TRADITION OFFERS ARTISTIC POSSIBILITIES FOR NEW MEDIA TECHNOLOGIES: AN ANIMATION SYSTEM FOR SHADOW THEATRE

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Abstract

We describe an animation system for *Karagöz*, which is a shadow theater. It is one of the most important traditional arts of Turkish culture. The animation system uses hierarchical modeling to animate two dimensional characters, like *Karagöz* and *Hacivat*. Hierarchical modelling animates the characters by using model parameters related to the different parts of the body and the joint parameters between these body parts. The system uses texture mapping to realistically render these characters since the body parts are modelled as two-dimensional polygon meshes. The animation system functions as an authoring tool creating keyframe animations, by editing the character parameters such as position and orientation for different keyframes. These animations can then be played back by reading the animation parameters from disk and interpolating between the keyframes.

Keywords: computer animation, keyframing, hierarchical modelling, texture mapping.

1. Introduction

The first performances of *Karagöz* (Karagheus), the traditional Turkish Shadow Theatre, date back to the 16th century. It was one of the most popular forms of entertainment right up until the cinema replaced it in the late 1950s. The opening of each play references a Sufi leader, Mehemmed Küşteri, as the patron saint of *Karagöz*. Legend has it that *Karagöz* and *Hacivat* were two masons working on the construction of a mosque in Bursa, then the capital of the Ottoman State. They were an odd couple, whose unending conversations were so entertaining that the other workers often stopped work to listen to them. When the Sultan learned why the mosque could not be completed in due time, he ordered that they be hanged, an order which he later regretted deeply. Seeing the Sultan in distresss, one of his advisors, Küşteri, designed an apparatus which he thought might console him. He stretched a translucent screen (*perde*) across two poles and then placed a light source behind it. He cut out two figures which resembled *Karagöz* and *Hacivat* and manipulated them behind the screen. We do not know if this really worked for the Sultan, but the story reveals another example of how art functions as a substitute for loss, an experience that is fundamental to the human psyche.

In fact, there is hardly any historical evidence of such an event. It is generally accepted that the Shadow Theatre was introduced into Turkey by the Egyptians who had adapted it from the Javanese shadow play. The masters of Karagöz, however, created their own indigenous types, stories and music. The figures, *Karagöz* (which means, perhaps referring to his Gipsy origins, Dark Eye) and *Hacivat* (albeit pretentious, a man of manners) being the most prominent of them, reflect the cosmopolitan nature of Ottoman society. *Karagöz*, like other Turkish theatrical forms such as *Meddah* and *Ortaoyunu*, plays largely on mimicry or imitation of the various ethnic, religious and regional personages inhabiting Turkey (or the then Ottoman Empire). Some examples of these are *Adjem* (a Persian), *Arnaut* (an Albanian), *Turk* (a peasant or cook), *Laz* (a person from

Black Sea Region), *Ermani* (an Armenian), *Arab*, *Yahudi* (a Jew), *Kaisarli* (a person from Kaisariye), *Kurd* (a person from South East), *Zaibek* (a peasant) and *Frenk* (a European). These were all popular figures that represented the pluralism of the Ottoman Empire. One of the sources of pleasure offered by comedy lies in language running against signification: accents and dialects, absurd rhyming, puns, and even stuttering come into play in order to invert possibilities of meaning. This may go to the limits of absurdity, which may perhaps offer further possibilities to experimental, pure and absurd theatre.

The Karagöz screen used to have a size of 2.0 x 2.5 meters, but was later reduced to 1.0 x 0.60 meters. The aspect ratio of the screen is very similar to those of cinema and television. It is a well-known fact that, in the early years of cinema, many theatre owners in Istanbul projected films on screens formerly built for Karagöz. The apparatus, however, bears more resemblance to television rather than cinema: the images are not projected on the screen, on the contrary the light source comes from behind it. When the light produced by olive oil lamps hit cut-out figures (*tasvir*) with tiny holes on the edges, the result is a flickering image, an aesthetic value which disappeared when the Karagöz operators began to use electric bulbs. The figures are made of animal skin (especially camel skin), which is smoothed out and dried under the sun and treated until it gets almost transparent. *Hayali*, the master performer of Karagöz (which means a person who is involved with the imaginary), attaches the figures to rods and skilfully manipulates them in all the possible ways. He performs all the dialogues as well as songs with some help from a *yardak* (apprentice), who plays some musical instruments to accompany him.

