution increasing along with urbanism. For the first time V.A. Filin provides an explanation of the link between this problem and visual deterioration, mental health and other health concerns. Methods of visual environment pollution definition are not currently developed. Eye tracking off the shelf- the process of measuring the motion of an eye. It may assist to make exact visual pollution test. This article provides that this method is more suitable than previous one. In addition, it considers the impact of homogeneous aggressive visual environment in cities and towns. As the result, it is provided that eye tracking method usage is permissible when assessing visual safety of buildings and constructions. The optimal algorithm for this method was developed.

Contents

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1. Introduction

Urban ecology situation is one of the issues not only among scientists but among the whole world. Yet, only problems with chemical, physical and other types of pollution are taken into consideration. But the ecological factor of visual environment is not taken into account. Whereas a number of research in the field [1-4,5-8,18] shows that the visual environment and the character of its visible elements concentration influence directly a human psychophysical condition. In addition, construction regulations of many countries take into account requirements of noise defense that is of hearing organs. On the other hand, measures on visual environment hazards defense (seeing organs) are not considered properly.

The problem of visual pollution has been historically build up globally. In 1995, in the USSR there was issued an act on "Architectural excess ellimination" [23], which put a direct prohibition on using any kind of decorative elements in buildings being in project or being constructed. This act led to a huge amount of one type buildings with repetitive elements built in those times. The same approach was widely accepted in many other countries.

Concept of visible environment as an ecological factor was first considered and grounded by V. A. Filin [17]. Basing on the theory of saccade automation [24] V. A. Filin researched visual objects influence on eyes perception and he grounded hazard impact of aggressive and homogeneous visual fields. Visual fields with big amount of indistinguishable elements are called aggressive, with two or more ones in an angle distance less then 2 degrees. Examples of such fields can be facades of residential construction with one type windows and coloration with repetitive stripes and cells elements. Homogeneous are the fields which are visually alike with full absence of any kind distinct elements at an angle distance of 15 and over degrees, for example solid walls or overall glass on buildings. There was shown a real threat to physiological mechanisms of eye vision, these mechanisms cannot fully work in an aggressive and homogeneous environments [25,26]. This fact increases possibility of psychic problems and stressfulness of urban citizens, and is a cause of functional and organs diseases.

Until recently, because of the field being new, any specific directions and recommendations on research and assessment of buildings visual environment were not done. Earlier researches [9-16] were aimed at studying of esthetic and art aspects of urban visual environment objects. There were no quality assessments or records of possible negative effects done.

Lately, research on visual pollution assessment of urban environment, including builldings and constructions, started to appear. So, the work by A.A. Golubnichiy [27] offered a method defining the rate of buildings and roads surface aggressiveness. For this purpose, considering the specific point of view a marking grid would be built and frequency of one type visually distinctive elements would be defined. Aggressiveness Ratio would be defined by this frequency. Also, his work offered devision of visual environment into four groups: visually unpleasant and visually neutral.

S. I. Fedosova [28] in her research worked out graphoanalitical methods of both aggressiveness and homogeneousness assessment of visual fields. She offered devision of visual environment into three categories: visually pleasing, neutral and not pleasing.

It should be said that the mentioned above authors used only theoretical assumptions about glance moving on object surfaces. This complicated the research and put in the factor of uncertainty.

Recently developed eye tracking technology can allow to eliminate this uncertainty. Despite the quite well developed method [4,19-22], it still has not been used to assess buildings from the point of view of visual pollution. This given work shows analysis of possible methods of eye tracking to do the assessment.

2. Aims and tasks

The main aim of the work is to define possibilities of using the eye tracking method to assess buildings visual environment.

To do so, we had to solve the following tasks:

1. To conduct testing of the control group using the eye tracking method with series of buildings images.
2. To assess the tests results from the point of view possibility to define surfaces homogeneousness and aggressiveness.
3. To define existence of other possible factors of visual environment which can be defined with the help of this method.
4. To make up theoretical algorithm of building visual environment assessment.

3. Methods

Eye tracking is a method which tracks and records eye vision movement on an object. The main tool is an eye tracker device which recognizes an eye pupil movement and records the glance direction synchronizing it with the image at which the person is looking. To do the research, the eye tracker device and the software are used.

