

Classification of Automatic Subtitling Tools. A Proposal

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Abstract: This article aims to provide a deeper understanding of the automatic subtitling tools that are currently being used and of their context of application. Based on the assumption that AVT, in general, and subtitling, in particular, are undergoing fundamental changes, it is our aim to analyse the range of tools that allow AVT translators to enhance their productivity and their efficiency. For this purpose, we have analysed 40 different automatic subtitling tools, currently available and accessible on Internet. Through this analysis, it has been possible to observe the main features of these tools and observe their functioning. Therefore, different criteria have been established in order to systemize this extensive inventory based on which 23 categories of software dedicated to automatic subtitling have been identified. These categories have been illustrated with examples. In this study, the aim is to provide a more accurate and more systematic understanding of automated subtitling programs. The paper is addressed to AVT professionals as well as to teachers and students having an interest in the state-of-the-art of automated subtitling.

Keywords: automatic subtitling, live captioning, classification of automatic subtitling tools, automatic transcription, real time speech recognition, machine translation, automatic spotting

1. Introduction

Nowadays, with the rapid development of artificial intelligence, professionals in many fields may have to adapt to new challenges given its significant impact within their work.

Over the last few decades, with the widespread use of multimedia communication (Dejica et al. 2020) and due to the need to provide rapid access to its linguistic content, artificial intelligence (AI) has become increasingly involved in AVT. The reason often given by companies for implementing automatic subtitling within this context is that human translators specialized in AVT are not able to cope

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with the volume of translations required inside a company, and that training of subtitlers and their work involves very high costs.

Despite the fact that it has been less addressed by researchers, automatic subtitling has developed significantly as a result of increased influence coming from industry, Internet and social media, being mostly used by the mainstream audience and some companies.

The present paper proceeds from the premise that the field of ATV in general, and subtitling in particular, is now undergoing thorough transformation due to the involvement of AI, this change has been reflected through the wide range of automated captioning tools that are now at the disposal of the general public and AVT professionals. This increasing involvement of automated translation in AVT, rather than being a threat towards professionals, enables them to enhance their IT skills in order to become more productive and efficient.

For this reason, this article aims to answer the following research questions: *a) which is the inventory of automatic subtitling tools currently accessible to the general public and professionals; b) which are the criteria by which these programs can be classified; c) which categories of automatic subtitling programs exist, and d) which are their general characteristics.*

In order to do this, we started by providing a timeline of the evolution of automatic subtitling tools, enabling us to understand the wide variety of programs that have been created and used in this field over the last decades in many different countries, and involving subtitling from and into many different languages. Furthermore, the timeline has been segmented into several stages of development enabling us to focus the analysis on the time period that best illustrates the latest developments in these tools, meaning the period 2015-2023.

For this purpose, a list of 40 automatic subtitling programs was created which were analysed and ranked according to multiple criteria. Through this approach, it is our aim to systemize and provide empirically based knowledge about the different categories of software that AVT professionals need to know in order to optimally respond to market demands.

The present article is aimed at professional AVT translators, researchers, teachers and students who may want to deepen their understanding of the changes that artificial intelligence brings to the subtitling practice which they can use for their own benefit.

2. Automatic subtitling. Diachronic developments

Although it has only gained greater visibility in recent years, automatic subtitling is a field that has been evolving for over two decades. Due to the increasing pressure of workload in this field (Karakanta et al. 2020, 3727), the audiovisual industry, social media and social marketers engage in the development of programs that would allow a more efficient subtitling work. Thus, since 1984, it becomes more and more frequent to attend academic conferences where computer applications and projects aimed at optimising translation work in AVT are presented. Early attempts at

automation were designed to assist the subtitler at certain stages of his/her work, such as automatic transcription based on *automatic speech recognition (ASR)*. As an example, Damper&Lambourne& Guy (1985) propose the automation of live subtitles using ASR as a complementary element of the keyboard. Another ASR-based subtitling application is the *VOICE project* (Pirelli 2004, 25-29), whose subtitling application and results are presented at a conference in Vienna, in 1998. The program is also used in some schools in Italy (Pirelli 2004, 28) and the project develops until 2003 with outstanding results.

The *project LINK*, also based on ASR, has been developed since 1998 in the UK. It is the result of a partnership between the University of Hertfordshire and SysMedia Ltd (Lambourne et al 2004, 270-271). Its aim was also to create real-time subtitles for television programmes. The authors mention that *SpeakTitle*, the application created as part of the *LINK project*, has been used for subtitling sport events and live broadcasts (Lambourne et al 2004, 270-271).