The mode of representation in Karagöz, which can also be observed in other traditional performance arts of the East, is in contrast with traditional narrative forms of the West. The western narrative produces a sort of classical realist text that presents itself as real, and in order to achieve this impression of reality it effaces the traces of its production. In addition, it relies heavily on character identification and exploitation of codes of reality. Karagöz, however, is non-illusory and self-reflexive in the sense that it quite often makes references to its fictitious nature, reminding the audience of the fact that what they are viewing is not real but *hayal* (imaginary). This attitude originates from the Sufi doctrine which repeatedly returns to the theme of the world as something unreal; a textual production which must be decoded in order to catch a glimpse of Truth. In addition to the opening songs and dialogues, the visual style is devoid of any impression of reality; just like the representational arts of the East, visual composition in Karagöz is innocent of perspective. It purposefully constructs a two-dimensional world that lacks depth of field, hence a total negligence of figure-background. The audience of Karagöz can side with the figures, especially with Karagöz himself, but identification is almost impossible; the visual style allows no point of view due to the positionings and movements of the figures. Finally, the play suggests its logic of representation and transgresses the diegetic boundaries: when Karagöz needs a telescope, he takes his leg off and uses it to see what is going on in the distance. This not only produces a comic effect, it also indicates that a leg can also be a telescope because it is actually not a leg but a representation of it, and any representational element can be used to represent anything.

The long-neglected tradition of Karagöz is being taken up again. Its artistic features and means of expression as described above are not yet exhausted but are open to further explorations. There is nothing nostalgic about seeking new potentialities of traditional arts. We should be prepared to witness media technologies turning to old forms in their search for new possibilities in art production. Karagöz as an apparatus may not be able to compete with the latest technologies exploited in film production and exhibition: digital dolby surround sound systems, special effects and large-screen formats seem to have formed a specific audience that would possibly be interested in specific sorts of narration only. Karagöz, however, does not require extravagant camera movements, fast editing, a full range of shot types or sound effects. As a matter of fact, its strength lies in the

economy of its stylistic devices and conventions. It should stay within the confines of a fixed frame that contains two-dimensional images devoid of perspective, and it should have a limited number of characters and settings. This does not mean that it is closed to adaptations, appropriations or diverse applications.

This article introduces a new computer software designed to accomplish the tasks described above in order to model and animate Turkish shadow play characters. It is exemplary not only in the sense that it shows how traditional forms can be adapted to new media, particularly computer and television, but also in the way that Karagöz can perhaps force the new media to develop new capabilities of artistic expression. We do not believe that one can or should restrict what awaits the multimedia artist in his/her path. Instead, the animation system offers the artist an altogether new set of possibilities that would also enable him to challenge the dominant modes of representation and forms of narration in the popular media.

The computer animation system described here uses hierarchical modelling to construct and animate two-dimensional articulated characters containing body parts and joints between these body parts. Different characters have different body parts and joints, and therefore have different hierarchical structures. Texture mapping is the technique used for rendering the characters since different body parts are modeled as simple two-dimensional polygon meshes and have a predefined texture that can be mapped to these polygons as the model animates. To animate the models, the system uses keyframing based on the model parameters of the characters. These model parameters include the positions of body parts and the angles of the joints between different body parts.

The animation system functions as an authoring tool creating keyframe animations involving the characters, by editing the character parameters such as position and orientation for different keyframes. These animations can then be played back by reading the animation parameters from disk for each keyframe and interpolating between the keyframes. The interpolated frames are rendered by using texture mapping on the characters appearing on the frame.