To assess possibilities of the method implementation in testings, series of buildings images was selected (fig. 1) – four images of recently built residential buildings in Devyatkino district, St Petersburg and four control images: previously accepted as highly hazardous (the wall with typical windows in a row), without hazardous elements (Kazan temple, St Petersburg) and neutral with some hazardous elements but at the same time leveled by decorative elements (a residential building in Kalininskiy district and Airport Pulkovo, St Petersburg).

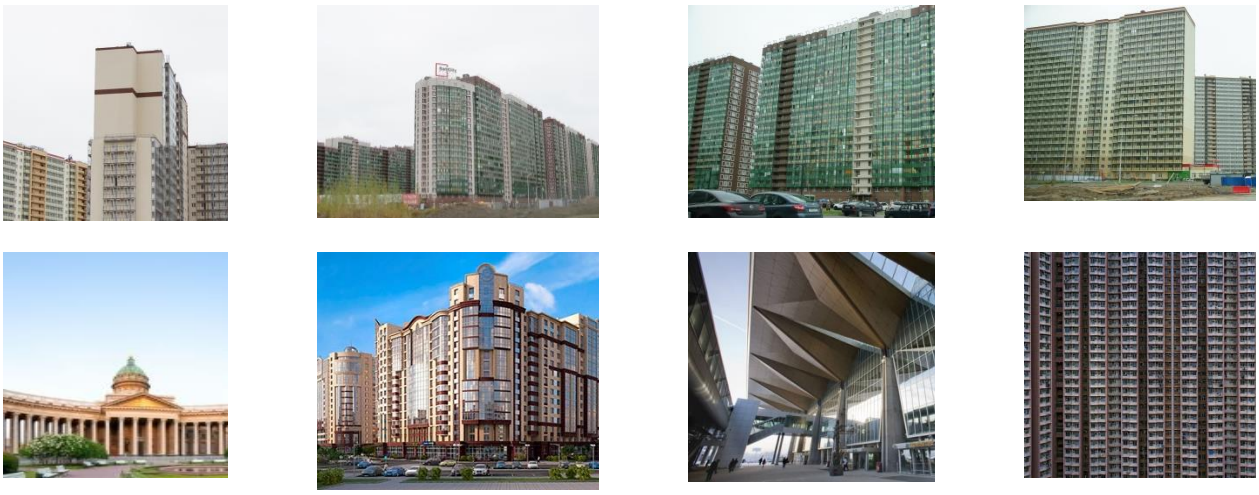

Fig. 1. Involved buildings

Every image was shown to the tested people during 7 seconds. This period of time was received by empirical way. This period is enough for a person to react to the changed image and to look it through.

Tracks of glance movement were recorded (shown with lines), stop points (circles) and stops duration (on the scheme they are shown by circles radius but were not taken into consideration at this level of analysis). Figures in circles indicate eyes movement consequence. Thus, one can trace the whole way of eyes moving on the building.

Distance from the monitor with eye tracker to a probationer's eyes was 45 cm, the monitor sizes were 60/36 cm. To define saccades range the corresponding scheme was made, the scheme was used to transfer distance in mm to the range in degrees (fig. 2).

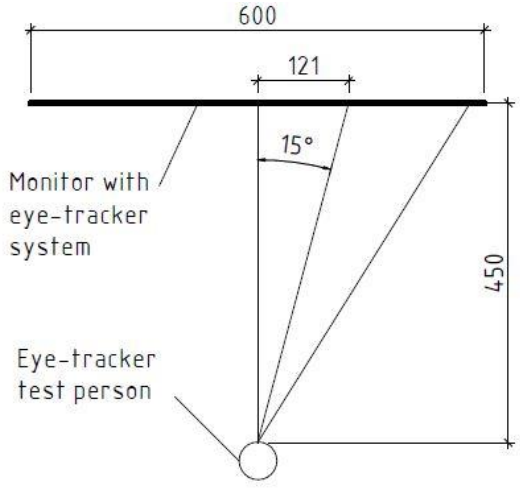

Fig. 2. Scheme of saccades range definition. Example for border homogeneousness index is 15 degrees (the sizes are in mm)

4. Visual environment assessment results

Firstly, attempt to check the building on homogeneous fields was made. According to the test results (fig. 3-4), we can see that the glance mainly does not stop and slides along stained glass windows of the airport, its glass balconies which reflect the light and along closed end walls or does not fall into these zones. In such slides the range is from 10 to 16 degrees which borders with unacceptable state.

