▶ Typographic shapes are no longer exclusively phonetic symbols. Over the time, they are also explored as a graphical object per se, by several artists and designers. An approach that is set to increase even further with the democratisation of the computer and desktop publishing tools. In this work, we seek to develop text composition shapes as images, particularly as portraits. This goal is aligned with the development of an interactive installation to integrate a permanent exhibition dedicated to Portuguese literature. This installation aims to involve the audience in the exhibition allowing visitors to create their portraits composed of typographic elements.

We conducted three experiments to test different approaches towards the creation of typographic portraits. In all experiments, we map the darkness of the input image into typographic structures with more or less visual emphasis. However, each experiment explores a different composition mechanism. In the first experiment, we implement a text compositor where each glyph changes its weight dynamically to create images with different shades of grey. In the second experiment, we implement a partitioning algorithm to create images consisting of an adaptable layout of words. In the third experiment, we implement an approach where glyphs with different sizes and densities are positioned to create different shades of grey.

The obtained outcomes demonstrate that it is possible throughout generative processes to create typographic compositions where typography is not only a communication tool, but it can also be shaped as an image.

Typography as Image: Experiments on Typographic Portraits

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KEYWORDS
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Tipografia como Imagem: Experiências no desenvolvimento de retratos tipográficos

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DESIGN GENERATIVO, INSTALAÇÃO INTERACTIVA, RETRATO TIPOGRÁFICO, TIPOGRAFIA

▶ Ao longo do tempo, as formas tipográficas deixaram de ser apenas símbolos fonéticos e começaram a ser exploradas como símbolos gráficos por designers e artistas. Uma prática que tem prosperado com a democratização do uso do computador e das ferramentas de *desktop publishing*. Assim, neste trabalho, exploramos as características visuais da tipografia com o objectivo de criar composições textuais que se assemelham a retratos. Este trabalho resulta do desenvolvimento de uma instalação interactiva para integrar uma exposição permanente dedicada à literatura portuguesa, que tem como principal objectivo envolver a audiência da exposição permitindo a cada visitante criar o seu retrato usando elementos tipográficos.

Desta forma, desenvolvemos três abordagens diferentes para produzir retratos tipográficos. Nas três abordagens, a luminosidade de uma imagem inicial é mapeada em um ou mais elementos tipográficos com ênfase visual variável. Contudo, cada abordagem utiliza um mecanismo de composição diferente. Na primeira abordagem, implementamos um compositor de texto onde cada glifo muda dinamicamente o seu peso, criando imagens com diferentes níveis de cinzento. Na segunda abordagem, desenvolvemos um algoritmo de particionamento que permite a criação de retratos através da composição adaptável de palavras. Na terceira abordagem, implementamos um sistema onde glifos com diferentes tamanhos e densidades são posicionados para criar diferentes níveis de cinzento no retrato final.

Os resultados obtidos revelam que, através de processos generativos, é possível criar composições tipográficas onde a tipografia não é apenas uma ferramenta de comunicação, mas é também uma ferramenta para "desenhar" imagens.

Introduction

The history of typography is both a share of the history of our society and our culture. When Johannes Gutenberg has presented, to the West, the movable types system and printed the first typographical book (c. 1450), he also triggered one of the greatest advances in human social development that shifted society's boundaries (McLuhan, 1964; Meggs and Purvis, 2011). From then on, typography has achieved the key role in social communication. Transmitting, storing and documenting knowledge has been further simplified and it could be repeated everywhere and anywhere (Spiekermann, 2008). Accordingly, knowledge spread rapidly, and literacy increased — changing the way people dialogue (Meggs and Purvis, 2011).

Typography has become an essential resource employed by graphic design to communicate (Lupton, 2014). As a key part of graphic artefacts, it is also subject to the *zeitgeist*, reflecting the "taste of the period" and the technological development of the time (Ambrose and Harris, 2006). However, typographic forms are increasingly part of daily life and are no longer exclusively used as phonetic symbols. In this sense, graphic designers are exploring the composition of text layouts where the graphical shape of the text is the central feature.

