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THESIS

Takahiro Fujiwara

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UNIVERSITY OF DUNAÚJVÁROS

COMPUTER SCIENCE ENGINEERING BSC

THESIS

REPRODUCING THE CLASSIC CALCULATOR USING MODERN WEB TECHNOLOGY

Takahiro Fujiwara

Candidate of Bachelor of Sciences in Computer Engineering

<reg.Number of thesis (e.g. A-003-INF-2021.)>

Thesis Topic Announcement printed form exported pdf from Thesis Management System (https://thesis.undiuna.hu)

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Thesis Assessment Sheet, printed form exported pdf from Thesis Management System (https://thesis.undiuna.hu)

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Abstract

The purpose of the abstract is to enable the student to summarize his / her dissertation in a concise way that is understandable to others. Another goal is to comply the thesis with keeping the formal requirements and the logical structure, therefore an attention-grabbing text can be created at the same time. The recommended length of the abstract is half, but not more than one A4 page, where subheadings, literary references, and footnotes are prohibited.

The beginning of the abstract contains the suggestions and the goals. After this, the rest of the abstract contains an explanation of the applied methods, omitting the exact details, but highlighting the new results.

The abstract contains only the necessary and interesting information that reflects the dissertation properly. It is very important that new features, for example the development and optimization of a new method, are really emphasized.

Table of Content

1. Introduction

The calculator is a ubiquitous device that we are all familiar with. We use it in various aspects of our lives, such as shopping, studying, and business. As Computer Science students, we even learn how to program a calculator. With the rise of digitalization in technology and life, these functions are now readily available on personal computers and smartphones. As a result, the need for dedicated calculator hardware is decreasing. This could lead to dedicated calculator hardware becoming as rare as public pay phones and classic cars. In the future, there might be an interest in classic calculators, similar to the interest in classic cars.

In such a situation, I felt the significance of revealing the historical value of the early calculator and preserving and publicizing it, so I decided to take on it myself. In preserving and publicizing the results of this exploration, modern computer technologies, specifically Web technologies and AI image recognition, play a significant role.

Firstly, by using web technologies, we can digitize and preserve the early calculator, and make it publicly available on the internet. Modern web technology allows us to simulate the operation of a calculator, so anyone can experience the operation of an early calculator on a web browser. These allow anyone to access and learn about the early calculator from anywhere in the world.

Secondly, AI image recognition technology can be used to analyze both the early calculator's real version and digital version. This technology can identify key features and components of the calculator and quantify their similarities. This provides an objective measure of how accurately the digital version represents the original calculator.

There are many definitions of early calculators, including desktop, portable, and handheld models. Early calculators could be placed on a desk, but not in the palm of your hand. I am very interested in the technological innovations that were made to make calculators small enough to hold in the palm of our hand. Therefore, I will focus my research on the early calculators that were small enough to fit in our hand, i.e., handheld calculators.

This knowledge not only enriches our understanding of the past, but also inspires us to imagine and shape the future. I hope that this paper and its results will provide valuable insights to many people.

1.1.Aims and Objectives of Thesis

There is a lot of information about how to use modern web technology, however, information on how to use it to simulate the look and behavior of real products is extremely rare.

Centered on the above, this paper hypothesizes that "modern web technologies can simulate real items at a practical level". Thus, the main aims and objectives of this paper are follows:

- Research the history of Classic Calculator and decide the target product.
- Prepare the source materials. Permission is also required.
- Define simulation points and create a basic outline of web page.
- Find and apply ways to simulate it by modern web technologies.
- Consider a method of similarity testing and evaluate the similarity.

1.2.Structure of Thesis

This thesis is composed of five major chapters. This sub-chapter provides a summary and introduces the structure of the entire thesis:

1. The 1st chapter provides an expansion of the title with more details on the topic to be tackled in this thesis, further explaining the relevance of the research, the scope of the research, and more detailed objectives that the thesis aims to achieve.
2. The 2nd chapter covers calculator history, focusing on electrical calculators before handheld calculators. It introduces the Sharp QT-8B, one of the first handheld calculators, and its base model, the QT-8D.
3. The 3rd chapter provides the simulation points on QT-8B. Also introduces the specific technologies. Next, the ways to simulate it with modern web technologies. Provides Web page design.
4. The 4th chapter provides the simulation result and its similarity between real photo and simulation work. First, outline of AI technology for similarity check. Next, actual measurement of similarity between real photo and simulation work.
5. The 5th chapter provides the deliverables to be published on the web, future possibilities, and suggestions for further research.

