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Portraying with Letters: An Interactive Installation

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As people became acquainted with typographic forms, letters soon began to be explored as visual shapes of their own accord. In this work, we explore the potential of typographic shapes in the development of an interactive installation that will be part of a museum's permanent exhibition about Portuguese literature. This installation employs generative design techniques to automatically create custom typographic images that combine facial portraits of the users and texts selected by them. Each portrait is made of letters strategically placed to better depict the input image. The final output image consists of a typographic portrait accompanied by a text selected by the user. In this paper, we present the computational approach behind the installation and assess it according to the museum's requirements.

Keywords: computer vision, interactive installation, generative design, graphic design, portrait, typography

1 Introduction

Letters have a key role in our society enabling the transmission and storage of knowledge. Similarly to symbols and figures, primitive letters were already used at prehistoric age such as a visual add-on to spoken language (Meggs & Purvis, 2012). The invention of movable types in western society (around the mid-fifteenth century) triggered one of the foremost shifts in human development (McLuhan, 1994; Spiekermann, 2008). Until then, to produce a book, one had to write the letters. Hereafter, this process could be mechanised and repeated anywhere and everywhere (Lupton, 2014; Meggs & Purvis, 2012). When people became more acquainted with typography, letterforms started to no longer be exclusively viewed as phonetic symbols. Consequently, many artists and designers began exploring how to assemble typographic shapes as a primary resource to create images, either by implanting new meanings in texts through the visual layout or by replicating an image.

In this paper, we explore a generative design approach for the automatic creation of typographic compositions that combine facial portraits, made exclusively of letterforms, and texts. This work is aligned with a commercial design project introduced to us by Fundação Cupertino Miranda (Portugal). They required an interactive installation to integrate a permanent exhibition dedicated to Portuguese literature, which will be installed in a continuous helical tower of ten floors located at the centre of Vila Nova de Famalicão, in Portugal. The main purpose of this installation is to allow visitors to create custom typographic compositions and this way promote a more interactive experience and a closer relationship between the exhibition and its visitors.

We present an interactive installation that works like a photo booth machine, but it only uses black typographic elements to render each photo. The interaction process is simple. First, the visitor enters a dedicated space to take a photograph of his/her face. Second, the facial photo is rendered using letterforms, thus creating a typographic portrait. Then, the visitor customises the typographic composition by selecting and adding to it one of the texts featured in the exhibition. In the end, the final composition is made available to the visitor through a dedicated section on the museum web page.

We developed a generative design process for the automatic creation of the typographic compositions. This generative process generates portraits by assembling letterforms so that their whole arrangement depicts the input facial image. The placement of the letters considers the visual features of the input image. Each letter is strategically positioned, rotated, and scaled in order to maximise the ability of the resulting portrait to recreate the input image. This generative design process also composes, in a dynamic way, each output portrait with a piece of text selected by the user.

We assess the presented installation, and the typographic compositions it creates, according to four goals identified by the museum as crucial: (i) the installation should be able to generate portraits, using only letterforms, that depict the facial features of the users, so they recognise themselves in the portraits; (ii) the user should be able to select the text that will appear with his/her portrait in the final composition; (iii) the final composition of the portrait with a text should please the user; and (iv) the interaction of each user with the installation should be fast, more exactly, not much more than one minute.

The remainder of this paper is organised as follows. Section 2 summarises related work on the automatic creation of portraits using typographic elements. Section 3 explains the behaviour of the presented interactive installation. Section 4 describes user testing on a prototype of the installation and provides the analysis of the obtained results. Finally, section 5 presents our conclusions and directions for future work.

2 Background

Over the years, several works explored the arrangement of typographic elements in order to produce layouts where the letters are assembled as an image. Poets and writers have explored this to insert expressiveness into their works. The first well-known examples date back to ancient times when some Greek poets composed his/her texts as visual shapes (Higgins, 1987). Until modern times, some authors sporadically designed similar composition (Higgins, 1987; Meggs & Purvis, 2012).

