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ALGORITHMS FOR THREE-POINT LIGHTING ADJUSTING FOR MONITORING OR STAGE OBJECTS CAPTURE

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Abstract: *Every scene in the filming has requirements for lighting. Standard lighting could use a three-point scheme of light sources. Highlighting the object on the background could easily be achieved if these sources are adjusted automatically by certain algorithms. There is two algorithm with three-point adjustment of light sources simulation in MATLAB.*

Key words: *Key light, fill light, back light, algorithm, scene*

Main problem – lack of model for optimized light setting in shooting or tracking object on the set. The light settings take a long time since each illuminant must be pointed and set individually. Their luminosity and direction must be tuned. The floodlights and the luminaries can be big and heavy. The problem with precise light setting can reflect on image quality when shooting. [2]

Task – Optimizing the operator and director's work on the filming set regarding the light. Knowledge transfer between one scientific area and another. (Use of some principles of radiolocation in filming industry).

Purpose – Creating an algorithm for automatic light adjustment in the scene. Facilitating the operator's work. Reducing the need of large team on the filming set.

Topicality – In the world of filming and stage lighting the three-point disposal of the light sources remains as a standard which means that the offered approach could be widely applied in a large part of the stage scenery for movies, commercials and broadcasting.

1. Introduction.

There is a need for reducing the light sources' settings when object tracking. To achieve this goal arise a need to optimize the focus settings of the lighting. [1, 2,3].

2. Stage lighting – main factor when shooting a subject. Light effect on subsequent computer processing of the captured image.

The stage lighting can be divided into several types: theater, film, lighting of buildings, interior lighting. Receiving and aesthetic effect and perception of the illuminated object can be achieved in different ways by using a special effect, implemented on preliminary set idea. Lighting is an art in itself. It can also serve to monitor an object in order to retrieve information. Each scene, which has to be created, has its own unique requirements regarding the light. For standard lighting of a typical object the photographers use three-point illumination scheme. This scheme may vary depending on the scene's specifics. This methods can be also applied in the computer animations [4, 5]. They are set as a standard when capturing people or objects.

3. Disposal scheme of Key and Fill lights

On Figure 1 is shown the disposal of **T1, T2** and **T3** lighting objects acting as a kye, fill and back lights, presented in 3D view. This is a found similarity between the disposal scheme of the light sources and radio antennas at radio holography. A knowledge transfer from radiolocation area with separated stations into the area of stage lighting. The distances between the objects are accepted as basic and are marked with **B1, B2, B3** . The distance between **T1** and the object **O** is marked with **R1**, and the projection of the distance **R1** on the plot XOY is marked with **Rpr1**. The other distances from sources **T2** and **T3** are marked with **R2** and **R3** respectively. The projections of these distances on the plot XOY are marked with **Rpr2 and Rpr3.** The key light source is with reflector, limiting the light flow at a certain angle **α1**. The angle **β1** is locked between the normal of the key flow's light source and the basis **B1**. The dropped perpendicular from the captured object to the base **B1** is marked with **h1**. The filling light is also restricted by reflectors as the beam is with angle **α2**. Angle **β2** is locked between the normal of the filling light source's flow and the base **B2**. The backlight is restricted by reflectors as the beam is with angle **α3**. Angle **β3** is locked between the normal of the back light source's flow and the base **B3**.

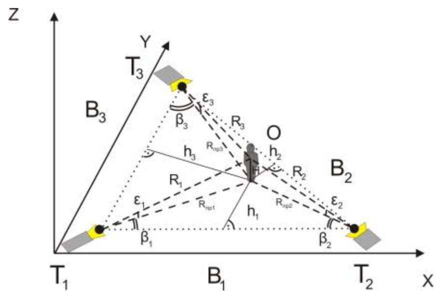

Fig. 1. 3D disposal scheme of light sources on filming scene or under object observation

On Fig. 1 is presented 3D dispoal scheme of light sources T1, T2 и T3, where: T1 – key light. Primary light source; T2 – fill light. Secondary light source; T3 – back light. Tertiary light source; B1 – basis, distance between the two spotlights T1 and T2; B2 – basis, distance between the two spotlights T2 and T3; B3 – basis, distance between the two spotlights T1 and T3; O – Monitored object. Object of observation. Captured object; R1 – distance from T1 to O; R2 – distance from T2 to O; R3 – distance from T3 to O; Rpr1 – Projection of R1 on the plane XOY; Rpr2 – Projection of R2 on the plane XOY; Rpr3 – Projection of R3 on the plane XOY; ε1 – angle between R1 and Rpr1; ε2 – angle between R2 and Rpr2; ε3 – angle between R3 and Rpr3; β1 – angle between Rpr1 and B1; β2 – angle between Rpr2 and B2; β3 – angle between Rpr3 and B3; h1 – projection of Rpr1 on the axis OX; h2 – projection of Rpr2 on the axis OX; h3 – projection of Rpr3 on the axis OX.