2. Research the Classic Calculators

2.1.History of Calculators

The history of calculators or history of computers has the same origin. Later, computers became devices that could be programmed with algorithms. Machines that simply perform calculations prepared by humans came to be called calculators [1].

The calculator that remains in the history of science and technology is shown in Figure ____.

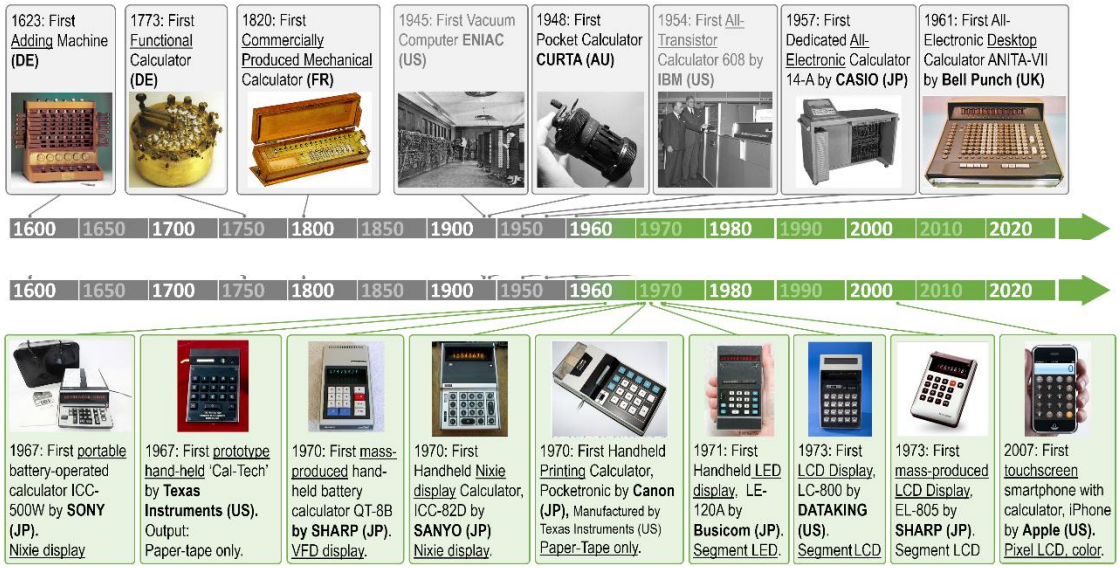

Figure 1. History of Calculators (Source: Author's own work)

The ENIAC (1945, US) was the world's first computer. The IBM 608 (1954, US), the first full transistor calculator, followed. Both could be programmed, so, I will classify these as a computer here.

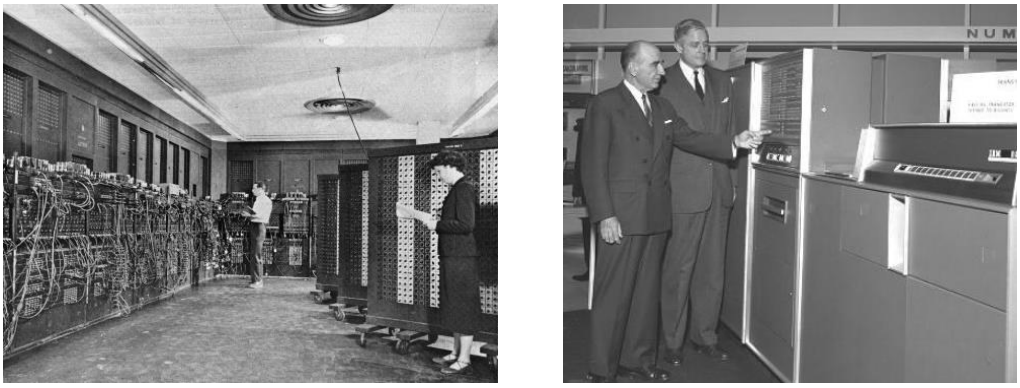

Figure 2. left – ENIAC (1945, US, source: ____),
right – IBM 608 (1954, US, source: _____)

2.1.1. The Advent of the Desktop Calculator

Therefore, the world's first dedicated calculator would be the CASIO 14-A (1957, JP, Figure 3). However, this machine was not a desktop calculator as the desk itself was part of the calculator. The world's first desktop calculator is the ANITA Mk7 by Bell Punch and Sumlock-Comptometer (1961, UK, Figure 3). It used vacuum tubes and cold cathode switching tubes for logic circuits and Nixie tubes for numerical display.