The use of automated real-time subtitling systems is starting to widespread worldwide, for example, the Japanese news programme "News7" of NHK has been using an ASR-based simultaneous subtitling system since March 2000 (Ando et al. 2000, 195). Since 2002, EU interest in AVT automation has materialised through the funding of research projects. For example, the *MUSA: MUltilingual Subtitling of multimedia. A content project* (<https://www.esat.kuleuven.be/psi/projects/archived/musa>), which combines several technologies such as ASR, MT and NLP, is running from 2002-2005. The automated subtitling software developed in the project is multilingual and works for English, French and Greek.

Starting with 2003, real-time subtitling systems are being implemented at national level in different countries. This includes the ASR-based Live Subtitling System implemented by the British BBC Television to streamline the work of subtitling broadcast audiovisual content (Marks, M. 2003, 4). In the USA, the TranslateTV system (www.translatetv.com) has also been in use since 2003 for real-time Spanish subtitling of television programmes. The same year, AUDIMUS.media, an ASR-based system for subtitling news programmes in Portugal, was developed (Meinedo et al 2003, Neto et al 2008). This system is able to identify specific information in multimedia files, perform audio segmentation, use domain detection techniques and perform automatic transcription of the audio/video stream.

Between 2004-2006, EU supports another real-time automatic subtitling project, namely *eTITLE* which brought together TV producers from the UK, Spain and the Czech Republic. This is a complex system whose importance lies in the fact that it integrates MT in the field of subtitling. An innovative element for its time. Also, *eTitle* could generate multilingual subtitles, the language pairs for which it was developed being *English-Spanish, Spanish-English, English-Czech, Catalan-Spanish, Spanish-Catalan English-Catalan, and Catalan-English* (Melero et al 2006).

As of 2006, in Canada, in Montreal, a system for automatically generating French subtitles (Boulianne et al. 2006) is being used in numerous events with large audience participation (Boulianne et al. 2008, 199-200).

Automatic subtitling is also being implemented in Chinese, in the paper by Gao et al. (2008, 576-577) it is mentioned that first steps have been taken to develop a text and speech synchronization system for news programs.

The Aragonese Public Television was using an automatic real-time news subtitling system based on ASR in 2008. However, the unexpected feature of this system is that it works with satisfactory results without human intervention Ortega et al. (2009, 2095-2098). Also, in the Spanish space, in 2010, the ApyCA project is mentioned, which has been developed with the aim of making the translation process more efficient and faster. The project is being developed due to pressure from the Spanish audiovisual law which required that by 2013 all television stations must provide subtitles for more than 90% of the programmes they broadcast (Álvarez 2010, 567). Later, in 2010, in the Czech Republic, a programme for subtitling parliamentary sessions is being developed (Trmal et al. 2010).

From 2011-2014, automatic subtitling tools are being developed in projects such as *SUMAT (Subtitling by Machine Translation)*, a multilingual project focused on 9 European languages (www.fp7-sumat-project.eu/about-us/index.html) and *Translectures (Transcription and Translation of Video Lectures)*, a multilingual project dedicated to automatic transcription and translation of educational video materials (<https://www.mllp.upv.es/projects/translectures/>) currently hosted by the Polytechnic University of Valencia.

Between 2012-2015 the *EU-BRIDGE platform* (<https://project.eu-bridge.eu/>) is being developed, providing solutions for many situations where subtitling is needed, such as: TV broadcasts, translation of academic lectures, translation in the European Parliament and subtitling for online events (conferences, webinars, etc.).

In 2012, the *SAVAS - Sharing AudioVisual language resources for Automatic Subtitling* project is being created by a research group of TV representatives, subtitling companies and software developers. The aim of the project was to develop a multilingual automatic subtitling program (Basque, Spanish, Portuguese, Italian, French, German,) to be used in TAV for news programmes, interviews, debates and sports broadcasts (Pozo 2014, 432).

As may be seen, most of these tools are either supported by broadcasters or are developed in an academic setting with EU funding and generally involve subtitling for TV, conferences, and for events such as: courses/seminars/webinars.

As may be seen, most of these tools are either supported by broadcasters or are developed in an academic setting with EU funding and generally involve subtitling for TV, conferences, and for events such as: courses/seminars/webinars. One of the first automatic subtitling tools for social media was implemented in 2006 for the platform *YouTube*. Named *YouTube Automatic Caption*, it allows users to automatically generate captions for a video file stored in their account (Harrenstien, 2006; 2009). This system was improved in 2013 by implementing a Deep Neural Network-based speech recognition system (Hank Liao et al., 2013).