It is with the Modernist art movements, in the first half of the twentieth century, that the visual shape of the letter is, definitively, separated from its phonetic function. Cubist artists, such as Pablo Picasso, George Braque, and Fernand Léger used, sometimes, typographic elements and words as pictorial and decorative elements in their artworks (Marcus, 1972). Futurist artists rejected "harmonious design" and proposed a novel typographical layout, coined as *Parole in Libertá*. Through this, the futurist artists created explosive and emotional poetry, marked by a dynamic and non-linear composition and by the expressive use of the words (Meggs and Purvis, 2011). These artistic experiments influenced subsequent artistic movements and typography continued to be explored as a pictorial element by artists. It is examples of the artworks of Kurt Schwitters, John Heartfield, George Grosz, Iliá Jdaniévitch, El Lissítzky, among others.

Furthermore, poets and writers have always explored the potential of the typographic layout to insert expressiveness into their works. For instance, the "*pattern poetry*" from the Greek poet Simmias of Rhodes (c. 33 BCE) or the book *Calligrammes* (1918) from Guillaume Apollinaire (Meggs and Purvis, 2011). However, it is with concrete poetry movement that some of the most interesting works are produced, where textual meaning is also generated through text composition (Polkinhorn, 1993). Besides that, during this artistic movement, the portrait thematic was explored 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)).

The Typewriter Art, sometimes linked to Concrete Poetry, is also an interesting exploration of typographic composition as an image. These artworks are often extremely pictorial and explored the portrait as one of their main subjects (Poynor, 2014; Riddell, 1975). It is emblematic, for instance, the portraits of "*Queen Elizabeth*" (1953), "*Churchill*" (1951) or the "*The Duke of Edinburgh*" (1957) from Dennis W. A Collins. Other artists that also explored this type of composition were, for instance,

Will Hollis, Zoran Popovic, Iqbal Fareed, Robert Morgan, Paul de Vree and Klaus Peter Dencher (Riddell, 1975).

Although Typewriter Art artworks were produced using a typewriter, the artists, perhaps without realising it, were employing algorithmic approaches. This presented something entirely new, at the time, long before the democratisation of the computer tools enabled everyone to reproduce images at any time and as often as they would like (Neill, 1982). With the introduction of the digital technologies, these approaches were appropriated by digital media creating artistic movements, such as the Radio Teletype Art or the ASCII Art (Stark, 2000). *Bob Neill's Book of Typewriter Art* (1988) is a good example of this, since it was sold with a program for Commodore PET that produced a printout of a portrait of *Prince Charles*.

Since the 1980s, with the release of the personal computer and the subsequent democratisation of the publishing tools — the so-called Desktop Publishing revolution —, the use of typography as visual shape has become even more common (Blauvelt, 2011; Licko and Vanderlands, 1989). Nowadays, graphic designers have increasingly adopted coded approaches in their practice to explore new visual and conceptual possibilities, thus affecting typography and layout design (Bohnacker et al., 2009). These generative systems allow designers to craft the process instead of crafting the singular outcome (Reas, McWilliams and LUST, 2010). In other words, the concept is translated into a computational program that systematically produces numerous instantiations of the original concept.

In this work, we seek to develop typographic compositions that resemble portraits. This goal is aligned with a real design project, where the idea is to develop an interactive installation that will integrate a permanent exhibition dedicated to Portuguese literature. Several designers have explored the use of calligraphic/typographic processes without using coding approaches, i.e. they generate each outcome through an individual, customized and unique process. However, the requirements for this installation will allow the visitor to create and see their own portraits composed of typographic elements. In this sense, an automatic approach is required. In this paper, we explore three different approaches to create typographic portraits. This way, each approach can be seen as a prototype for the system of the installation.