Figure 3. left – CASIO 14-A (1957, JP, source: _____),
right – Bell Punch and Sumlock-Comptometer ANITA-VII (1961, UK, source: _____)

2.1.2. The Advent of Portable Calculator

The next "world's first" is the battery-operated portable calculator, SONY ICC-500W (1967, JP). Although it's called portable, as you can see from the photo, it looks like a desktop calculator with a handle. But the weight is lighter than desktop calculators, have a look at table _____. (FYI. Sony withdrew from the calculator business in 1972, unable to find a position for itself amid price competition with other companies.)

Figure 4. left – SONY ICC-500W (1967, JP, source: ____),
right – ads on newspaper NIKKEI 1967.05.20. (source: _____)

2.1.3. The Advent of Handheld Calculator

In 1967, when Sony released the world's first battery-operated portable calculator, the prototype of the modern handheld calculator was announced by Texas Instruments Cal-Tech (1967, US). This influence was so great that it is said to be the prototype of the modern calculator. Although it was never commercialized, Canon later purchased the blueprints, made improvements, and released it with the name Canon Pocketronic(1970 Oct, JP)

Figure 5. left – Texas Instruments Cal-Tech, prototype (1967, US)
right – Canon Pocketronic (1970 Oct, JP)

2.1.4. What Are the Released Handheld Calculators?

I would like to pick up the world's first commercialized handheld calculator. In that case, Cal-Tech or Canon Pocketronic would not apply. Next, in 1969-1970, SANYO and SHARP calculator appear. SANYO's information is scarce and now part of Panasonic, making fact-checking is impossible. The leading information is that SANYO ICC-0081 was announced in 1969, but sales began at the same timing of the SHARP QT-8B.

Figure 6. left – Sharp QT-8B (1970, JP),
right – Sanyo ICC-0081 (1970, JP)

2.2.About the first handheld calculator handled here

It is generally considered to be the world's first handheld calculators are Sharp QT-8B, SANYO ICC-0081/ICC-82D, and Canon Pocketronic. There is an article that states that Canon Pocketronic's announcement was the same as Sharp's selling timing, but it was released half a year later. Considering this, the world's first handheld calculator was the Sharp QT-8B and SANYO ICC-0081 / ICC-82D.

There is a lot of information about the Sharp QT-8B, and this model will be the subject of this article.

2.3.Introduction about Sharp QT-8B

2.3.1. Outline of QT-8B

The Sharp QT-8B, also known as the Micro Compet, was a portable electronic desktop calculator and the first mass-produced calculator to be battery-powered. It was introduced in May 1970 and was based on its immediate predecessor, the QT-8D, which was introduced in late 1969. The QT-8B replaced the QT-8D's integrated power supply with a rechargeable battery pack. It has the same calculating integrated circuits as the QT-8D and is of similar appearance and dimensions; the power supply is the only major difference. The QT-8B's release price in Japan was 117,000 JPY. The U.S. price in mid-1971 was $495, equivalent to about $2,700 in 2010.

Figure 7. left – Sharp QT-8B (1970, JP), middle – rechargeable battery pack, right – QT-8D (1969, JP)

2.3.2. Display technology in QT-8B

The Sharp QT-8B's display is a vacuum fluorescent display as called VFD, the first of its kind to be used in a production calculator. It has eight digits of precision, with both

a minus sign and an overflow indicator dot on the right-hand side. The decimal point is "floating"—it is positioned automatically by the calculator logic. This was an advanced feature for the time; many desk calculators of this era had fixed decimal points and required very wide displays to maintain a minimum level of precision across the entire range of numbers available. The QT-8B's floating decimal allowed its display to be much narrower while still keeping eight digits of precision.