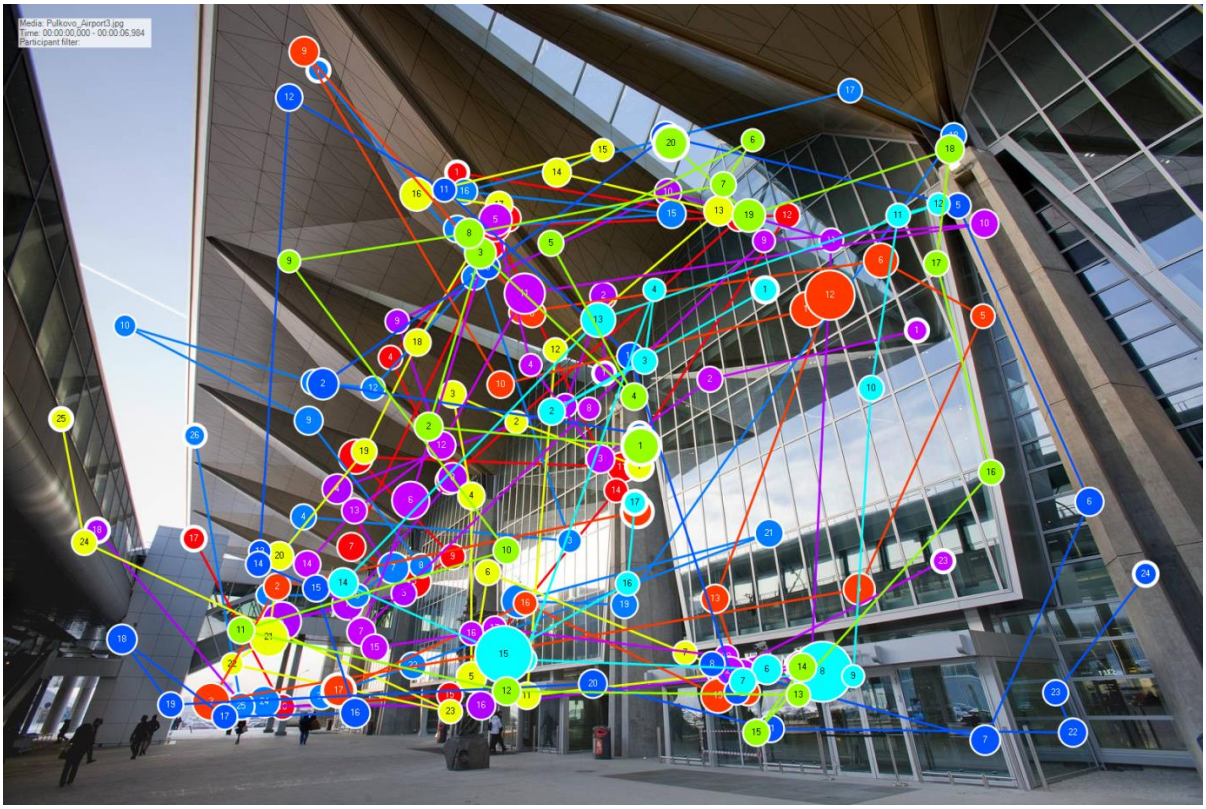

Fig. 3. Glance movement trace and stops points in the photo of new buildings in Devyatkino district, St Petersburg.