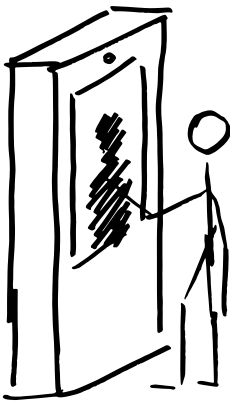

Figure 1. Sketch of the interactive installation aimed to produce typographic portraits of the audience.

The installation that allows visitors to create their own typographic portrait consists in a box with a touchscreen and a camera, on top of it, connected to a computer, which is hidden inside it (see Figure 1). The interaction between the visitor and the installation is simple: (i) the visitor approaches the interactive display; (ii) presses a button to take a picture; then, (iii) the system generates and presents to the visitor a typographic portrait produced from that picture. During the image capture, a computational face detector is used to automatically crop the image to the face(s) captured by the camera. Each typographic portrait is identified with a unique code that allows the visitor to download and share it with anyone.

The remainder of this paper is organised as follows. Section 2 presents the related work with the focus on the approaches of the automatic generation of portraits using typography. The following three sections describe the different experiments that we conducted in this research. In the three experiments, we create typographic portraits with text, words, and glyphs, respectively. In each experiment, we describe the approach explored and the results obtained with it. Finally, section 5 summarises our work and presents future research directions.

Related Work

In 1964, Philip Peterson created the work *Digital Mona Lisa*, a digital representation of the painting Mona Lisa by Leonardo da Vinci. Peterson scanned and transformed the original painting into digits with a computer and printed out the resulting image with a mechanical plotter (Mezei, 1967). The Digital Mona Lisa is composed of approximately 100.000 square cells. Each cell contains a pair of decimal digits whose magnitude is proportional to the average darkness of the corresponding area in the original painting. The typeface used to print the digits was designed by Peterson in order to visually emphasise the digits with bigger magnitudes by making them darker. By using this typeface, Peterson was able to produce 100 shades of grey (Peterson, 1965).

In 1966, the computer scientist Kenneth Knowlton and the artist Harmon developed an automatic method to create digitalisations of images. With this method, they produced the image *Studies in Perception I*, a precursor work in image processing and probably the first computational nude (Dietrich, 1986). In short, the original photography was digitalised and converted to a composition of electronic symbols (Beddard, 2009). For each value of the digitalisation, an electronic symbol is randomly selected by the computer from a preselected set of symbols that represent the corresponding brightness level (Rosen, 2011). The final composition of symbols was then printed with a microfilm plotter (Dietrich, 1986).

In 2007, the artist Gui Borchert (Borchert, 2007) created a series of portraits with typography. The creation process of each portrait is 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.

In 2008, the programmer Jeff Clark (Clark, 2008), who was interested in the generation of tag clouds, stumbled upon one of the typographic portraits by Borchert and 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 various 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 2009, to promote the 51st Annual Grammy Awards, the advertising agency TBWA\Chiat\Day produced a series of posters featuring typographic portraits of a variety of musicians. The depicted musicians were asked to name 10 to 20 of their favourite artists and songs that have influenced them in any way. This information was then embedded in their typographic portraits.

In 2016, the artist Sergio Albiac (Albiac, 2016) used code 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 is then transformed and complemented with related literary and philosophical passages. The resulting text is used to create typographic rectangular textures that are 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.

Experiment I – Text

Setup

In the first experiment, we explore an approach based on ASCII art. We developed a system that composes an input text using glyphs that change their weight to depict an input image. The text is composed in a rectangle that is proportional to the image. The weight of each glyph changes dynamically according to the average brightness of the corresponding area in the input image. A glyph positioned over a dark area of the image has a greater weight than a glyph positioned over a lighter area.