However, it is with Futurism and Concrete Poetry movements that these kinds of compositions became known. Futurist artists explored a novel disruptive layout — coined as *Parole in Libertá* — where emotional texts were designed as dynamic and non-linear compositions (Meggs & Purvis, 2012). On the other hand, concrete poets explored non-standard layouts to insert meaning in their texts (Polkinhorn, 1993). The portrait was well-explored thematic, either in its conceptual form (e.g. Fernando Aguiar's *Auto-Retrato em Forma de Soneto* (Aguiar, 1993:548)), or in its visual shape (e.g. Duarte's *Sin Título* (Gutierrez, 1993:418)). Also, modernist visual artists explored the letters' visual shape. They ignore the letter phonetic functions and handled with letterforms as visual artefacts per se. It is notable the work of cubist artists, such as Pablo Picasso, George Braque, and Fernand Léger, that used typographic elements and words as pictorial elements in their artworks

(Marcus, 1972). Similar approaches can also be seen in artworks of other artists such as Kurt Schwitters, John Heartfield, George Grosz, Iliá Jdaniévitch or El Lissítzky (Meggs & Purvis, 2012).

Although with a low status compared to the other artistic practices, Typewriter Art is one foundational reference in our research. In these artworks, letterforms were mostly used as a visual resource to design an image (Poynor, 2014; Riddell, 1975). The portrait was one widely explored subject. It is emblematic, for instance, the typed portrait of *"Queen Elizabeth"* (1953) from Dennis W. A Collins (Riddell, 1975:71). Perhaps without realising it, typewriter artists produced artworks employing algorithmic approaches. At the time, this presented a forward-looking approach, enabling everyone to reproduce an image as often as he/she would like. With the democratisation of personal computer, these approaches were transposed to digital media leading to the emergence of movements such as Radio Teletype Art or ASCII Art.

Using coding approaches, graphic designers can explore new visual and conceptual possibilities, creating systems that allow crafting one process that generates multiple outcomes, instead of crafting a singular outcome (Reas, McWilliams, & LUST, 2010). Nevertheless, in the typographic portraits' generation, these approaches are not widely explored. Most of the designers employ calligraphic or typographic processes to create typographic portraits. However, they are time-consuming processes, inapplicable for our work due to the goals defined by the museum.

Nevertheless, there are some interesting examples of computationally generated typographic portraits that should be referenced. The earliest experiences were associated with ASCII Art and appeared during the advent of the computation. *Digital Mona Lisa* (Philip Peterson, 1965) and *Studies in Perception I* (Kenneth Knowlton, 1966) are some of the first experiments in typographic portraying (Dietrich, 1986; Mezei, 1967).

More recently, in 2007, the artist Gui Borchert (Borchert, 2007) created a series of portraits with typography. The creation process of each portrait was twofold. Firstly, Borchert generated an initial mapping with a program developed with Noel Billig. Then, based on this automatic mapping, Borchert manually crafted the final design. Based in typographic portraits of Borchert, in 2008, the programmer Jeff Clark (Clark, 2008) decided to try to do something similar in a completely automatic fashion. To do so, he adapted a word-filling algorithm, that he previously developed, to automatically fill shapes with words. The resulting algorithm reconstructs the input image using words in varied colours and sizes. With this algorithm, he built, for instance, the image *Obama Word Portrait* with repetitions of the text fragments "HOPE", "CHANGE" and "YES WE CAN".

In 2016, the artist Sergio Albiac (Albiac, 2016) used a code approach to generate typographic portraits from collages of typographic textures. Users were asked to take a picture and describe themselves to the software. Their voice was automatically transcribed into text, which was after transformed and complemented with related literary and philosophical passages. The resulting texts were used to create typographic rectangular textures that were used as collages to construct the resulting portraits.