In order to provide a comprehensive overview on the evolution of automatic subtitling tools, we add the diagram (fig. 1) which will allow to illustrate more clearly

the extent of the process. Many of the programs developed between 1998 and 2015 constitute the basis of the online automatic subtitling applications and platforms that exist today.

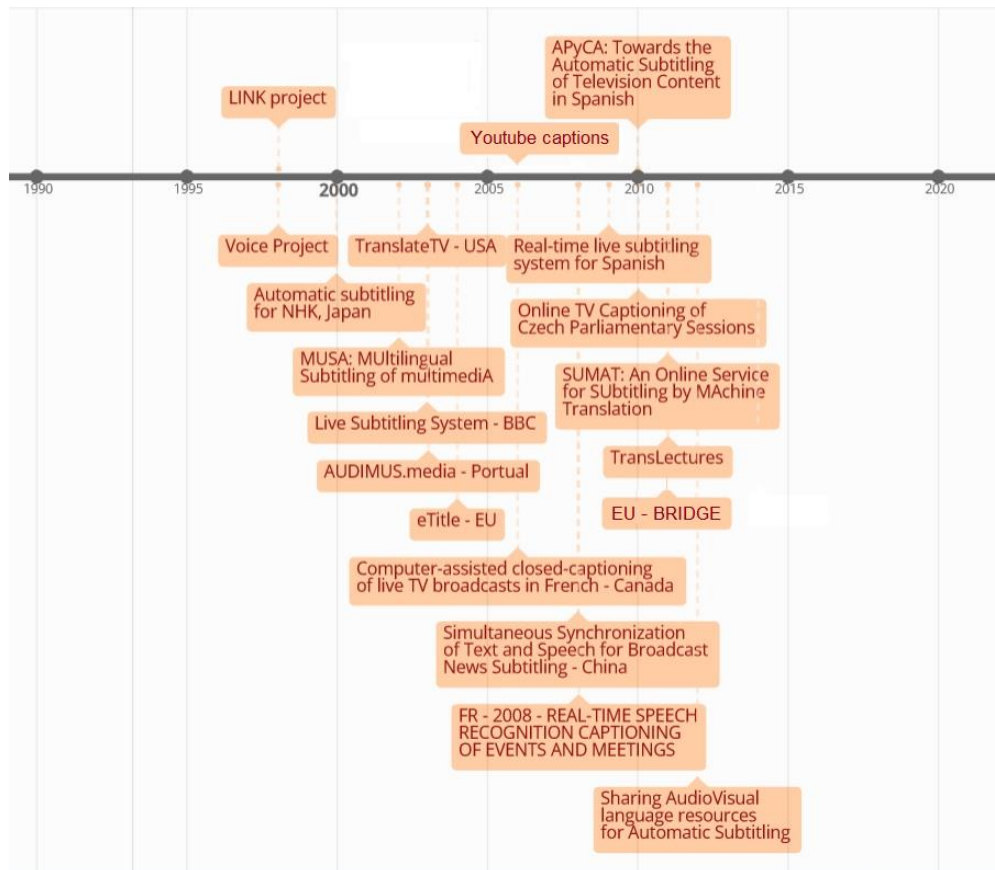


Fig. 1 Overview of the development of automatic subtitling (1984-2015)

All these tools represent only milestones in the evolution of automatic subtitling, nowadays existing a wide inventory of such tools with various degrees of complexity.

Depending on the subtitling software being used, the organization of the workflow and the output obtained may be different. It can also be remarked that these tools have a rather short useable life, some of them disappearing from the virtual space after a few years of operation.

There is a possibility that this phase of rapid development of subtitling platforms that we are currently witnessing will be transient, and that the next phase of

evolution of these programmes will focus on developing fewer subtitling tools but with a higher quality a complexity of the services they offer to users.

3. Classifications of automatic subtitling tools

Nowadays, it is rather difficult to assess the variety and the typology of automatic subtitling tools. Over the last two decades they have developed in different directions, seeking solutions for different specific AVT situations, and have often developed in parallel. For this reason, it is now difficult to determine accurately what place each of these tools hold in the heterogeneous inventory of automatic subtitling programs. Thus, given that many of them remain poorly known to the general public and to specialists, we believe it is important to establish an overview of them, to analyse them and to establish their typology. This will provide a better understanding of the tools involved in automatic subtitling and will allow us to know more about their structure, their functioning, and about the range of services they offer.