The system behaves as follows. The input image is converted to greyscale. Then, we calculate the brightness value of each pixel and normalise it according to a minimum and a maximum threshold. These two thresholds allow us to adjust the darkness and brightness sensibility of the system, which may be useful to calibrate it according to external conditions, e.g. light at the installation space. After calculating the brightness values of the image, the system composes the input text, from left to right and from top to bottom, in a rectangular area proportional to the input image. For each glyph, the system calculates the average brightness of the pixels that are located inside the area occupied by that glyph. This average brightness determines the typographic weight of the glyph. A glyph that is positioned in a darker area of the input image will be thicker than a than a glyph positioned in a lighter area. The system does not hyphenate words. Therefore, when a word is cut by the right limit of the text area, the system moves that word to the next line.

This experiment requires a type family with several weights to be able to represent different shades of grey. This necessity led us to employ a type stencil evolved with *Evotype* (Martins *et al.*, 2018), a system that automatically evolves stencils to draw letters. By using a stencil generated with *Evotype*, we are able to draw the same letter with as many weights, i.e. thickness, as we want (see Figure 2). This continuous range of typographic weights allows the creation of different shades in the typographic portraits.

Figure 2. Type stencil evolved with *Evotype* (left) and letters drawn with it using different thicknesses (right). See (Martins *et al.*, 2018) for more details.

The system developed in this experiment can be configured at different levels. We can change, for instance, the number of text lines, leading, space between glyphs, width of the glyphs, and minimum and maximum thickness of the glyphs.

Figure 3. Photo of João Cunha (CISUC) that is used in this paper as input image to create typographic portraits.

In the three experiments of this work, we use as input image one photo that we took of one lab mate of ours (see Figure 3). Regarding the input text that is used, in this first experiment and in the second one, we use the poem "*Eu Nunca Guardei Rebanhos*," written in 1914 by Alberto Caeiro, an *alter ego* of Fernando Pessoa.

Results

We tested different configurations of the system to assess to what extent the input image remains recognisable in the typographic portrait and to analyse how each parameter affects its visual properties. Figures 4 and 5 show typical portraits created in this experiment.

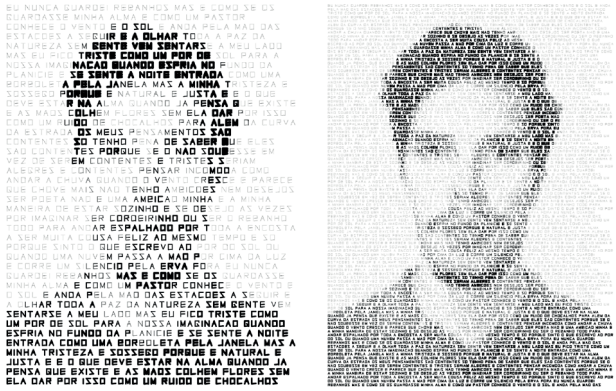

Figure 4. Typographic portraits created in experiment I with 40 (left) and 100 (right) text lines.

Based on the portraits created in this experiment we consider they are able to represent the input images. Regarding the impact of each parameter on the portraits, we can say, for instance, that: (i) increasing the number of text lines provides more detail to the portrait (see Figure 4); (ii) decreasing the leading and/or the space between the glyphs makes the portrait visually more dense; (iii) increasing the difference between the minimum and maximum thickness of the glyphs provides more contrast to the portrait; and (iv) setting the width of the glyphs to a fixed value creates portraits composed with monospaced glyphs (see Figure 5).

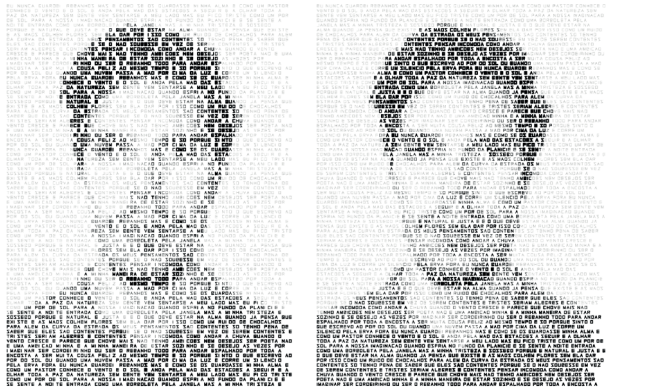

Figure 5. Typographic portraits created in experiment I with the width of the glyphs fixed (left) and not fixed (right).