The software engineer Jonathan Feinberg, who has created the famous word-cloud layout system "Wordle", demonstrated in 2010 (Feinberg, 2010) the use of a randomised greedy algorithm to fill an input image with a set of words. In short, the algorithm places words of different sizes over the dark parts of the image in a way that minimises the space between the words. The output is a compact composition of words that well represents the original image.

Unlike the automatic design of typographic portraits, the development of template-based compositions is a well-explored field. Usually, someone develops a framework, and after the user performs the necessary adjustments to generate outputs as desired. Due to the recent trend of developing a more participative practice in Graphic Design, these kinds of compositions became even more popular (Armstrong & Stojmirovic, 2011). The installation *Productive Posters* (2008), developed by Project Projects Studio in collaboration with Kounkuey Design Initiative, enabled anyone to design posters, applying this approach. The poster's content was defined by the user (via filling blank spaces). Afterwards, he/she defined the visual style of the elements, employing pre-defined operation modules over the poster's elements (Armstrong & Stojmirovic, 2011). The installation *Poster Machine* (2013), designed by Luiz Ludwig, generated poster designs in a similar fashion. In the installation, the user could generate poster designs through the manipulation of a series of knobs and switches (Ludwing, 2013; Pelsoh, Kin, Dlugash, & Zotter, 2014).

Computer Vision techniques are sporadically used on some works with the aim of collect user/environmental data to generate designs. *Text Rain* installation, developed by Camille Utterback and Romy Achituv (Utterback & Achituv, 1999), displayed texts that respond to users' motion. The installation displays the user mirrored in a large projection screen while letters are falling. The user's body works as an obstacle whenever the letters are falling. The text displayed in the installation was a poem chosen by authors. On the other hand, *Camera Postura* installation (LUST, 2014), developed by LUST for Netherland Film Festival, used the user's gestures to generate poster designs. It achieved this by searching for scenes where a gesture similar to the user was performed in the frames of most popular movies at the festival. The matching scenes were, then, used as background in poster designs. The posters were generated by adding information about the chosen movie, e.g. title, credits, nominations, awards, etc.

3 Approach

In this work, we present an interactive installation that allows users to create compositions with their own portraits made of letters and texts by their favourite authors featured in the exhibition. The main hardware components of the installation include a computer, a camera, and a touchscreen. The camera and the touchscreen are connected to the computer and positioned in order to face the user. The camera is placed on the top of the screen.

The interaction with the installation is described as follows: (i) the user observes his/her face on the screen, in a mirror-like style, and presses a button to take a picture, when the image framing pleases him/her; (ii) a countdown of three seconds to the image capturing begins; (iii) after capturing the image, the system generates the portrait, and presents it to the user; (iv) if the portrait pleases the user, he/she selects the option to continue, otherwise, the user has the option to take a new picture and therefore going back the beginning; (v) the user selects his/her preferred text, from a preset list of Portuguese writers, that will go along with the portrait, whenever the user selects a text, the composition of the portrait with the text is updated and displayed; (vi) the user finishes the composition, and the system saves it to a database and presents a QR code for the URL of his/her portrait at the museum web page;

(vii) the user may scan the QR code at the moment or find afterwards his/her portrait in the museum web page, more precisely in a section that is dedicated to this interactive installation and that compiles all portraits it generated. Figure 1 compiles screenshots of the different interaction steps. In the following paragraphs, we detail the mechanisms behind each step.