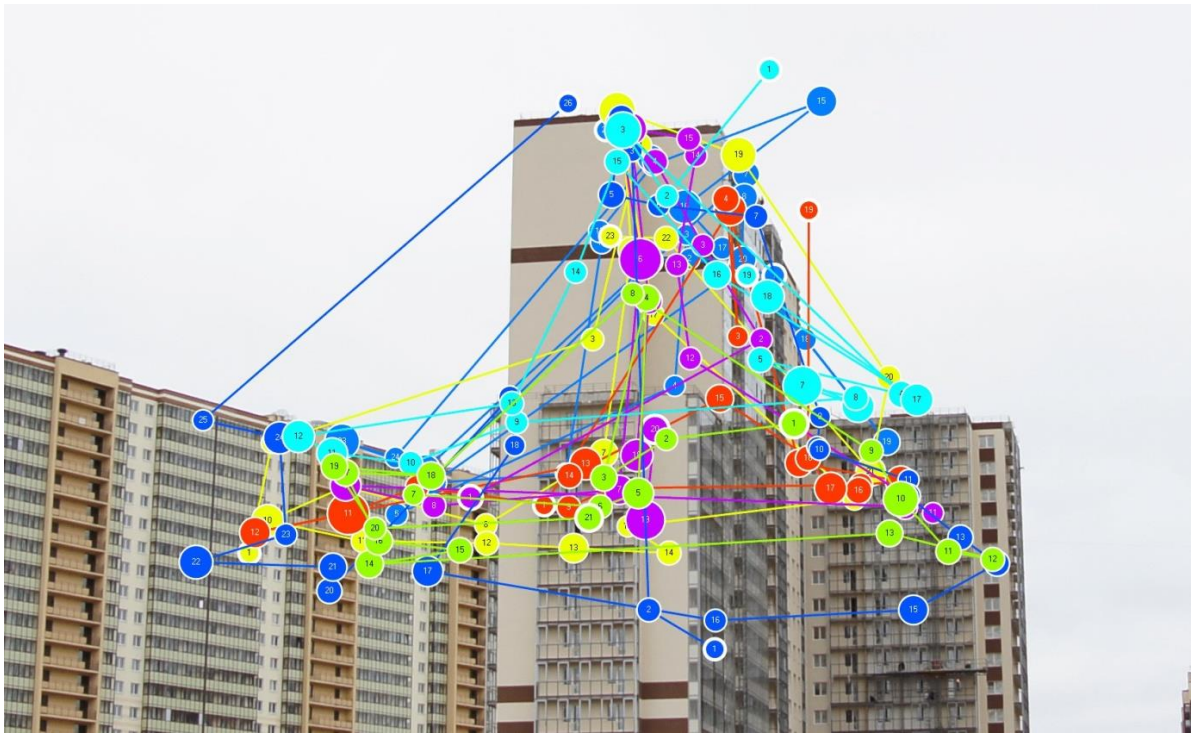

Fig. 4. Glance movement trace and stops points in the photo of Pulkovo airport terminal, St Petersburg.

Крупина А.А., Беспалов В.В., Ковалева Е.Ю., Бондаренко Е.А. Eye tracking в городской визуальной среде / Krupina A., Bespalov V., Kovaleva E., Bondarenko E. Eye tracking in urban visual environment. Construction of Unique Buildings and Structures ©

It was received that buildings aggressive environment can be indirectly defined by non-systematical eyes movement on an image. In figure 5, we received scheme of probationers eyes moving on a wall with a lot of typical windows. After fixation at the first central area at eye level glances movement on facades followed different ways and tracks went randomly. Glance did not stop long enough at any point which is shown by circle diameter. Eye tumbles in the search of fixating point and does not find one which increases saccades frequency and is hazardous. Also, on this wall over two repetitive window elements are seen at 2.5 degrees which says about aggressiveness of the environment. With previous cases it was on the contrary, normalized movement could be seen. In the airport case there is such a consequence: entrances with inscriptions above, bridge intersection, roof elements. In the residential building case, the consequence is the following: central and sidelong buildings triangle, yet the tracks on each of them were rather unsystematic and the quantity of some elements was also over 2-3 at 2.5 degrees.