The rest of the paper is organized as follows: In Section 2, we describe the two main techniques that are used to produce animation, namely hierarchical modeling and texture mapping. The main data structures that are used to model and animate the characters are described in Section 3. In Section 4, we explain how the animations are produced using the animation editor. An illustration of the user interface of the system and still frames from the animations are also given in this section. Section 5 gives conclusions and describes possible future extensions to this work. Some of the characters for the shadow play can be found in the Appendix.

2. Background Work In this section, we describe the two basic techniques employed by our animation system: hierarchical modelling to model and animate articulated characters and texture mapping to realistically render them. (It should be noted that by “realistically” we refer not to the realism of the visual composition and to the narrative plot, but to the “authenticity” of Karagöz. In other words, we did not intend to reproduce reality but the reality of Karagöz.)

2.1. HIERARCHICAL MODELLING

Hierarchical modelling is a technique to model and animate articulated structures consisting of links connected by joints. Hierarchical modelling accomplishes this as follows: once simple parts of a hierarchy are defined as primitives, we combine these simple parts into more complex hierarchical (articulated) objects. The main theme of hierarchical modelling is that a group of parts (aggregate objects) can be treated just like a

primitive object. Any operation that can be performed on a primitive object can be applied to aggregate objects too [3].

To implement hierarchical modelling, the model hierarchies for different characters are defined in our system. The model hierarchies for the two main characters are given in Figure 1. To display and animate a hierarchical model, we have to apply transformations to different parts of it. These transformations, such as translation and rotation, are generally represented using constant matrices. To apply transformations to hierarchical models, we used OpenGL's matrix stack data structure [7], which has operations defined for manipulating the matrix stack storing the transformations. Moreover, it is very fast since it is implemented in hardware on Silicon Graphics workstations (Silicon Graphics is a registered trademark of Silicon Graphics, Inc.). While drawing the characters, we apply the required transformations using the model parameters, such as joint parameters. For example, when a transformation is applied to the hip, the two legs connected to it are also affected, and these may have other transformations applied to them as well.

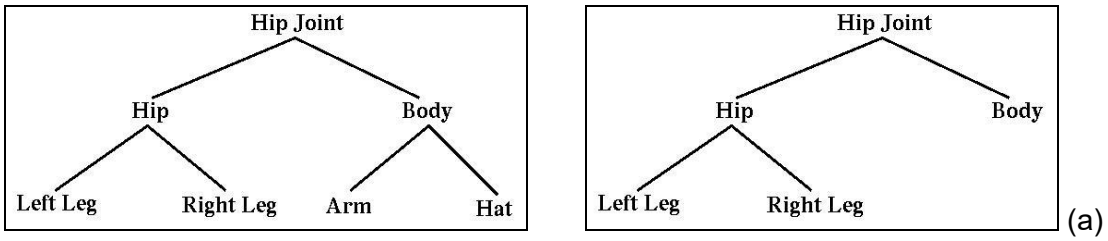


Figure 1: (a) Karagöz hierarchy and (b) Hacivat hierarchy.

2.2. TEXTURE MAPPING

Texture mapping is one of the most popular techniques to increase realism of rendered objects. It allows one to glue an image to a two or three-dimensional object, usually represented as a polygon mesh. Detailed explanation of texture mapping can be found in [5].

3. Data Structures

The data structures are defined to be used effectively for hierarchical modelling and texture mapping. The parts of the characters are modelled as two-dimensional polygons. Textures of the parts of the characters remain the same although the position and orientation of the characters change. The data structures are described below. They are given in the C programming language [6] format with some details omitted for simplicity and clarity.