Figure 8. Vacuum fluorescent display (VFD) in Sharp QT-8D (source: __)

2.3.3. Characteristics of VFD Display

A Vacuum Fluorescent Display (VFD) uses a mesh, or control grid, to manage the electrons emitted from the cathode. When the cathode is heated by an electric current, it releases electrons. These electrons are then controlled and diffused by the mesh. The accelerated electrons that reach the anode cause the phosphor to emit light, creating the bright and high-contrast display characteristic of a VFD.

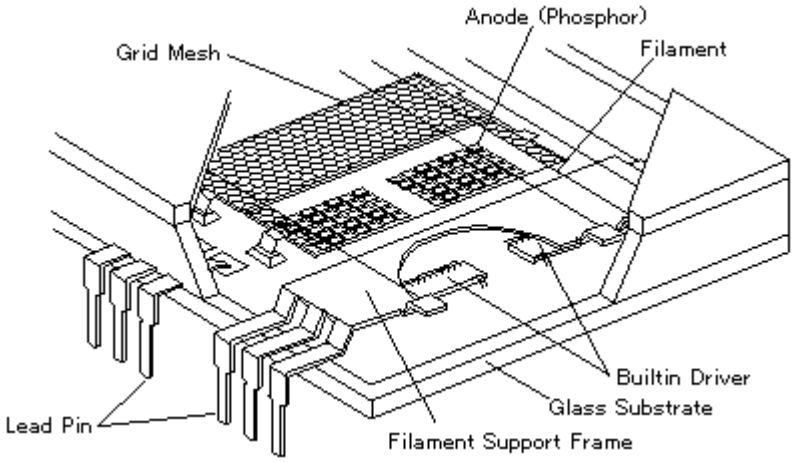

Figure 9. Basic Structure of VFD Display (Source: Noritake)

2.3.4. QT-8D operation for calculation

As you can see from the photo, the operation of the QT-8B is different from that of a typical calculator. This is because the idea of an adder like a cash register is introduced.

1. ADDITION

Ex. 1 – 1 123.1 + 864.2

Steps	operation	display
1	123.1	123.1
2	+=	123.1
3	864.2	864.2
4	+=	987.3

2. SUBTRACTION

Ex. 2 358.8 – 1241.6 – 27.5

Steps	operation.	display
1	358.8	358.8
2	+=	358.8
3	1241.6	1241.6
4	−=	882.8–
5	27.5	27.5–
6	−=	910.3–

Figure 10. . Arithmetic operations from QT-8B Instruction Manual (1).

3. MULTIPLICATION

Ex. 3 – 1 1.1 x 2.2

Steps	operation	display
1	1.1	1.1
2	×÷	1.1
3	2.2	2.2
4	+=	2.42

4. DIVISION

Ex. 4 – 1 264 ÷ 12

Steps	operation	display
1	264	264.
2	×÷	264.
3	12	12.
4	−=	22.000000

Figure 11. Arithmetic operations from QT-8B Instruction Manual (2)

3. Simulation Points and Corresponding Web Technologies

3.1.Concept of Simulation Method

3.1.1. Using photo of real product

To immerse audience in the world of classic calculators, I will utilize photographs of the actual devices. This approach transcends mere simulation, offering a tangible connection to these technological artifacts.

3.1.2. Simulate the Finger Movement

Simulate finger shadows on real photos. *Figure 12* shows moving finger on the picture. The left picture shows nothing, middle picture shows moving finger on the "9", right picture shows try to press the "9" button.