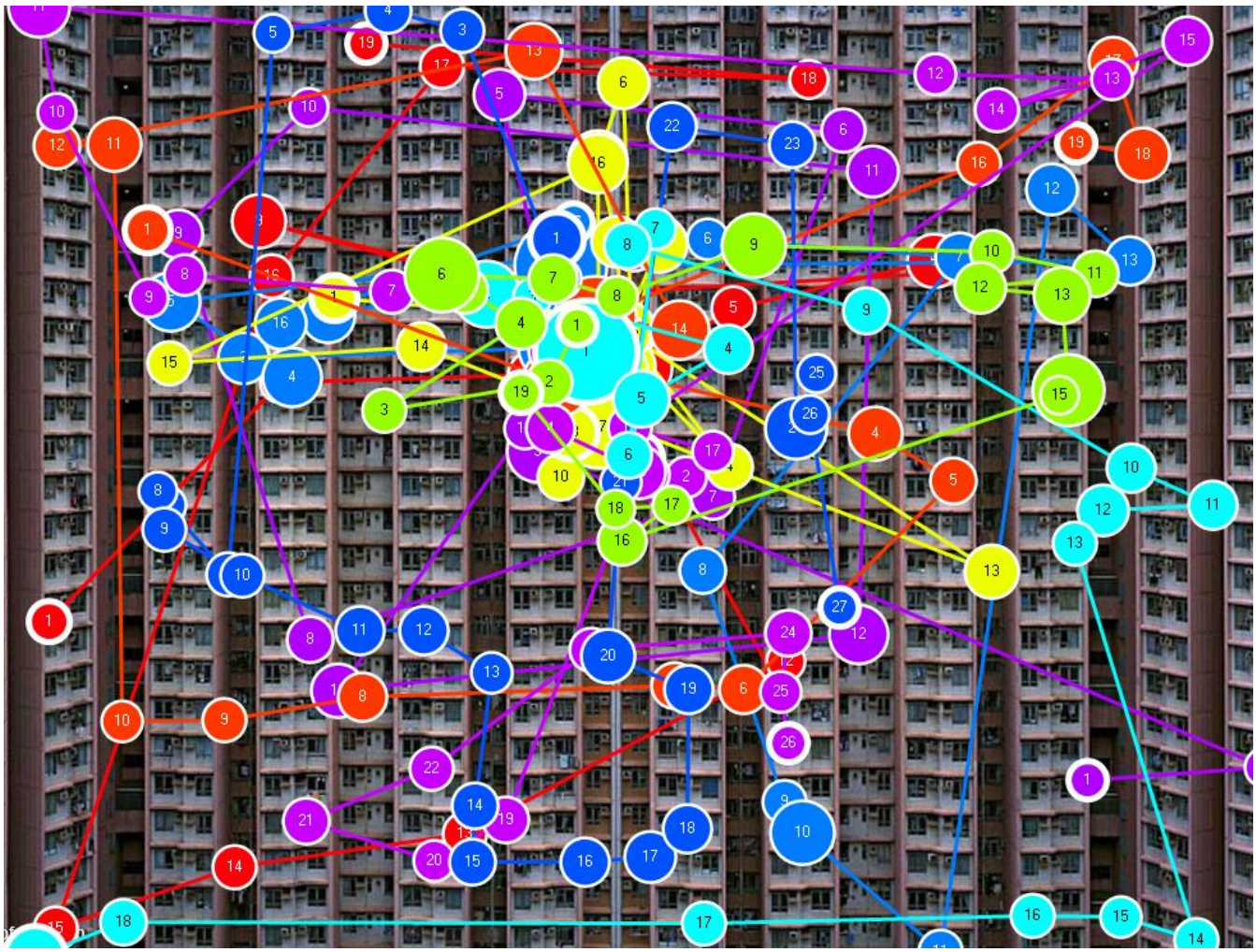

Fig. 5. Glance movements and stop points on the image of a facade with typical windows.

On the next building (fig. 6) typical windows with concentration of over 2-3 at 2.5 degrees are also present, however they are put into separate visual blocks which compensates aggressiveness. Areas with aggressive environment here are also seen as if it were homogeneous fields. Besides, the building angle is architecture dominant so it is the real fixating element. Glance movement is traced by the following principle: central podium, architecture elements on the sides, then other elements not related to the building.

Fig. 6. Glance movements on a building in Kalininskiy district, St Petersburg.

In Kazan cathedral (fig. 7), case similar elements were almost absent, glance moved equally looking at the central part and then moving to side columns where one could notice sharp increase up to 15-16 angle degrees yet their quantity was minimal. This fact shows the minimal level of aggressiveness and lack of homogeneous fields.