The point data structure keeps the x and y coordinates of a point. A z-coordinate is stored for the global positions of the characters in the structures for keeping the character parameters.

```
typedef struct {
   float x, y;   // x and y coordinates of the point
} point, *Point;
```

The vertex data structure contains the information needed for a vertex of a polygon. The parts of the characters are subdivided into triangular polygons. We also keep the texture coordinates of the vertex in this data structure, for use in the texture mapping process.

```
typedef struct {
```

```
    point xy;     // (x,y) coordinate of the polygon vertex
    point tex;    // corresponding texture coordinate for the vertex
} vertex, *Vertex;
```

Our models use triangular polygons, which are defined using the polygon data structure containing pointers to vertices.

```
typedef struct {
    vertex vert[3]; // vertex coordinates of the triangles
} polygon, *Polygon;
```

The characters consist of movable parts, which are modelled as polygons. So, we keep a polygon for each body part and do the required initializations and settings to display the characters with their texture. Since each character has different body parts, we define a different data structure for each character. To define the models of the different characters of the shadow play, we divide the characters into body parts, then generate the polygon meshes and the texture maps for these body parts. The data structures for Karagöz and Hacivat are shown below. (In these structures, texName is the texture binding for the characters and texpic is the texture data for the character parts.)

```
typedef struct {
    GLuint texName;
    Pic *texpic;
    Polygon hat;
    Polygon body;
    Polygon hip;
    Polygon rightLeg;
    Polygon leftLeg;
    Polygon arm;
} *Karagoztype;
```

```
typedef struct {
    GLuint texName;
    Pic *texpic;
    Polygon body;
    Polygon hip;
    Polygon rightLeg;
    Polygon leftLeg;
} *Hacivattype;
```

The following data structures for the model parameters of Karagöz and Hacivat are used for producing the animations. Other characters have similar model parameter data structures.

```
typedef struct {
    float x, y, z;
    float rotx, roty, rotz;
    float bodyangle;
    float hipangle;
    float hatangle;
    float leftlegangle;
    float rightlegangle;
    float armangle;
} *KaragozParameters;
```

```
typedef struct {
    float x, y, z;
    float rotx, roty, rotz;
    float bodyangle;
    float hipangle;
    float leftlegangle;
    float rightlegangle;
} *HacivatParameters;
```

The aniparameters data structure stores information for a keyframe of an animation. If a character does not appear on this keyframe then its pointer is null.

```
typedef struct {
    int FrameNo;
    KaragozParameters karagoz;
    HacivatParameters hacivat;
    ZenneParameters zenne;
    IhtiyarParameters ihtiyar;
    GostermelikParameters gost1;
```

```
} aniparameters, *AniParameters;
```

The animation data structure stores information for an animation as a list of parameter values of different characters for the keyframes.

```
typedef struct {
   int nframes;       // number of frames in the animation
   AniParameters par;  // array of character parameters for keyframes
} animation, *Animation;
```

4. The Animation Editor

The animation system works as an authoring tool creating keyframe animations involving these characters, by editing the character parameters such as position and orientation for different keyframes. These animations can then be played back by reading the animation parameters from disk for each keyframe and interpolating between the keyframes. The interpolated frames are rendered by using texture mapping on the characters appearing on the frame.

A screen snapshot of the animation system is given in Figure 2. The user interface is divided into two main parts: the display window to display the animations and the animation editor to edit the character parameters. The animation editor has buttons to select the character whose parameters will be changed. The parameters are adjusted by moving the sliders in the animation editor and the effect of modifying the parameters on the character is displayed in the display window. The user interface also has elements to write model parameter values for a keyframe to a file, and save/load an animation file in the form of parameter values for the keyframes. A sample animation file is given in Figure 3. Each line in a keyframe definition contains the position, orientation and the model parameters, like hip angle, body angle, arm angle, etc. Figure 4 gives still frames from two different shadow plays. (Sample animations can be found in http://www.cs.bilkent.edu.tr/~gudukbay/hacivat_karagoz.html.)