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Both the literature and our analysis of automatic subtitling tools indicate that the evolution of this field has taken place in a number of stages, each of which presents its own characteristics and has influenced the development of AVT tools. Considering these inputs, we propose the following stages of automatic subtitling development:

- a. the beginnings (1984-2000);
- b. development (2000-2015);
- c. widespread use and diversification (2015-present);
- d. standardisation and specialisation of software (forthcoming stage of development).

Thus, the first stage is characterised by the emergence and development of theoretical models describing automatic subtitling and/or the automatization of some stages of the process. There are no automatic subtitling tools as such yet, but work is underway to implement some of their components. Even though it is known that ASR technology is essential to automate subtitling, there are still steps towards its development.

In the second stage, the evolution is characterized by the automation of the whole subtitling process. The first automatic subtitling tools and research projects in this field are presented at conferences and attempts are made to promote their use in schools. A number of countries develop automatic subtitling tools which are successfully used by national TV stations. Software is beginning to diversify and the question of automatic subtitling in new contexts such as social networks is raised.

We are currently at the third stage of the evolution of automatic subtitling. During this stage, the technological evolution of automatic subtitling tools is influenced by AI, which improves the quality of both ASR and MT. The use of automatic subtitling platforms become widespread, especially in the use of automatic subtitling programs for social networks. Browsers use live subtitling software. Thus, automatic subtitling is no longer limited to the needs of TV companies, it is no longer carried out only by translators specialised in AVT. Virtually anyone can use the services offered by these automatic tools in case of need.

3.1. Overview of Automatic Subtitling Tools

In order to better understand automatic subtitling, an overview of the most important tools and their systematic analysis is a first step. For the identification of these tools, relevant literature was consulted and a number of searches were carried out in Internet using a search engine and advanced search operators. This allowed us to create a list of 40 automatic subtitling tools of different types. This first list used for analysis was enriched during the entire duration of the investigation.

- | | |
|---|---|
| 1. Ai-Live Captioning - https://www.ai-live.com/ | 21. Live Caption Chrome |
| 2. Animaker - https://app.animaker.com/subtitle/ | 22. Maestrasuite – https://maestrasuite.com/ |
| 3. ASG - https://www.autosubgen.com/ | 23. MateSub - https://matesub.com |
| 4. AudioType - https://www.audiotype.org/subtitles/ | 24. Media.io - https://www.media.io |
| 5. Auto-Subtitle Firefox extension | 25. Ooona - https://ooona.net/ |
| 6. CapCut - https://www.capcut.com/ | 26. Otter.ai - https://otter.ai/ |
| 7. Checksub - https://www.checksub.com/ | 27. Rev – https://www.rev.com/checkout/capti-onfiles |
| 8. Clideo - https://clideo.com/add-subtitles-to-video | 28. Simplified - https://simplified.com/video-editor/auto-subtitle-generator |
| 9. Diy captions - https://www.diycaptions.com | 29. Subtitle video - https://www.subtitlevideo.com/auto-subtitle-generator-online.php |
| 10. EasySsub - https://easyssub.com/ | 30. SubtitleBee - https://subtitlebee.com/ |
| 11. Edge Live Caption Feature | 31. Transkriptor - https://transkriptor.com/ |
| 12. EVE - https://starteve.ai/ | 32. Veed.io - https://www.veed.io |
| 13. Facebook's Automatic Caption Feature | 33. Wave.video - https://wave.video/video-captioning |
| 14. Filmora - https://filmora.wondershare.com | 34. Wavel.ai - https://wavel.ai/studio/auto-subtitles-generator/ |
| 15. Flexclip - https://www.flexclip.com/tools/auto-subtitle/tomatic-subtitles/ | 35. Wearenova - https://wearenova.ai/nova-tools/au |
| 16. Flixier - https://flixier.com/ | 36. Webcaptioner - https://webcaptioner.com/ |
| 17. HappyScribe - https://www.happyscribe.com/ | 37. YouTube Automatic Caption |
| | 38. Zubtitle - https://zubtitle.com |

- | | |
|--|--------------------------------------|
| 18. Hei.io - https://www.hei.io/subtitle-generator | 39. Zoom's closed captioning feature |
| 19. Instagram Automatic Captions | 40. Meet's closed captioning feature |
| 20. Kapwing Auto-Subtitle - https://www.kapwing.com/ | |

Fig. 2 List of automatic subtitling tools used in the present investigation

Without being exhaustive, the list that has been created reveals a rather startling variety of automatic subtitling tools that can be used by professionals and/or amateurs. Of these, some are of a rather general nature, while others are used in specific settings such as the Internet, television, conferences, etc. Each of the selected tools has been tested and analysed in order to see which features they have. As a result, several categories of automatic subtitling software were identified, which will be presented hereafter.