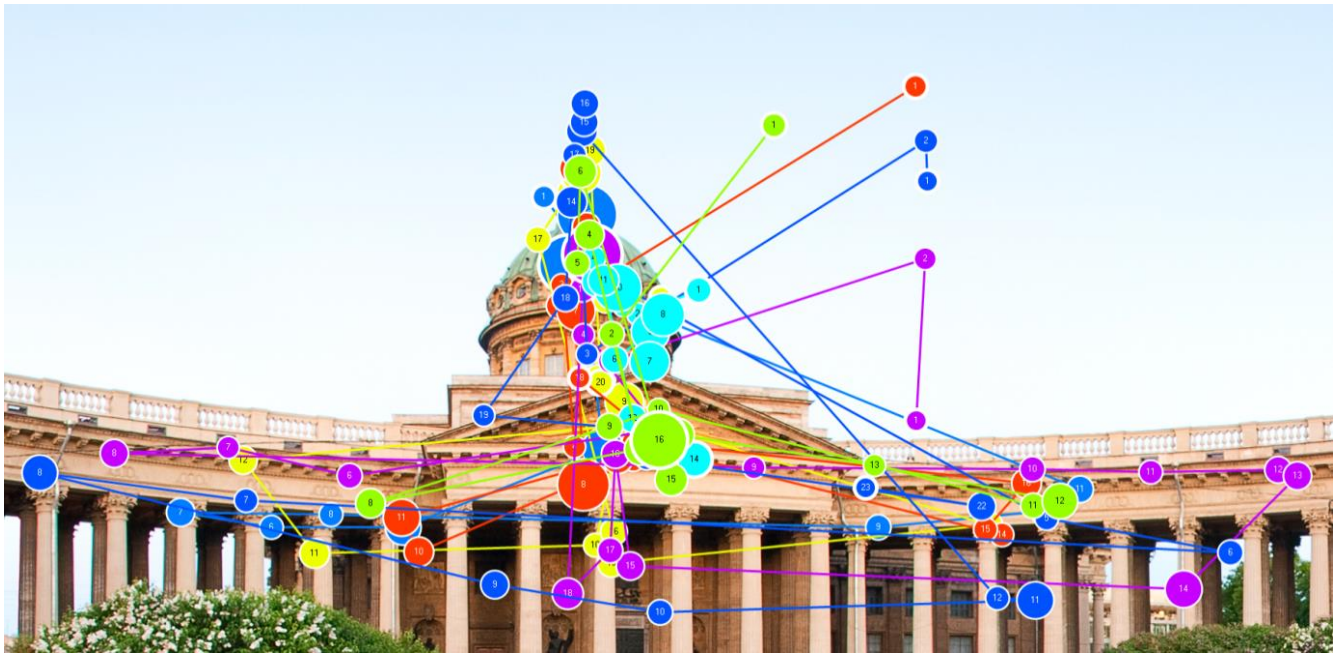

Fig. 7. Glance path looking at Kazan cathedral in St. Petersburg.