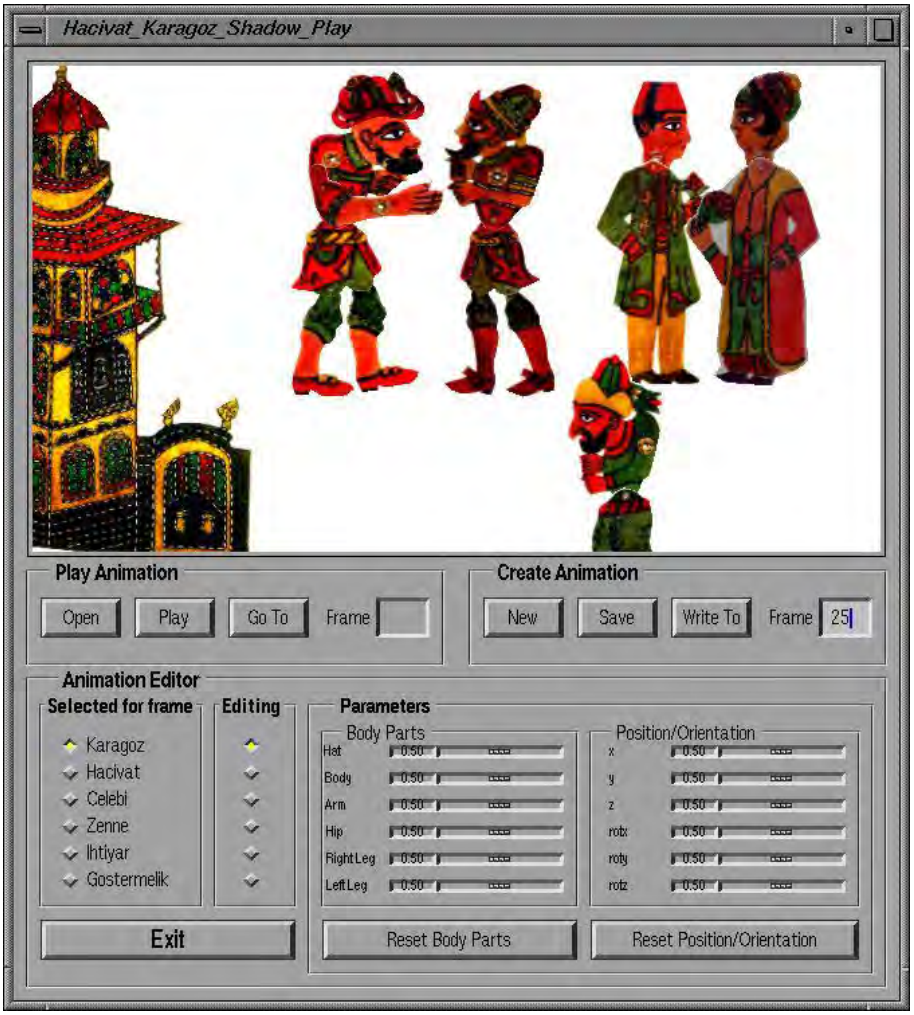
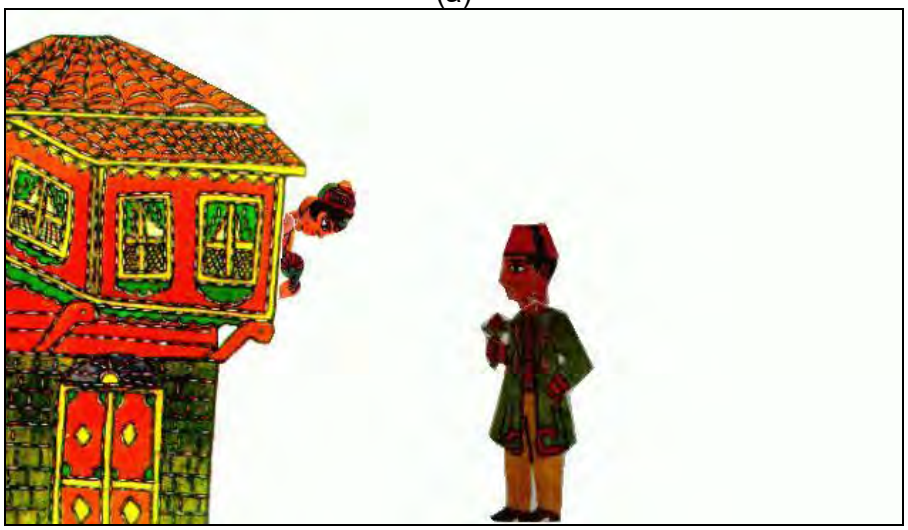