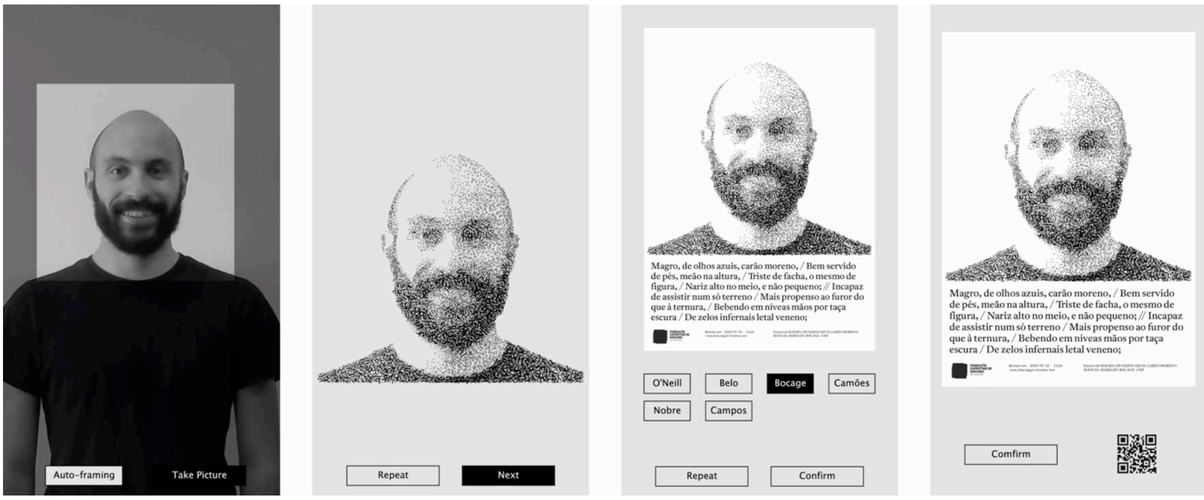

Figure 1. Screenshots of the different interaction stages. From left to right: (i) the user observes his/her face on the screen; (ii) the system presents the portrait to the user; (iii) the user selects his/her preferred text from a preset list of Portuguese writers featured in the exhibition; and (iv) the final composition is presented to the user, along with a QR code for the URL of that composition at the museum web page. A demo video of the installation can be seen at www.cdv.dei.uc.pt/portraying-with-letters.

At the beginning of the interaction, when the image of the user is being captured, we use a computational face detector to locate automatically faces in the image and, according to this, calculate the region of interest. This region includes the area of the face plus a preset margin around it (see Figure 2). This region will be rendered in the typographic portrait, while the remainder of the image will be ignored. This allows us to automatically frame the portrait to a region of interest (the faces of the users) and this way provide focus and detail to the resulting portrait where is essential. We implemented this feature to handle a different number of faces. When multiple faces are detected (group portraits), the region will consist of a smaller rectangle that encloses all detected faces. When users are seeing their image, in a mirror-like style, the region that will be rendered is calculated and shown on the screen in real time. This way, users know when a face is being detected or not, and which region of the face will be rendered in the portrait. Users have the option to turn off this feature, which is useful when users are not pleased with the region that is being calculated automatically.

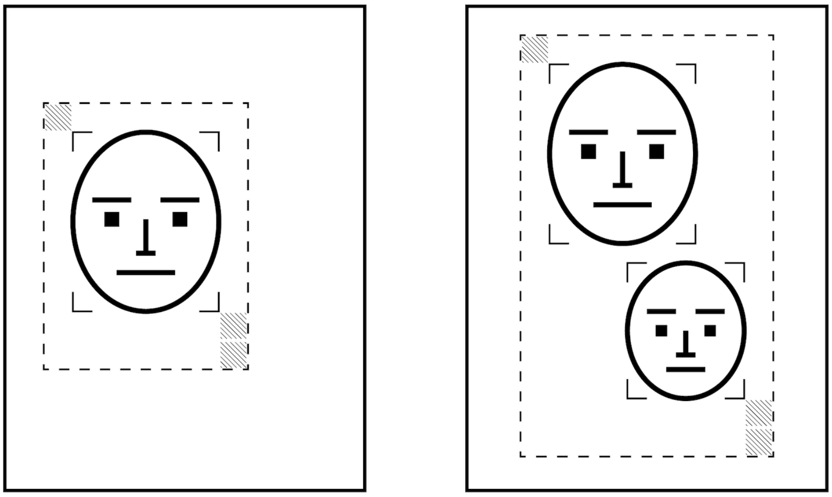

Figure 2. Calculation of the region of interest (dashed boxes) for two example scenarios according to automatically detected faces in the captured image. Each region of interest encloses the detected face(s), plus a preset margin (shaded squares).