3.2. Automatic Subtitling Tools. Criteria of Classification

Based on the analysis of the profile of automatic subtitling tools, the following classification criteria were considered: structure of the software (*embedded or stand-alone*), mode of operation (*fully automatized, partially automatized*), type of user (*amateur, general public, professional*), medium for using subtitles (*browser, social networks, online conferencing, browser, general use*), type of access (*free, demo or commercial*), linguistic criteria (*monolingual, multilingual*). In this section, we present the categories of automatic subtitling tools observed, describe their most important characteristics and mention which of the programs in the list analysed fall into these categories. The analysis will allow us to establish a clear profile of each automatic subtitling tool.

3.2.1. *The structure of the software* is an important criterion because it is the first clue as to whether the subtitling tool we are using is dedicated to professionals or to the general public. Depending on this, two categories of software are distinguished: *embedded software* and *stand-alone software*. The difference between them lies in the different way they are implemented and in the importance of the automatic subtitling activity within the software. Thus, in the case of embedded programs, we are talking about multifunctional software in which subtitling plays a secondary role, often reduced to the level of a simple option. In general, these are studio-type software where the main activity is video editing and which offers its users, among other options (filters, text insertion, transitions, etc.), also subtitling. One can usually choose between automatic subtitling, uploading an already made subtitle file and creating subtitles manually. In other cases, it is a matter of options integrated into a browser, a conferencing program or a social network. In this category fall: *Animaker, AudioType, Auto-Subtitle Firefox extension, CapCut, Edge Live Caption Feature, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, HappyScribe, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome,*

Media.io, Otter.ai, Simplified, Veed.io, Wave.video, Wearenova, și YouTube Automatic Caption.

Stand-alone programs are those in which automatic subtitling is the primary activity, whether they offer one type of subtitling or several. These are dedicated software programs such as: *Ai-Live Captioning, ASG, Checksub, Clideo, Diy captions, EasySub, EVE, Hei.io, Maestrasuite, MateSub, Oona, Rev, Subtitle video, SubtitleBee, Transkriptor, Wavel.ai, Webcaptioner, Zubtitle.*

3.2.2. *Depending on their working mode*, automatic subtitling programs fall into two categories: programs that are *fully automatized* and programs that are *partially automatized*. The first category includes software that performs all the steps necessary in order to obtain a subtitle (transcription, spotting, and translation), their output being comparable in form to TV/cinema/DVD subtitling. This category includes the following software: *Ai-Live Captioning, Animaker, ASG, AudioType, Auto-Subtitle Firefox extension, CapCut, Checksub, Clideo, EasySub, Edge Live Caption Feature, EVE, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, HappyScribe, Hei.io, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome, Maestrasuite, MateSub, Oona, Rev, Simplified, Subtitle video, SubtitleBee, Veed.io, Wave.video, Wavel.ai, Wearenova, YouTube Automatic Caption.* Despite the fact that the quality of automatic subtitling nowadays requires post-editing by a human translator; the capability of such software to perform complex tasks such as *real-time speech recognition, machine translation, text-to-speech synchronization*, and *spotting*, enables us to consider them as *fully automatized*. Among them, there are tools that can perform less common types of subtitling, such as *CapCut*, which has an option for automatic subtitling music videos.

Partially automatized tools are those that can display text on the screen yet without going through all the above-mentioned stages. This is their ability to display text in a multimedia file, which is not a subtitle in itself from the point of view of professional translators. In some cases, it is simple ASR-based transcription as carried out by: *Otter.ai, Transkriptor, Webcaptioner și Zubtitle.* Despite not being as advanced, this type of software can be used successfully by professional translators, especially for *simultaneous subtitling*, used in television and conferences.