Figure 2: *The animation system user interface. The user interface has two parts: the display window and the animation editor. The display window is used to display the animations. The animation editor has user interface elements, such as buttons and sliders, that are used to produce, save and play keyframe animations.*

```
50          // number of frames in the animation
1 :         // keyframe definition for frame #1
karagoz     0 0 0 0 0 0 40 20 20 40 40 40
hacivat     0 0 0 0 0 0 0 0 0 0
celebi      0 0 0 0 0 0 0 0
gostermelik 0 0 0 0 0 0 0
;
20 :        // keyframe definition for frame #20
karagoz     0 0 0 0 0 0 60 0 0 0 0  4
hacivat     0 0 0 0 0 0 0 0 30 0
celebi      0 0 0 0 0 0 30 0
gostermelik 0 0 0 0 0 0 0
;
50 :        // keyframe definition for frame #50
karagoz     0 0 0 0 0 0 0 0 0 0 0 10
hacivat     0 0 0 0 0 0 0 0 0 60
gostermelik 0 0 0 0 0 50 0
;
```

Figure 3: A sample animation file. The animation file contains the posture definitions and locations of the characters appearing on each keyframe.

(a)



(b)

Figure 4: Still frames from two different shadow plays. (a) One of the unending conversations Karagöz and Hacivat. (b) *Çelebi* is wooing a *Zenne*.

5. Conclusions and Future Work

This paper introduces an animation system for modeling and animating Karagöz, the Turkish shadow theatre. The system uses hierarchical modeling to construct and animate two-dimensional articulated characters containing body parts and joints between these body parts. Texture mapping is used for rendering the characters.

To animate the models, we use keyframing based on the model parameters of the characters. These model parameters include the positions of some body parts and the joint angles between different body parts. After the user defines the keyframes, the system interpolates these keyframes and displays the characters by rendering them using texture mapping to produce animation.

The animation system works as an authoring tool to create keyframe animations involving these characters by editing the character parameters for different keyframes. The animations can be played back by reading the animation parameters for each keyframe from disk and then interpolating between the keyframes. The interpolated frames are rendered using texture mapping.

There are possible future extensions to this work.

1. The real shadow theater is performed by using sticks attached to different parts of the characters and these sticks are used to move the parts of the models. These sticks could be simulated by binding them to different keyboard/mouse buttons to interactively animate the models as in the real shadow theater. This may enable an operator/artist to give live performances.

2. The number of animated characters could be increased. The Appendix provides an almost complete set of characters for the shadow play. We are also implementing a hierarchy editor to add any user-defined character to the system.

3. Sound-track: Dialogue, sound effects and music are components that are crucial to Karagöz. Currently, the software does not include these features, so a sound-track must be added in the post-production stage, using a standard sound editor. A music composer, effects library and dialogue program could be integrated into the software.

Acknowledgement

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Appendix: Characters of the Shadow Play

Some of the most frequently used characters are given in Figure 5 ([1, 2, 4]). The characters are grouped according to the type of movable parts as follows.

- Characters having a movable hat jointed with head: *Karagöz*.
- Characters having a movable joint in the neck: *Çelebi*, *İmam*, *Acem*, and *Zenne*.
- Characters having a movable joint in the arm: *Karagöz*, Karagöz's son, *Tahmisçi*, *Hançerli Tahir*, *Çengi*, and *Köçek*.
- Characters having a movable joint in the waist: *Karagöz*, *Hacivat*, *Tuzsuz Deli Bekir*, *Yahudi*, *Kayserili*, *Frenk*, and *Laz*.
- Characters whose legs can move: *Karagöz*, *Hacivat*, *Tuzsuz Deli Bekir*, *Cambaz*, and *Beberuhi*.
- Stationary characters: *Cazu* and *Cihazcı*.

The personality of the characters are described below [1, 2, 4].