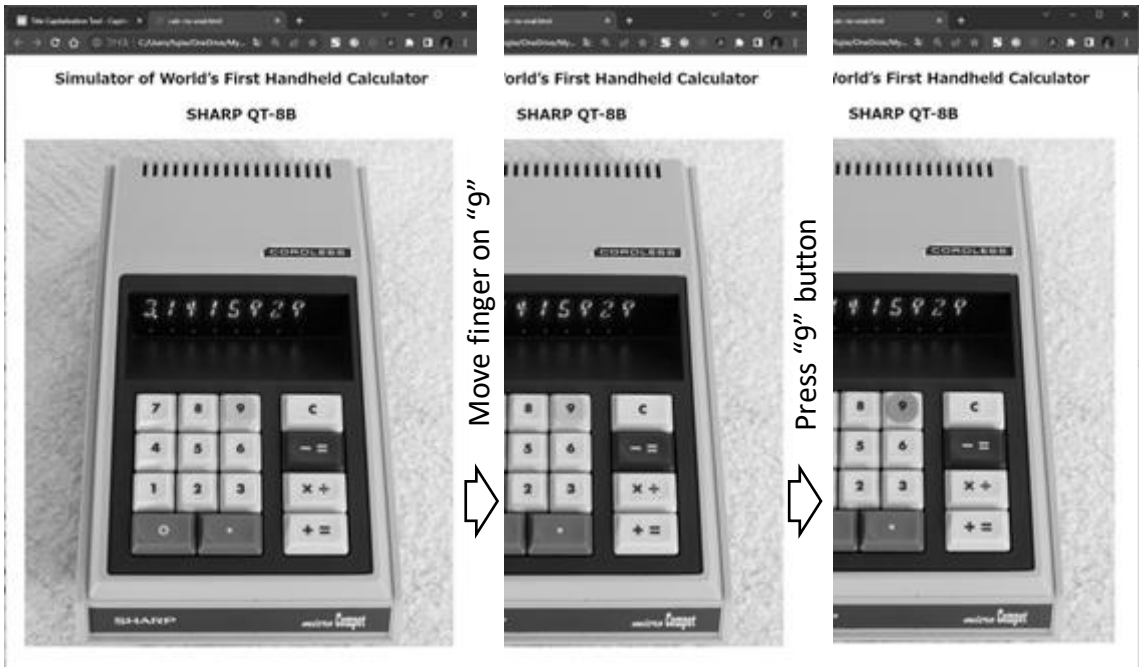

Figure 12. Simulation of moving finger on the picture.

3.1.3. Simulate Button Pushing Sound

Enhancing the real experience can be achieved by producing a sound when a button is pressed. Each button should have a slightly different sound, and you can recreate it by recording and playing back the sound of each button.

3.1.4. Simulate 3D perspective

The photographs are taken diagonally from above, so the sense of perspective is expressed in the photographs. The one in front is bigger and the one in the distance is smaller. Therefore, a quadrilateral placed on a plane looks like a trapezoid.

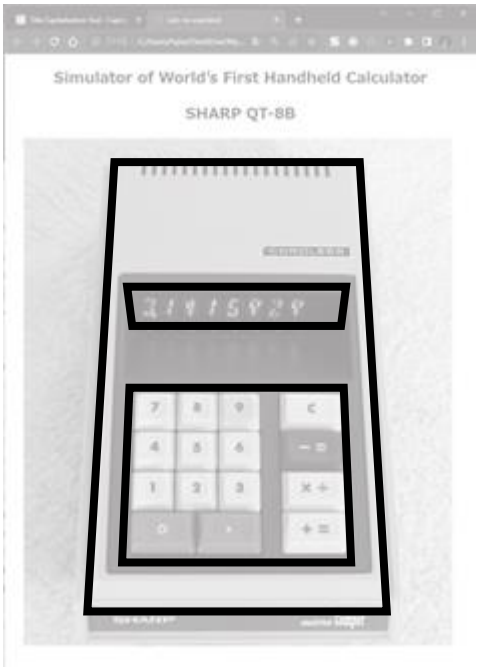

Figure 13. 3D perspective on the photograph (source: author's work)

3.1.5. Simulate VFD Display

It simulates the shine of the display, the mesh of the surface, and the reflections and blurring that only occur in the real thing. This is the biggest simulation point. The design of the letters will also be the same as the real thing.

3.2.How to Achieve Simulation With Modern Web Technologies

3.2.1. Using photo of real product

Aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaaa aaaaaa aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaa aaaaaaaaaa aaaaaaaa aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaa.

3.2.1. Simulate the Finger Movement

Aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaaa aaaaaa aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaa aaaaaaaaaa aaaaaaaa aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa aaaaaaaaa.

3.2.1. Simulate the Finger Movement

4. Simulation Result and its Similarity Check

5. Rules of Headings and Subheadings

Each heading / title (Heading 1 style) start in new blank page.