Of the same category, but with a higher degree of complexity because they can *transcribe* and *spot* the spoken content of a video file, but without having to go through all the steps required for a proper subtitling, are the programs such as: *Diy captions* and *Media.io.*

3.2.3. *Classifying software according to the type of user* is a worthwhile distinction, given that subtitling has become a very common practice nowadays due to the increased attention paid to accessibility. Thus, there are the following types of users of automatic subtitling tools: *the general public* (people who occasionally need subtitles in their daily lives), *amateurs* (people who are enthusiasts of subtitling but have no professional training in this field, they create the so-called *funsubs*), and

professionals (people working in the AVT field). Depending on these categories of users, a distinction is also made between software for the general public, for amateurs and for professionals. The first category includes software offering generic subtitling services, for which no professional training is required. The general public may include, for example, influencers, content creators and multimedia artists. They may use software such as: *Animaker, ASG, Diy captions, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, Instagram Automatic Captions, MateSub, Media.io, Wavel.ai* and *YouTube Automatic Caption*.

Programs for amateurs have a simple interface and offer a minimum set of options for subtitling. However, they differ from those intended for the general public in that the user can intervene and modify the subtitles that have been created. On the other hand, some essential options for editing subtitles are not implemented in these programs, which makes them unsuitable for professionals. The following fall into this category: *Ai-Live Captioning, AudioType, Auto-Subtitle Firefox extension, CapCut, EasySub, Edge Live Caption Feature, EVE, HappyScribe, Hei.io, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome, Maestrasuite, Otter.ai, Simplified, Subtitle video, SubtitleBee, Transkriptor, Veed.io, Wave.video, Wearenova, Webcaptioner, and Zubtitle*.

Professional software is distinguished by a more complex user interface and by providing all the necessary elements for editing and spotting subtitles. In this category we mention: *Checksub, Clideo, Ooona, and Rev*.

3.2.4. *The context of use of subtitling* is also an important classification criterion because it indicates to users which programmes should be used in a specific situation. For example, for a conference, for browsing the Internet or for social networking it is not necessary for the users to rely on professional software that requires training and involves high purchase costs. At present, there are four categories of automatic subtitling software used in specific contexts: *browser subtitling tools, social networking subtitling tools, online conferencing subtitling tools, and TV/DVD/streaming subtitling tools*. Examples in the browser software category are: *Auto-Subtitle Firefox extension, Edge Live Caption Feature, and Live Caption Chrome*. They are rather complex browser extensions, for example, the latter can do automatic subtitling in 22 languages.

In the category of *subtitling software dedicated to online conferences*, the following software has been identified: *EVE, Zoom's closed captioning feature, and Meet's closed captioning feature*. These are recently developed programs that use speech recognition to perform simultaneous subtitling. At the moment, they can only perform simultaneous intralingual subtitling and provide accessibility for online conferences.

Automatic subtitling has also been implemented on social networks through options such as *Facebook's Automatic Caption Feature, Instagram Automatic Captions, and YouTube Automatic Caption*. These features perform intralinguistic captioning, which is highly required by users as the time spent watching videos with

captions is increasing on social media. Thus, it is estimated that 69% of social media users watch video content without sound in public spaces, preferring the use of captions.

A final category consists of automatic subtitling tools for TV/DVD/streaming. These are most similar to the concept of professional subtitling as they are tools designed to generate subtitle files that will later be integrated into various media such as TV/DVD, streaming, theatre, opera, and so on. Within this category fall the following programs: *Ai-Live Captioning*, *Animaker*, *ASG*, *AudioType*, *CapCut*, *Checksub*, *Clideo*, *Diy captions*, *EasySub*, *Filmora*, *Flexclip*, *Flixier*, *HappyScribe*, *Hei.io*, *Kapwing Auto-Subtitle*, *Maestrasuite*, *MateSub*, *Media.io*, *Otter.ai*, *Ooona*, *Subtitle video*, *SubtitleBee*, *Transkriptor*, *Veed.io*, *Wave.video*, and *Wavel.ai*.

3.2.5. *Access to automatic subtitling tools* is a criterion that distinguishes between several categories: *open access*, *commercial+demo* and *commercial programs*. Most of the open access programs are browser-integrated (*Auto-Subtitle Firefox extension*, *Edge Live Caption Feature*, *Live Caption Chrome*) or social media subtitling features (*Facebook's Automatic Caption Feature*, *Instagram Automatic Captions*, and *YouTube Automatic Caption*), where automatic generation of captions involves no cost for users. There are also a number of generic subtitling tools that are currently free to access: *ASG*, *CapCut*, *Diy captions*, *Simplified*, and *Zubtitle*. Some of which, such as *Webcaptioner*, allow users to support the development of software through donations.

At the other end of the spectrum there are the professional, *commercial subtitling tools*, which are usually available on a subscription basis, such as: *Ai-Live Captioning*, *Kapwing Auto-Subtitle*, *Ooona*, and *Rev*. Generally, they are the most advanced automatic subtitling tools and illustrate the new trends in the development of up-to-date subtitling software.