- *Karagöz:* Karagöz and his partner, Hacivat, are the most important and active characters. Karagöz represents the public. He is known as a brave person but is uneducated. The movable joints of Karagöz are his waist, his legs, one of his arms and his hat. Karagöz's hat, called *Işkırlak*, moves back when he hits Hacivat with his head, although it remains connected to the rear of Karagöz's head. For this reason, his hat is modeled in such a way that it can move around the joint at the back of his head. There is another joint at his shoulder that connects his arm to the body. Karagöz is sometimes seen in different forms like Lady-Karagöz, Pride-Karagöz, Donkey-Karagöz, Naked-Karagöz, and Guard-Karagöz, etc.

- *Hacivat:* Hacivat is the other important character in the play. Hacivat is a person who knows about everything. He represents the intellectual part of the society. The movable joints of Hacivat are his waist and his legs.

- *Tuzsuz Deli Bekir* (Drunkard and Braggart): He is known as a man who solves the complex problems. He is also known as the murderer of many people and represents the rude segment of the society. He usually carries a sword in his hand. He has a joint in his waist.

- *Zenne* (Lady): All women are called *Zenne* in the *Karagöz* and *Hacivat* plays. They usually have bad ethics as they live with many men. Most of them have joints in their heads. The most important ladies are the wife of *Karagöz*, *Kaynana* (Mother of *Tuzsuz Deli Bekir*), and *Kanlı Nigar*.

- *Çelebi* (Gentleman, Native of Istanbul): Always speaking clearly and politely and with an Istanbul accent, this character represents the rich, womanizer part of the society. There are two types of *Çelebi* according to their hierarchical structure: some have joints in their heads and others have joints in their waists. The ones with joints in their waists usually have umbrellas in their hands. The ones with joints in their heads usually have walking stick or flower in their hands.

- *Tiryaki* (Opium Addict): He is one of the oldest people in the play. He represents people who prefer the amusing environments in the society. There are two types of Tiryaki according to their hierarchical structure: some have joints in their waists and others have joints in their arms. The ones that have joints in their arms usually have opium stick in their hands.

- *Bebe Ruhi* (Dwarf): He is a dwarf who speaks with an Istanbul accent. He holds a big hat and represents insolent people. The character usually has joints in its legs.

- *Laz* (Man from the Black Sea Coast): This character represents the people of the Black Sea region. He is either a boatman, a wool-beater, or a tinsmith. He is impatient and talks too much. He has a joint in his waist.

- *Kayserili* (Man from Kayseri): Representing the foxy people of Kayseri region, he has a single joint in his waist.

- *Kastamonulu Baba Himmet* (Baba Himmet from Kastamonu): He represents the tall, impolite people of the Kastamonu region. He is a wood cutter and carries a large axe on his shoulder. He has a joint in his arm.

- *Muhacir* (Immigrant from the Balkans): He is either a wrestler or a carter.

- *Acem* (Persian): Representing the exaggerative Persian people, Acems are sometimes shown as riding a horse. They have a joint in their heads.

- Other Characters: Historic characters that are rarely used include the play are *Külhanbeyi*, *Zeybek*, *İzmir Efesi*, *Kambur Mehmet Efe*, *Çengi*, *Köçek*, *Cazu*, *Aşık Hasan*, *Çingene* (Gipsy), *Ferhat*, *Cihazcılar*, *Arap* (Negro), *Arnavut* (Albanian), etc. There are also some other characters who represent Istanbul minorities, such as *Yahudi* (Jew), *Ermeni* (Armenian), *Rum* (Greek), *Frenk* (European), *Çerkes* (Circassian), and *Haham*.

- *Göstermelik:* Background pictures used in the play. The examples are house, sandal etc.

Figure 5: *Some of the main characters in the shadow play. First Row: Karagöz, Hacivat, Zenne-1, Zenne-2, Tiryaki; Second Row: Çelebi-1, Çelebi-2, Beberuhi-1, Beberuhi-2, Beberuhi-3; Third Row: Tuzsuz Deli Bekir, Kastamonulu, Bolulu, Kayserili, Laz; Fourth Row: Arap Köle, Çerkes, Muhacir, Yahudi-1, Yahudi-2.*