Comparing the two portraits of Figure 5, one can see that when the width of the glyphs is fixed (portrait on the left) the portrait displays many gaping holes and rivers of white space across the text lines, which are more noticeable at the darker areas. These spaces are not visible when the width of the glyphs is not fixed (portrait on the right). This is due to the greater probability of horizontal alignments of white spaces when a fixed width is used. This way, portraits composed of glyphs with not fixed width perform better in the representation of the input image.

We think some typographic details of the portraits could be refined. For example, it would be interesting to have a mechanism that automatically moves orphans, at the end of each line, to the next line.

Experiment II – Words

Setup

In the second experiment, we explore the creation of typographic portraits through the design of a composition of words, i.e. the words are composed in order to fulfil a well-defined region of a picture (normally a face). Therefore, the system produces black and white outcomes where the brightness of the original image is represented through the size, weight and density of the composed words. We were only focused on the exploration of the layout defined by the words. In this sense, we decide to not explore the use of other visual variables (e.g. colour, contours, etc.). Even though these variables could contribute to increase the level of detail of the portrait, they also could blur the expression of the words in the composition.

The system behaves as follows. First, the system pre-processes the input image to create a sharper image. It turns the image into a greyscale image and thereafter it applies a threshold filter to define the composition's interest region, i.e. the space in the image where the words will be composed. Next, the system subdivides the image through the calculation of a quadtree (Samet, 1984) according to the uniformity of the brightness in the pixels of the corresponding area of the image. The resulting quadtree is, after, simplified through the elimination of the white uniforms quads and the junction of the contiguous areas (both vertical and horizontal) which the same size and/or similar brightness average values (see Figure 6). This information is used to define the position of the text boxes that will construct the portrait. Moreover, each quad has orientation information allowing the placement of words in a vertical and horizontal way.

The process of composing the words can be defined as follows. From a set of pre-loaded typefaces in the system (with information about its density and weight), the system looks to the average brightness of the quad and chooses the corresponding typeface. It uses thin and extended typefaces in lighter quads, and heavy and condensed typefaces in darker quads. Subsequently, the system chooses a word and calculate the font-size in order to fit the words in all the width of the text box. If for any reason, it cannot make the word fit along the whole quad width, recursively, it adds other words until the quad is fulfilled. This process is repeated until all spaces, in the textbox, are fulfilled, reducing the font-size until no longer white spaces exist in the quad.

Figure 6. Quadtree of the input image (left); Outcome after of simplification process (middle); and the same quads filled with the average brightness of the corresponding area of the input image (right).

All system settings are parameterised and may be redefined in order to achieve different results.

Results

Based on the experimental results, we consider the system is able to generate typographic portraits where the main characteristics of the original image and fragments of the text (i.e. words) are recognisable. Figure 7 display two typographic portraits generated using two different range values during the process of junction of contiguous quads with similar brightness average values.

The quality of the result dependents on the typeface used in the rendering of images. In this experiment, visual properties such as the contrast or the readability are defined by the typefaces used by the system. To achieve good outcomes (i.e. typographic rendered images where the face of the user is distinguishable) we need to load, in the system, typefaces with different levels of density and weight. Layouts composed with typefaces with low weight ranges create less distinguishable compositions and vice versa (see Figures 7 and 8). Therefore, large typographic families (Lupton, 2010), such as *Titling Gothic FB* or *Interstate*, have a good performance in this experiment.

Figure 7. Typographic portraits created by experiment II configured with different range values during the process of junction of contiguous quads with similar brightness average values. The left image presents a wider range value and the right a closer ranger value. Image rendered using the Titling Gothic FB Family, designed by David Berlow and published by Font Bureau (2005).