4. Algorithm for luminaries setting.

step1. The following data is set :

N of object, R1 – distance from T1 to the Object, B1, B2, B3 – Corresponiding basis distances, ε1 – ground anle of the main spotlight;

step2. Rpr1 = R1cos ε1;

step3. Rx1 = Rpr1.cosβ1;

step4. h1 = Rpr1.sin β1;

step5. B1 – Rx1 = D1;

step6. Rpr2 = $\sqrt{B_{1^2} - D_{1^2}}$;

step7. β2 = arctg h/Rpr2; ε2 = arctg H/Rpr2;

$$\sqrt{R^2_{np2} + H^2} = R;$$

step8. Ry3 = Rpr1.cos β3;

step9. B3 – Ry3 = D3;

step10. h3 = Rpr1.sin β3;

step11. Rpr3 = $\sqrt{D_3^2 + h_3^2}$;

step12. β3 ` = arctg h2/D3;

step13. ε3 = arctg H/Rpr3;

5. Experimental part.

Simulation on C++ environment using the given algorithms for regulation determination of the lighting sources.

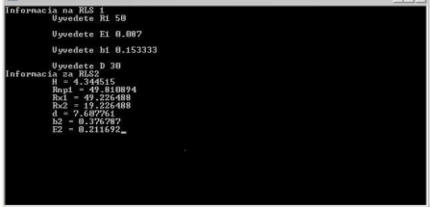

Fig. 2. Input window of a programme for part of the parameters computation T1, T2 and T3 in C++ environment

```
#include <iostream.h>
#include <conio.h>
#include <math.h>
long double
R1,E1,b1,D,H,Rnp1,Rx1,Rx2,d,b2,E2,tgb,
b2p,Rnp2;
int pro;
void main()
{
pro=0;
do
```

```
{
clrscr();
cout<<"Informacia na T1";
cout<<"\n\t Vyvedete R1 ";
cin>>R1;
cout<<"\n\t Vyvedete E1 ";
cin>>E1;
cout<<"\n\t Vyvedete b1 ";
cin>>b1;
cout<<"\n\t Vyvedete D ";
cin>>D;
```

Fig. 3. Part of the programme in C++ environment for parameter determination of the light sources

When shooting the short film “Mustela nivalis” is made experiment with setting the main light sources in scene with a green background [7,8]. Three light sources of the type QL II-1000 with a color temperature 3200K and a potential for setting the power of emitted light by power change from 100W to 1000W. On the attempt are used the following values for disposal of the light sources:

Basis – distance between the two lighting objects B1 = 10 m; Distance from the key source of light to the object R1 = 5m; Angle site (locked between R1 and the R1's projection on the plane XOY) of the key source ε1 = 10deg; Angle (locked between the projection of the distance R1 on the plane XOY and basis B1) β1=30deg; Site angle (locked between R2 and R2's projection on the plane XOY on the secondary light source ε2 = 8deg; Angle ((locked between the projection of the distance R2 on the plane XOY and basis B) β2=23deg.

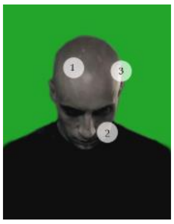

Fig. 4. Frame with using three-point light source scheme

Mainly three areas are observed on the captured object. 1 – area, lit by the key light, 2 – area, lit by fill light, 3 – area, lit by the back light. The key light is main. It creates dark shadows in the unlit part of the object. To achieve weaker shadows is applied filling lightning, in this case achieved using reflecting disk. In this approach, the fill light is carried out by reflector, which lighting power is proportional to the main source's light. To avoid unwanted infusion of the object's background a back light is used. To filter the colored background into transparent is used a suitable filter “keylight” of the company “Foundry” in software environment “Adobe After effects”. On Figure 6 is presented the final result after image processing by means of the “keylight” filter. The lack of good light setting would do the object's position unnatural in the given scene and also may cause unwanted noise and lost image quality. [4,5,6]

7. Conclusion.

The offered algorithms may be used for automatic spotlight positioning setting which may reduce the number of the staff. The idea is when setting one of the light sources (the key light) the two remained sources will be automatically set towards the object. In this way easily can be achieved object tracking.

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