The headings are followed by at least 1-2 paragraphs! Never include headings that are directly followed by a new, lower-level heading. Insert at least 1-2 paragraphs (through 2-3 lines each) of text bellow each heading. Furthermore, where a chapter has only one subchapter, the division of the subchapters is unnecessary. In this case, the whole content must be described within the chapter (without sub-chapter).

5.1.Rules of References

The following sub-chapter overviews the rules of references in the different cases of thesis elements.

5.1.1. Rules of Bibliography References

Readers can get information of the depth of Candidate's scientific work and research from the bibliography list at the end of the thesis. References also prove that Candidate has avoided plagiarism and acknowledges his/her sources of information.

If Candidate makes non-literal reference from one specific scientific literature in case of one sentence, does so that in front of the punctuation mark at the end of the sentence, e.g.:

This is an example sentence to illustrate the reference type discussed above [1].

If a full paragraph is referenced from a piece of literature, put the reference number at the end of the paragraph, after the punctuation mark at the end of the sentence.

This is an example paragraph to illustrate the reference type discussed above. This is an example paragraph to illustrate the reference type discussed above. This is an example paragraph to illustrate the reference type discussed above. [1]

If there are more scientific sources of the paragraph(s), use references at the end of the text, divided them by . (comma) in case the references are in different part of the list of bibliography. In case they are after each other in the list, use references divided by – (hyphen). The following example shows the appropriate reference format for a sentence:

This is an example sentence to illustrate the link type discussed above [1-4], [5], [10].

The following example shows the appropriate reference format for one or more paragraphs:

> This is an example paragraph to illustrate the more than one references type discussed above. This is an example paragraph to illustrate the reference type discussed above. This is an example paragraph to illustrate the reference type discussed above. [1-4], [5], [10]

In each case of literal quotation Candidate should enclose it in " (quotation marks), align the quotation to the right and format italics, and place the reference at the end of the quotation. The dissertation can be continued in a new paragraph. For example:

> *„This is an example for a literal reference." [1]*

5.1.2. Requirements for Reference of Images

The figures are placed in the dissertation according to Figure 1, as template provides, so centered, space before 18pt, line height is 1.5, with the appropriate resolution and size for easier readability. Each figure must be followed by its fig. caption. Each fig. caption must be inserted as a reference and contains a fig. number and a title. The format of the fig. caption as template (TNR, 12pt, italic, centered, space before 0pt, after 18pt). If Candidate uses/inserts a figure from outer source, the literature reference has to be inserted at the end of the fig. caption enclosed by […]. If Candidate uses self-edited figure, the fig. reference is the following text enclosed by (…): (self-edited figure). Candidate has to refer to each figure by its fig. number in the text, where it is mentioned, e.g. (Figure 1)!

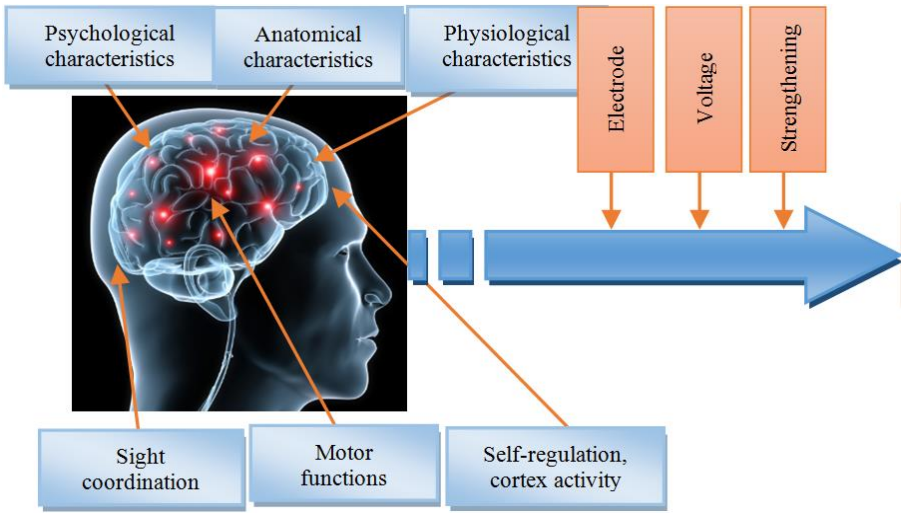

Figure 1: A simple model for processing bioelectrical signals [1]

Figures can also be inserted on the previous or next page, avoiding blank spaces at the bottom of the page.

