Using the rear projection of the Socibot Desktop robot for creation of applications with facial expressions

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Abstract. This article aims to implement some practical applications using the Socibot Desktop social robot. We mean to realize three applications: creating a speech sequence using the Kiosk menu of the browser interface, creating a program in the Virtual Robot browser interface and making a new guise to be loaded into the robot's memory in order to be projected onto it face. The first application is actually created in the Compose submenu that contains 5 file categories: audio, eyes, face, head, mood, this being helpful in the creation of the projected sequence. The second application is more complex, the completed program containing: audio files, speeches (can be created in over 20 languages), head movements, the robot’s facial parameters function of each action units (AUs) of the facial muscles, its expressions and its line of sight. Last application aims to change the robot's appearance with the guise created by us. The guise was created in Adobe Photoshop and then loaded into the robot's memory.

1. Introduction
Socibot Desktop is a humanoid robot built by the Engineered Arts Company in the United Kingdom in 2014. It is presented in figure 1 [1], and its physical structure is composed of the following elements [1]:

- Integrated high-definition webcam;
- High-fidelity incorporated loudspeaker;
- 3 electrically-regulated axes at the neck level;
- Incorporated calculator;
- Integrated Infra-red depth sensor for gesture detection.
- Digital projector.

SociBot can follow simultaneously up to 12 persons using the depth sensor. The SociBot robot runs based on rear projection, using the digital projector. Expressions can be projected on the cast plastic face of the robot, each expression being created directly through the browser interface.

Pre-installed facial expressions are in concordance with FACS (Facial Action Coding System) in order to establish differences between facial expressions.

FACS is a system used to classify the movements of the human face by how they look on the face, based on the system developed by Paul Ekman and Wallace Friesen [2]. Paul Ekman, Friesen and Joseph C. Hager published an important update for FACS in 2002 [3].

Engineered Arts offers a complete content management browser-based interface and a programming interface of the SociBot. To access this interface we have to key in the url field of the
browser //sb-yyyy/, where yyyy stands for the robot serial number. If this does not work, we could try inputting the robot’s IP directly in the url field.

![Image](image-url)

**Figure 1.** Structure of the Socibot Desktop

The Socibot robot and the calculator connect to the router using an ethernet network cable. The router is connected to the Internet and also ensures access to the robot through the browser interface, as explained above.

The general connection structure of the calculator in order for the Sociobot robot to realize applications is:

![Diagram](diagram-url)

**Figure 2.** Proposed Block Diagram

The Socibot robot also integrates the facial motion capture technology through markers, using the Visage SDK marker and aiming to record in real-time the 3D position of the head, line of sight, and facial features coordinates, including mouth, chin, eyebrows contours and the closing of the eyes [1].

2. Applications using the Socibot Desktop robot

2.1. Creating a speech sequence in the kiosk menu of the browser interface

Creation of speech sequences using the Socibot robot is realized in the compose submenu of the Kiosk menu of the browser interface. The Compose submenu is used for easy and fast generation of a new sequence, using this same method. The eye graphic, cheek colours, head movements and emotional states can be over-imposed on the speech and also audio effects can be used in order to create a complete sequence. Sequences are saved from now on and remain accessible until deleted.

The sequence created in figure 3 has a duration of eight seconds and consists of the following elements: 4 audio files, 7 eye representations, 7 facial expression representations, 3 moves of the robot’s head and 7 emotional states.

The functions and icons of the Compose submenu can be identified in figure 3 and are described as:

- 1 – Audio files, eye graphic, cheek colours, head movement and aspect selection can be selected from this window;
- 2 – Timeline – Selection, slide and arrange as required;
- 3 – Start and Stop controls to run the sequence on the Socibot;
- 4 - Scrollbar Timeline – scroll buttons. We slide the cursor or press the left and right arrows to scroll through the sequence;
5 – Sequence selector – there are 10 numbered implicit sequences that can be created, but this can be extended. We press any of the numbers to select the desired sequence that we want to modify;

6 - Text-to-Speech Editor – the speech editor. Left-click on the mouse on the create button to create new speeches, or to drag already created speeches in the timeline to edit them here;

7 - Bin – the recycle bin. We drag here the animations that we wish to eliminate from the sequence. Also, we can drag a number directly from window five to delete the whole sequence.

Figure 3. Creating sequences in the Compose submenu

Figure 4. Running on the robot of the sequence created above

2.2. Creating a program in the virtual robot menu and transferring it to the Socibot robot

Virtual robot offers an integrated menu in which we can create programs to transfer on the actual robot. We can select files already installed or we could build our own program using this dynamic integrated menu for our type of robot.
Figure 5 presents the Virtual Robot programming interface. This consists of the following five important windows:
1. Menu Bar – here we can realize a few file controls and it displays the following: the name of the created file, authentication details and the IP of the controlled robot;
2. Staging area – this is the desktop. We can control the robot in this area using only the mouse;
3. Library – The library of the interface comes with preinstalled content, this being available to copy through drag and drop in the window 4 timeline;
4. Timeline – here we arrange the aspects in the order we desire. We can insert the audio components, speeches, robot head movements;
5. Inspector – here we can modify robot facial parameters, entries and the moves that we want it to make, these being displayed in real time on the desktop.