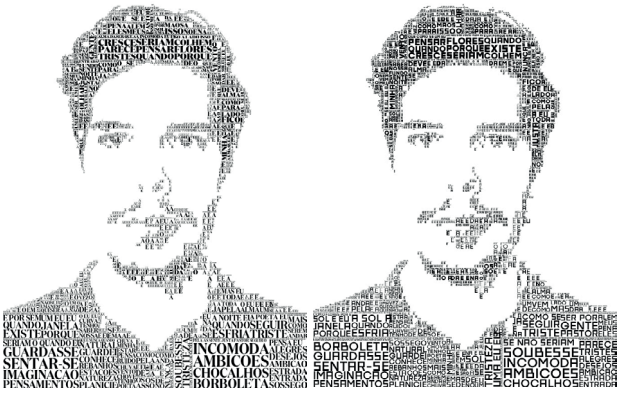

Figure 8. Typographic portraits created using different typography typefaces. Left: Domaine Text designed by Kris Sowesby and published by Klim Type Foundry (2013). Right: Stolzl Display designed by Mariya V. Pigoulevskaya and published by The Northern Block Ltd (2015).

We think some details in the generation of the portraits can be refined. For instance, the system should be able to recognise expressions in the text and compose them as a word. Besides that, the experiment's generation process can be time-consuming and, therefore, less responsive for the user.

Experiment III – Glyphs

Setup

In this last experiment, we explore an approach that is more chaotic in comparison to the previous two experiments and, at the same time, is able to resemble more the input image. The first experiment is about text. The second one is about words. This last experiment is about a smaller element, the glyph. The idea is to create portraits as compositions of glyphs that are positioned over the darker parts of the input image. The variation of the size and density of the glyphs create different shades of grey.

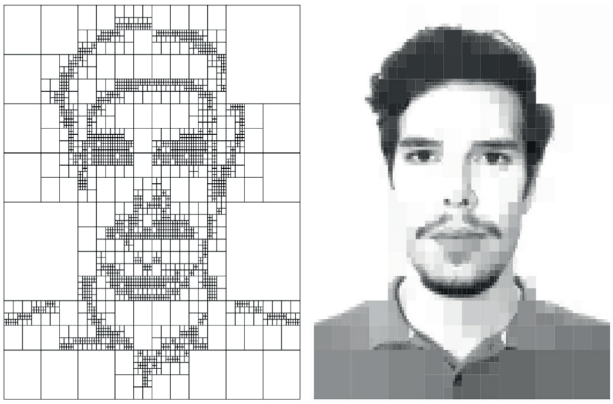

Figure 9. Quadtree of the input image (left) and the same quadtree with its quads filled with the average brightness of the corresponding area of the input image (right).

Similar to the second experiment, the generation process of typographic portraits begins with the calculation of the quadtree of the input image and the average brightness of the corresponding area of the image (see Figure 9). This information is used to regulate and focus the positioning of glyphs that construct the portraits. Each quad of the quadtree is filled with, more or less, bigger or smaller, glyphs according to its brightness level. A lighter quad is filled with a few small glyphs, while a darker quad will be filled with more glyphs with varied sizes.

The mechanism that places glyphs in each quad can be described as follows. If the brightness of the quad is below a predefined threshold, we initiate the placement of glyphs in the quad. Otherwise, the quad is ignored, and no glyphs are placed in it. According to the brightness of the quad that is being filled, some aspects are determined: (a) the number of font sizes that can be used — darker quads can be filled with glyphs of different sizes, while lighter quads can only be filled with small glyphs; (b) the minimum area of the glyph that must be covering non-white pixels — greater minimum area in lighter quads; (c) the maximum number of

consecutive failed attempts to place glyphs — more attempts in darker quads; and (d) the space around the glyph — more space in lighter quads. After deciding all these aspects, the placement of glyphs is initiated. For each font size (aspect a), from the greater to the smaller, the system places glyphs of random characters at random positions with random angles inside the quad until the maximum number of consecutive failed attempts (aspect b) is reached. A placement is considered successful if the glyph that is being placed covers a minimum or greater area of non-white pixels (aspect c). When a glyph is placed, it is drawn on the input image in white with a white outline with a thickness equal to space (aspect d).