5.1.1. Requirements for Reference of Tables

Just like figures, tables should be referenced in the text too (e.g. Table 1 shows the results of the research). Creating table captions with ref. number is like fig. caption (use Word references service). Table caption is centered with 1 normal style blank row before and after (or the better to use 12pt spacing before and after). Combine it with the appropriate colors for easier readability. The style in Table 1 example table is optional but recommended. If the table is broken by a page, do not leave it "cut in half", use page break.

Table 1.: Results [1]

Course	Groups	Average	Deviation	Impact	t-test
Mathematics	G1 G2	3,036 3,15	0,769 0,933	0,14*	t = 0,53 (p < 0,05)
Electronics	G1 G2	3,345 3,3	0,886 0,979	0,05*	t = 0,19 (p < 0,05)
Programming	G1 G2	3,254 3,3	0,927 0,979	0,05*	t = 0,18 (p < 0,05)

**small impactg (d<0.5).*

Tables can be inserted on the previous or the next page to avoid large blanks.

5.1.2. Requirements for Reference of Annexes

The appendices should be referred to in the text as with the figures and tables, e.g.: ”I have depicted the current state in the manner found in Appendix 1.”

5.2.Source Code in the Text

Source code parts recommended to be display in the thesis as text not as figures. Format them differently than body part (e.g. apply `Consolas font type`). Long codes (e.g. multi-page codes) have to be placed as appendices. In thesis body Candidate should highlight the essential elements only. The most elegant way to represent the algorithm is to use language-independent description. Do not cut and insert the code-base written in a specific language into the thesis body. Here are some samples bellow:

The following language-independent source code snippet contributed significantly to the optimization of the xy algorithm:

```
Algorithm arrayMax(A,n)
   currentMax ← A[0]
   for i ← 1 to n-1 do
      if A[i] > currentMax then
         currentMax ← A[i]
{ increment counter i }
return currentMax
```

The following C# source code snippet contributed significantly to the optimization of the xy algorithm:

```
int? currentMax = null;
int index = -1;
for (int i = 0; i < array.Length; i++)
{
   int currentNum = array[i];
   if (!currentMax.HasValue || currentNum > currentMax.Value)
   {
      currentMax = currentNum;
      index = i;
   }
}
```

6. Summary

Candidate should summarize the essence of the dissertation in this chapter, with a strong emphasis on his/her own results. Recommended size is up to 1 page.

Bibliography

The scientific literature should be referred, therefore set its ref. number encloses by […]. In case of Internet sources the time of viewing must also be displayed. The required reference stye is IEEE (use Word bibliography references tool).

The following examples show different types of science literature. Thesis recommended to contain at least 15-20 references, preferably of each type.

Journal article:

[1] J. Katona and A. Kovari, "A Brain–Computer Interface Project Applied in Computer Engineering," in *IEEE Transactions on Education*, vol. 59, no. 4, pp. 319-326, Nov. 2016.

Book:

[2] J. Sharp, *Microsoft Visual C# 2005 Step by Step.* Szak kiadó Kft., Bicske, 2005.

Book excerpt:

[3] J. Katona, T. Ujbanyi, G. Sziladi, A. Kovari: *Electroencephalogram-based brain-computer interface for Internet of Robotic Things*, Cognitive Infocommunications, theory and applications, Topics in Intelligent Engineering and Informatics, Springer, pp. 249-272, 2018.

Conference announcement:

[4] J. Katona, T. Ujbanyi, G. Sziladi and A. Kovari, "Speed control of Festo Robotino mobile robot using NeuroSky MindWave EEG headset based brain-computer interface," *2016 7th IEEE International Conference on Cognitive Infocommunications (CogInfoCom)*, Wroclaw, 2016, pp. 000251-000256.

Internet source:

[5] *EEG Headsets | NeuroSky Store*, Store.neurosky.com, 2017. [Online], Access: https://store.neurosky.com [Download: 2017. 07. 24.]

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https://americanhistory.si.edu/collections/object-groups/handheld-electronic-calculators. [Accessed 28 9 2023].

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Annex 1.

Efficiency of combat nerve gases

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