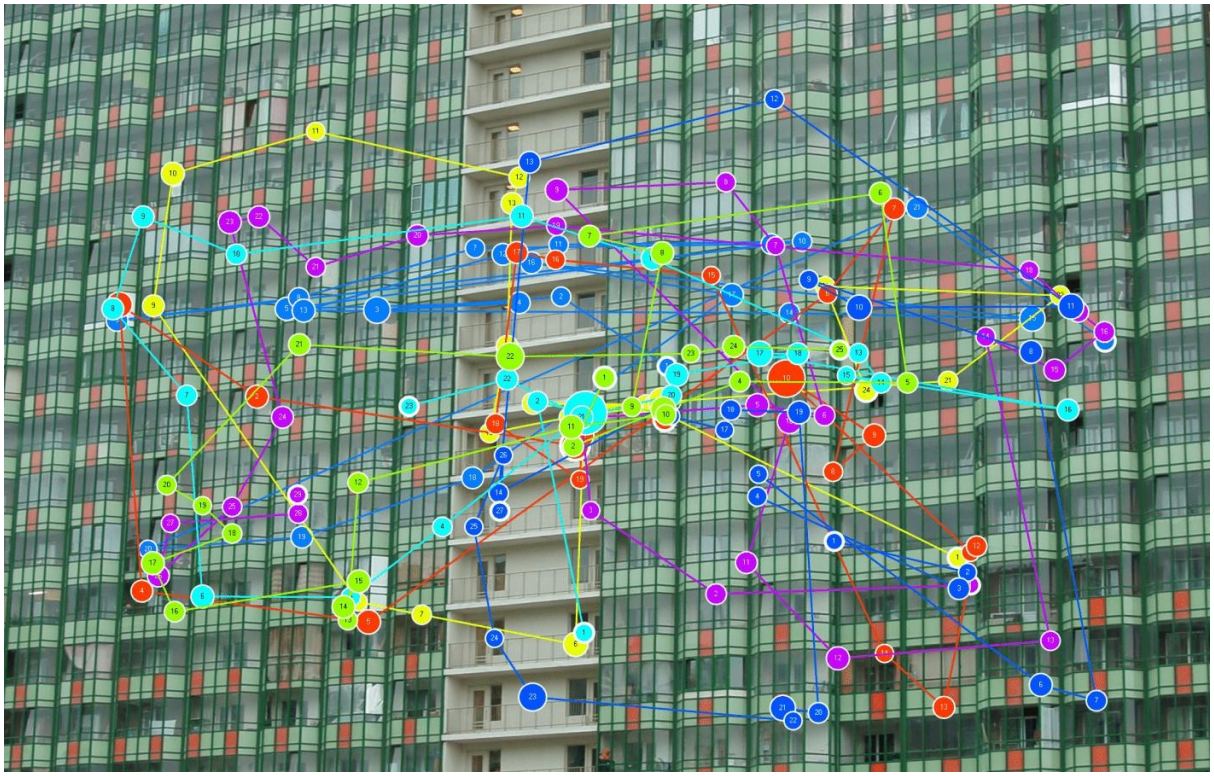

Fig. 8.Glance movements path on façade of a building in Devyatkino district, St Petersburg.

The same as figure 5, figure 8 shows unsympathetic eyes movements on the façade despite non typical forms of balconies and some elements outlined with different coloring. Glance slides on the stained glass and captures central balconies without stained glass. The following finding can be made here: the building creates aggressive environment.

5. Conclusion

Taking into account the received results, we can make the following resume about permissibility of eye tracking method usage when assessing visual safety of buildings and constructions. The following algorithm seems to be optimal:

• Selection of comprehensive quantity of photographs of the researched building or of visualized images of a projected building from different points;

• Creation a text for eye tracking method using the above mentioned images;

• Testing people in groups of 5-10;

• The results analysis according to the criteria of aggressiveness, homogeneousness, fixating ways and dots;

• Conclusion preparation with recommendations to visual safety of the object improvement.

The given method is recommended to be implemented when developing projects on urban environment renovation and also for constructions being built and for constructions being restored.

To further develop the research, revision of the presented method is planned using time scale of saccades and making time-range scales for different architecture surfaces. Also, combination of the eye tracking method with previously worked out graphoanalitical method of assessment are expected.

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Eye tracking в городской визуальной среде

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визуальное восприятие;
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здания;
экология;
городская среда;
айтрекинг;
обследование зданий;
экологический дизайн;

АННОТАЦИЯ

Экология городской среды на сегодняшний день является областью внимания не только ученых, но и всего общества в целом. Однако, рассматриваются в основном проблемы химического, физического и иных видов загрязнений окружающей среды. Впервые В.А. Филин дает объяснение связи между визуальным загрязнением городской среды и ухудшением зрения, психическим здоровьем, и другими проблемами со здоровьем. Методы визуального определения загрязнения окружающей среды в настоящее время не разработаны, либо дают неточную оценку. В данной статье рассмотрена возможность применения метода айтрекинг к оценке визуальной городской среды. Для исследования были выбраны здания с элементами агрессивной или гомогенной сред, произведен их анализ и подобран оптимальный алгоритм для оценки здания с точки зрения визуальной загрязненности.

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