All aspects of the system already mentioned are parameterised and therefore can be configured to achieve different results. In addition to these, other parameters include the font, the set of characters that can be used, and the maximum angle variation of the glyphs.

Results

Based on the experimental results, we consider the system is able to generate typographic portraits that depict the main features of the input image and this way is able to resemble it (see Figure 10).

Figure 10. Typographic portraits created in experiment III configured to have less (left) and more (right) detail.

The creation of portraits through the composition of glyphs with different sizes and angles allows the reproduction of details and gradients present in the input image. Figure 10 shows two typographic portraits with two different levels of detail. This can be achieved by, for example, changing the set of font sizes that can be used. Other visual properties of the portraits, such as the contrast, can also be adjusted. Figure 11 shows two portraits with different levels of contrast. The difference between these two portraits is the amount of overlay between the glyphs (more overlay to create darker areas) and the space around them (more space to create lighter areas).

We consider that the approach explored in this experiment is able to create the two main visual features observed in the portraits created in the two previous experiments. First, the continuous transitions from darker to lighter areas observed in experiment I. Second, the high contrast observed in experiment II.

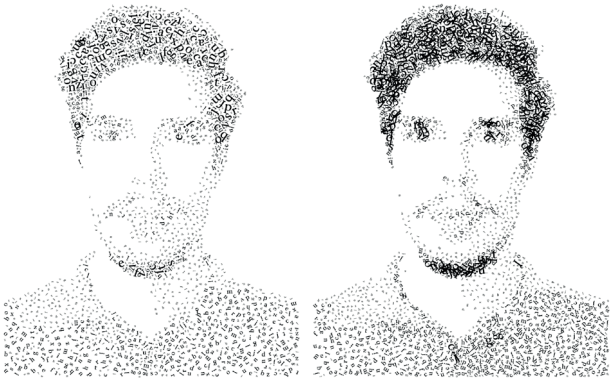

Figure 11. Typographic portraits created in experiment III with less (left) and more (right) overly between glyphs.

Conclusions

In this paper, we have described and conducted three experiments for the generation of typographic portraits. Due to the nature of the work, we also presented a section about related work with the focus on approaches related to the automatic generation of portraits using typography. The three following sections describe the different experiments conducted to create typographic portraits with text, words, and glyphs, respectively. The three experiments presented in this demonstrate how typography can be used as an image. In each experiment, we describe the approach and the kind of results obtained from it.

Although other methods may also be used to transform typographic shapes into images, we consider that the experiments presented in this paper produce interesting instances of typography rendered as images, more particularly typography as portraits.

In each of the abovementioned experiment, we explore a distinct composition mechanism which enables the creation of typographic portraits with different commitments in terms of the relation between readability of the imagery of the textual content. In our viewpoint, the outcomes of the experiment I are closer to a text than an image, i.e. the outcomes are more to be read than seen. By contrast, the portraits generated using the systems of experiment II and III are closer to an image. This is due to two main points. First, each one of the three experiments uses distinctive typographic elements to create portraits (text, words and glyphs, respectively). Therefore, the smaller the typographic elements used by the system are, the more detailed the outcomes are. From the first to the third experiment, respectively, the systems are developed using mechanisms increasingly focused on the production of recognisable images, instead of outcomes that value the readability of the textual content.

Another important point is that all the experiments export the portraits such as a vector file, more accurately a PDF file. It enables the user to have the freedom and the flexibility to use the outputs generated for the purposes that he/she wants (e.g. to produce postcards or posters).

Future work will focus on: develop the physical installation for the system; study and develop the system interface; and, experiment with

other types of rendering and/or other types of images. Besides that, future directions of this experiments will also be related with the increase of the system features (including, for instance, the experimentation with animation of portraits and the inclusion of colour in the portraits).

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