For the portraits' generation, we have explored different approaches. This allowed us to attain results with different levels of granularity and precision, as well as different balances between the recognisability of the input image and the readability of textual content used to render the image (Rebelo, Martins, Bicker, & Machado, 2018). Together with the museum, we analysed the advances and disadvantages of each approach and selected one to continue the installation development. In this paper, we focus on the approach that will be implemented at the museum, including the user interaction with the installation and the resulting outputs.

Each portrait consists of a composition of letters that are placed over the dark regions of the input image. By varying the size and density of the letters, we are able to render different shades of grey. The process that creates a portrait from an input image comprises the following steps: (i) convert the input image to greyscale; (ii) normalise each pixel brightness according to a minimum and a maximum threshold; (iii) perform a quadtree decomposition of the image (Samet, 1984); (iv) calculate for each rectangle of the quadtree structure the average brightness of the pixels located inside it; and (v) place letters inside each quadtree rectangle according to its brightness. Figure 3 shows the image processing process before the placement of the letters, which is detailed in the following paragraph.

The positioning of letters over the quadtree rectangles is implemented so that each quadtree rectangle is rendered with a composition of letters with a more or less visual weight depending on its brightness. This way, a dark rectangle is rendered with more visual weight than a bright one.

Different levels of visual weight are attained by adjusting the following aspects: (a) number of font sizes that can be used — darker rectangles are filled with letters that can have different sizes, while brighter rectangles are filled with small letters; (b) minimum area of each letter that must be covering non-white pixels of the processed input image — greater minimum area in lighter rectangles; (c) maximum number of consecutive failed attempts to place letters while complying with aspect b — more attempts in darker rectangles; and (d) the space around each letter — lighter rectangles are filled with letters that have more space around them.

Figure 3. Processing of the input image. From left to right: image converted to greyscale; image normalised according to preset minimum and maximum thresholds; and quadtree decomposition with quads filled with the average brightness of the corresponding regions in the normalised image.

For each quadtree rectangle with brightness below a preset threshold, we calculate the aspects mentioned above and initiate the placement of letters. For each font size (aspect a), from the larger to the smaller, random letters are placed inside the rectangle at random positions with random angles until the maximum number of consecutive failed attempts (aspect b) is reached. The placement of each letter is considered successful if it covers a certain minimum, or more, area of non-white pixels of the input image (aspect c). When a letter is placed, it is drawn on the output portrait canvas in black, and on the input image in white with an outline with a thickness set to provide a certain margin (aspect d).

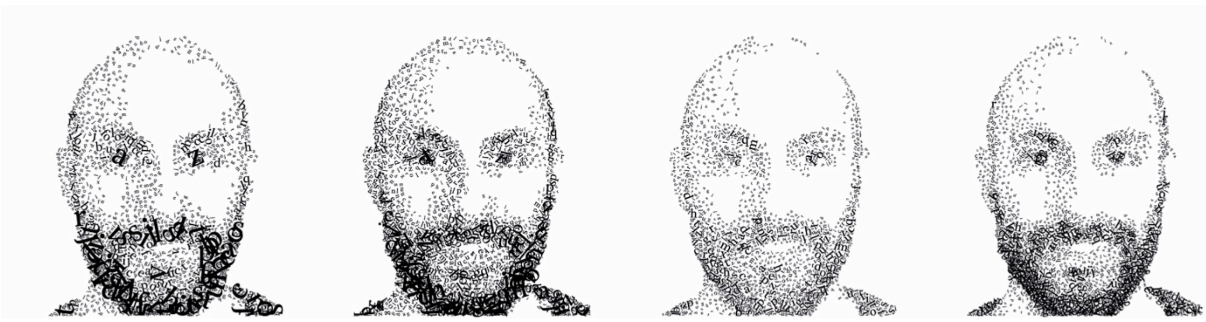

Figure 4. Portraits generated from the same input image using different configurations. The two portraits on the left have different levels of detail. The two portraits on the right have different levels of contrast.