In the libraries window we can access the stored data in order to use them in the timeline sequences. When copied in the timeline, the length of the audio file or movement file will be reflected in the duration of each component as displayed in the timeline.

For the speech subclass in the libraries window we use the buttons in figure 6 to create a speech, as follows:
1. Language – we select the language;
2. Voice selection – a number of voice samples are available;
3. Voice style – some voices (especially in the US English) have optional speech modulations, for example: mood, age, character;
4. Text input – we input the speech we want in here and press “add Speech” (low-right on the desktop) to insert it in the timeline;
5. Volume – it controls the text-to-speech (TTS) component volume;
6. Speed – it controls the speed;
7. Shaping – controls the inflexion of the text-to-speech component;
8. Lipsync Gain – it controls the range of motion for the maxillary/jaw;
9. Append & Add at Marker – adds the TTS to the voice track;
10. Expand & Contract Library Area – enlarges and shrinks the library zone.
In the Inspector window we can modify: the facial parameters of the robot, its expressions, the line of sight, the head rotation etc. In figure 7 we present an example of a modification we made to the Socibot’s “Sad” expression that resulted in a change of the facial expression of the robot also in the desktop area.

The program created in the Virtual Robot menu has a duration of 62 seconds, contains 23 movements of the head, four speech sequences and one appearance of a robot. I transferred to the real robot and I captured two images shown in figure 8: one at 45 seconds and the second at 53 seconds of sequence created.

![Figure 6. The speech subclass and its functions for editing a speech](image)

![Figure 7. Correlation between the changes in the Inspector window and the desktop](image)
2.3. Creating a guise for the Socibot robot
InYaFace is a graphic 3D application, as shown in figure 9, that uses a series of facial models in order to generate images for rear-projection onto a surface of similar form to the human face. If we choose to select a new expression we click on the menu list (marked as 1), and the values of the facial units actions, AUs, change according to the facial expressions (marked as 2), and in the desktop area (marked as 3) the guise that will be projected on the robot’s face is shown.

Figure 8. Running on the robot Socibot of the program created

Figure 9. The InYaFace interface and the configuration instrument
Editing the expressions is realized as the notations in figure 10 show: to create and store a new expression, we click on the „new expression” button (marked as 1) and we input a name for the expression in the text bar (marked as 2). We can adjust the facial action units using the cursors (marked as 4). The symmetry is activated implicitly for all slides – to disconnect the action units on the left side from those on the right side, we click the yellow tab placed on the right of the cursor. Once we are satisfied with the expression, we can save or delete it (marked as 3).

The guise realized in Adobe Photoshop is shown in figure 11. This is constructed based on the model presented on the manufacturer’s website [4]. The model contains the UV positional map of the face in the model, a representation of the teeth and tongue (marked as 1), a basic layer for the face (marked as 2) and the face (marked as 3), positioned on top of all the layers. The created image has a square form and we need to save in the png format, to maintain the transparency of the positional map of the face.

If we want to project one of our guises, we can load it through pushing the green, „+” form button (marked as 3 in figure 14) and then a window will open, as shown in figure 12, where we can write the name and path of the image so that it is loaded into the robot’s memory.

To modify the robot’s guise we click the „Appearance” button, as show in figure 14, and we select a guise for it (marked as 1) from the toggle list. We can also change the color of the eyes and their size (marked as 2). In the figure 13 is shown the created guise on the Socibot robot.

![Figure 10. Editing expressions in the InYaFace interface](image)

![Figure 11. Creating the guise in the Adobe Photoshop for the Socibot robot](image)
Figure 12. Loading a guise on the robot memory

Figure 13. The display of the guise created on the Socibot robot

Figure 14. Showing the guise loaded in the InYaFace application
3. Conclusions and future works
For the first application we conclude that: the compose submenu is an intuitive one with a series of five types of files which can be combined in order to create a sequence so that we can run it on the robot. For the second application, which is more complex, we can conclude that in the virtual robot programming environment we can do the following: we can change spoken language; we can change the facial action units in order to obtain new expressions created by us, we can change the robot’s guises and we can create speech sequences. For the third application can be said to be easy to use for loading an appearance, as if inserting a file on a computer, and the design of its guises is based on a model available on the manufacturer’s website. The result of application demonstrates that Sociobot robot can project any appearance desired by the user. In the future we want the Sociobot Desktop robot to recognize our facial expressions in real time and to talk with us when it detects our presence using its camera.

4. References
[1] https://www.engineeredarts.co.uk/socibot/interface/.
[2] Ekman P and Friesen W V 1978 Facial Action Coding System: Investigator’s Guide (Palo Alto CA: Consulting Psychologists Press)
[3] Ekman P, Friesen W V and Hager J C 2002 Facial Action Coding System: The Manual on CD ROM A Human Face Salt Lake City
[4] http://robo-thespian.com/socibot/wiki/index.php/Guises.