Most of the automatic subtitling tools offer a quite *flexible access*, consisting of an *option for limited access* or a *demo version* of their software. Thus, the user can put the program to the test and decide whether he/she wants to continue using it. This category includes: *Animaker*, *AudioType*, *Checksub*, *EasySub*, *EVE*, *Filmora*, *Flexclip*, *Flixier*, *HappyScribe*, *Hei.io*, *Maestrasuite*, *MateSub*, *Media.io*, *Otter.ai*, *Subtitle video*, *SubtitleBee*, *Transkriptor*, *Veed.io*, *Wave.video*, *Wavel.ai*, and *Wearenova*.

3.2.6. We conclude with the last classification criterion, the linguistic criterion, which refers to the working languages available within automatic subtitling tools. Therefore, a distinction is made between monolingual and multilingual subtitling tools. The first category consists of subtitling tools using a single working language, where the source and target languages of the subtitling of a multimedia file are identical¹. These are tools which provide transcription and/or subtitling in the same language (captions). This category includes: *AudioType*, *Auto-Subtitle Firefox extension*, *Edge*

Live Caption Feature, Diy captions, Facebook's Automatic Caption Feature, Instagram Automatic Captions, Live Caption Chrome, Otter.ai, Zubtitle, Transkriptor, and Webcaptioner.

The second category encompasses subtitling software that can provide speech-to-text transcription, intralingual and interlingual subtitling. That means that the software can support a wider range of subtitling types and provide access to the communicative content of multimedia files in multiple languages, which makes them a more suitable solution for different subtitling environments. In this category, programs with a wide range of working languages include *Ai-Live Captioning, Animaker, ASG, Checksub, Clideo, EasySsub, Filmora, Flexclip, HappyScribe, Hei.io, Kapwing Auto-Subtitle, Mastrasuite, MateSub, Media.io, Ooona, Rev, Simplified, Subtitle video, SubtitleBee, Veed.io, Wave.video, Wavel.ai, and YouTube Automatic Caption.*

Furthermore, it is noteworthy to mention that although all these programs are multilingual, their subtitling capacity differs from one software to another since their working language inventory is different. In addition, within a multilingual subtitling program, differences will be observed in the quality of machine translation for primary and secondary languages. For example, while we expect a multilingual automatic subtitling program to have primary languages such as English, French, Spanish or German, for secondary languages the situation is different. There are a number of programs that do not have Romanian as a working language, such as *CapCut, EVE, Flixier, and Wearenova.* Also, for multilingual automatic subtitling programs, the quality of subtitling in English will always be much better than the quality of subtitling in Romanian.

With this overview of automatic subtitling software, it can be stated that they present a wide variety of programs which have been developed under different trends and represent solutions for specific subtitling situations. Following the classification criteria, we can therefore distinguish 6 main categories of automatic subtitling software:

No.	Criteria of classification	Typology of automatic subtitling tools	Examples
1.	software structure	embedded	Animaker, AudioType, Auto-Subtitle Firefox extension, Edge Live Caption Feature, CapCut, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, HappyScribe, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome, Media.io, Otter.ai, Simplified, Veed.io, Wave.video, Wearenova, și YouTube Automatic Caption
		standalone	Ai-Live Captioning, ASG, Checksub, Clideo, Diy captions, EasySsub, EVE, Hei.io, Mastrasuite, MateSub, Ooona, Rev, Subtitle video, SubtitleBee, Transkriptor, Wavel.ai, Webcaptioner, Zubtitle