The process that generates the portraits can be configured to attain different results. For instance, the darkness and brightness sensibility of the rendering process can be controlled by adjusting the minimum and maximum thresholds of the normalisation of the input image. This is useful to calibrate the system according to external conditions, such as the light at the installation space. Regarding the characteristics of the portraits, different levels of detail can be attained, for example, by changing the range of font sizes that can be used (larger ranges of font sizes tends to create more detail) or by adjusting thresholds of the quadtree decomposition (more quadtree rectangles tend to create more detail). The adjustment of these parameters also influences the ability of the system to reproduce smooth gradients. The contrast of the portraits can be adjusted by setting the amount of overlap between the letters (more overlay creates darker regions) and the space around them (more space creates lighter regions). Figure 4 shows a set of portraits generated from the same input image using different configurations. The two portraits on the left have different levels of detail and the two portraits on the right have different levels of contrast. Based on preliminary tests, we consider the configuration that generated the rightmost portrait in Figure 4 works better in most images. Therefore, the tests described in this paper use this configuration.

The final outputs created using the installation are compositions made of two main components: (i) the portrait of the user; and (ii) a piece of text selected by the user. Also, they present complementary technical information. The components are placed on outputs through a template-based layout. The portrait is placed on the output's upper section and fulfils most of the available space. The text is placed following. In the end, technical information is placed in the output's bottom section. Figure 6 display some typical outputs.

The texts available in the installation are selected by the exhibition’s staff and may change over time. Accordingly, these texts are inputted dynamically in installation, through the placement of text files in a specific folder on file. The texts should be provided with section cutting marks, i.e. special characters that identify the text's sections. These marks are used to compose the text automatically on the output.

When the user chooses one text, it is presented immediately in output. This is achieved by a method that permits the automatic composition of a text in a rectangular area of varied dimensions. This method is described as follows. First, it subdivides the text according to the section cutting marks. Next, it composes, line by line, the text according to default font size and baseline height. If the section does not fit in the remaining space, the system, incrementally, downsizes the font size (and, consequently, the baseline height) until the section fits. It tries to compose the next section until the text is composed at minimum possible font size or it not possible to place the next section in the remaining space. When this occurs, the system keeps the last best arrangement achieved. Line and paragraph breaks are replaced by special characters in order to uniform the texts. By default, the system uses the slash (‘/’) to identify a line break and the double slash (‘//’) to identify the paragraphs. Similarly to portraits' generation method, text composition method can be configured to attain different results.

Also, the outputs present some technical information about the installation, their generation, and the museum. These pieces of information always have the same position, arrangement, and visual style. They consist of: (i) the portrait code and the permalink for the web repository where the image can be downloaded; (ii) the date and hour where the image is generated; (iii) the text title, author and date; (iv) the logotype of Fundação Cupertino Miranda.

Each output is automatically stored, after its generation, in a database linked to the museum web page. The user can obtain the output scanning the QR code displayed at the end of his/her interaction. Furthermore, the user can find the output, later, accessing to museum web page and looking for it in a special section. Herein, the outputs are organised by date to aid users in finding a specific one. After locating it, users can download a digital version or order a print-on-demand copy. Since the outputs are exported as vector graphics, they can be applicated in different kinds of media.

4 Testing

We tested the presented installation with users in order to assess to what extent it accomplishes the goals identified by the museum as crucial (see Section 1). We have set up a functional prototype of the installation at our laboratory and invited people who were passing through to test it (see Figure 5). This way, we tested the prototype with 44 users. Most of the users were students and professors of the bachelor and master's degree in design and multimedia.

Figure 5. The prototype being tested by users.

Each test began with a brief introduction to explain to the user the purpose of the installation. Then, we asked the user to experiment with it in order to generate his/her own typographic portrait. Also, we informed the user that he/she could create different portraits until he/she appreciates the output.

In each test, we measured (M1) the number of portraits generated and (M2) the time the user took until a satisfying output was attained. In the end, we asked three questions to the user: (Q1) "How much do you recognise yourself in the portrait?"; (Q2) "How much do you appreciate the final composition?"; and (Q3) "Would you like to make any comment on the installation or on the generated output?". We asked the user to answer Q1 and Q2 with an integer number between 1 and 5. The numerical results obtained from the 44 tests are listed in Table 1. We calculated the average and the median of the results for M1, M2, Q1 and Q2. We set side by side the average and the median in order to analyse the tendency of the results and how skewed the data is.

Table 1. Results of the 44 users who tested the interactive installation.

Variable	Average	Median
Portraits created (M1)	1.3	1
Interaction time (M2)	1m 16s	1m 2s
Recognition (Q1)	4.4	4
Satisfaction (Q2)	4.6	5

Analysing the visual results, one could say the portraits generated are able to (i) depict distinct facial expressions and (ii) render high contrast features and continuous transitions from darker to lighter areas present in the input images. Some typical outputs created by different users are shown in Figure 6. One can access all outputs created during the tests session (in raster and vector format) at www.cdv.dei.uc.pt/portraying-with-letters.

Comments made by some users when they were asked question Q3 were valuable to identify aspects that can be improved. Most comments were related to the step when the user selects one text by a Portuguese writer. For instance, users mentioned that (i) the selected text should somehow influence the portrait; (ii) the variety of texts is too small, and suggested that this could be solved by providing more writers or selecting a random part of one text of the selected writer; and (iii) the writer selected by default should be random rather than the first one.

In more general terms and based on the observation of the users during the tests, we can say that all users had no major issues in using the installation to generate portraits. In other words, they were able to operate the installation without any external help. We consider therefore the installation interface is able to guide the user through the steps required to obtain an output. Another general comment goes to the enthusiasm observed on most users, who enjoyed the experience of creating, seeing, and recognising their own portraits made of letters.

Figure 6. Typical outputs generated by different users. More results can be visualised at www.cdv.dei.uc.pt/portraying-with-letters.

These tests also allowed us to assess some technical parts of the installation, namely the performance of the mechanism that automatically detects and crops the face(s) of the user(s) when the camera is capturing them. Despite the diversity of faces the installation was tested with, the face detection mechanism performed well, detecting all faces during most of the time.

As mentioned above the outputs are also exported as vector graphics. This way, the visitor can buy a print version of the output in the museum store. Also, this allows the use of outputs (or part of them) in various kind of media, with varied sizes and formats, always ensuring high quality in the resulting prints. To validate this scenario, we designed some visual applications wherein the output, in whole or in part, is the main visual element. Some results are displayed in Figure 7.

Figure 7. Some print designs created using outputs. Postcards created from the outputs (left) and staff identification badges where the photograph is replaced with a typographic portrait (right).

5 Conclusions and Future Work

We have presented an interactive installation to integrate a permanent exhibition dedicated to Portuguese literature. This installation creates custom typographic images that combine facial portraits of the users and texts featured in the exhibition. We employ a generative design process to generate each portrait by strategically placing letterforms in order to depict the input image.

We conducted user testing sessions to evaluate to what extent the installation accomplishes the museum requirements. We tested a functional prototype of the installation with 44 users. In each test, we studied the user interaction and appreciate the quality of the outputs from the users' point of view. The tests unveil that most of the users recognised themselves in the portraits and highly appreciated the outputs. The average time of user interaction was 1 minute and 16 seconds, which is a value that complies with the requirements of the museum.

Future work will focus on: (i) improvement of the installation according to users' feedback obtained from the testing sessions; (ii) performing further tests on the installation when it will be working at the museum with the ideal hardware and lighting conditions; and (iii) testing the installation in the creation of portraits of multiple persons.

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