2.	working mode	fully automatized	Ai-Live Captioning, Animaker, ASG, AudioType, Auto-Subtitle Firefox extension, Edge Live Caption Feature, CapCut, Checksub, Clideo, EasySub, EVE, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, HappyScribe, Hei.io, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome, Mastrasuite, MateSub, Oona, Rev, Simplified, Subtitle video, SubtitleBee, Veed.io, Wave.video, Wavel.ai, Wearenova, YouTube Automatic Caption
		partially automatized	Otter.ai, Transkriptor, Webcaptioner și Zubtitle, Diy captions și Media.io
3.	user type	general public	Animaker, ASG, Diy captions, Facebook's Automatic Caption Feature, Filmora, Flexclip, Flixier, Instagram Automatic Captions, MateSub, Media.io, Wavel.ai și YouTube Automatic Caption
		amateurs (fans)	Ai-Live Captioning, AudioType, Auto-Subtitle Firefox extension, Edge Live Caption Feature, CapCut, EasySub, EVE, HappyScribe, Hei.io, Instagram Automatic Captions, Kapwing Auto-Subtitle, Live Caption Chrome, Mastrasuite, Otter.ai, Simplified, Subtitle video, SubtitleBee, Transkriptor, Veed.io, Wave.video, Wearenova, Webcaptioner, și Zubtitle
		professionals	Checksub, Clideo, Oona, Rev
4.	the context of use of subtitles	browser	Auto-Subtitle Firefox extension, Edge Live Caption Feature, Live Caption Chrome
		social networks	Facebook's Automatic Caption Feature, Instagram Automatic Captions și YouTube Automatic Caption
		online conferencing	EVE, Zoom's closed captioning feature și Meet's closed captioning feature
		TV/DVD/streaming	Ai-Live Captioning, Animaker, ASG, AudioType, CapCut, Checksub, Clideo, Diy captions, EasySub, Filmora, Flexclip, Flixier, HappyScribe, Hei.io, Kapwing Auto-Subtitle, Mastrasuite, MateSub, Media.io, Otter.ai, Oona, Subtitle video, SubtitleBee, Transkriptor, Veed.io, Wave.video, and Wavel.ai
5.	aces type	Open acces	Auto-Subtitle Firefox extension, Edge Live Caption Feature, Live Caption Chrome, Facebook's Automatic Caption Feature, Instagram Automatic Captions, and YouTube Automatic Caption, ASG, CapCut, Diy captions, , Simplified, Webcaptioner, Zubtitle
		commercial + demo	Animaker, AudioType, Checksub, EasySub, EVE, Filmora, Flexclip, Flixier, HappyScribe, Hei.io, Mastrasuite, MateSub, Media.io, Otter.ai, Subtitle video, SubtitleBee, Transkriptor, Veed.io, Wave.video, Wavel.ai, and Wearenova
		commercial	Ai-Live Captioning, Kapwing Auto-Subtitle, Oona, and Rev
6.	linguistic	monolingual - SL and TL are the	Auto-Subtitle Firefox extension, Edge Live Caption Feature, AudioType, Diy captions, Facebook's

	same	Automatic Caption Feature, Instagram Automatic Captions, Live Caption Chrome, Otter.ai, Zubtitle, Transkriptor, and Webcaptioner
	multilingual - different SL and TL	Ai-Live Captioning, Animaker, ASG, Checksub, Clideo, EasySsub, Filmora, Flexclip, HappyScribe, Hei.io, Kapwing Auto-Subtitle, Maestrasuite, MateSub, Media.io, Ooona, Rev, Simplified, Subtitle video, SubtitleBee, Veed.io, Wave.video, Wavel.ai, and YouTube Automatic Caption
	multilingual – without Romanian language ²	CapCut, EVE, Flixier, Wearenova

Fig. 3 Classification of the automatic subtitling tools

The development of automatic subtitling software is not going to stop at this point. These programs will continue to develop and enrich their services according to technological advances and the language requirements of users and the industry. We believe that the classification criteria we have established will prove reliable in the future, allowing for a comprehensive on-the-ground approach no matter how much automatic subtitling software evolves and changes in the future.

4. Conclusions

In this article, we hope that we have succeeded in illustrating the wide variety of automatic subtitling software currently available to the general public and AVT professionals. Furthermore, we believe that the extensive list of subtitling tools presented in this article provides valuable guidance for the training and skills development of translators, allowing each of them to choose the tools best suited to their specific professional context.

Perhaps the most surprising finding of our research is the significant number of automatic subtitling tools that had to be analysed and classified. This indicates that in future the training of subtitlers should include computer skills related to the use of automatic subtitling tools. The fact that the list of subtitling tools has continued to grow over the course of the study is indicative of the interest in AVT automation, mainly on the part of the industry. In this regard, we are aware that in Europe, in addition to the various subtitling tools developed at national level, an automatic subtitling tool is being developed for use by EU bodies.

In light of this continuous development, the classification of the translator's working tools in the AVT field is necessary. And our analysis of existing programs has revealed the possibility of distinguishing 6 classification criteria for automatic subtitling programs. Although there are certainly other classification criteria, however, we have selected the most important ones in our research, namely: *structure, working mode, type of user, context of use of subtitling, access, and linguistic aspects of automatic subtitling programs.*

Based on the established criteria, a complex classification was made, in which 23 categories of automatic subtitling programs were highlighted as follows: embedded, stand-alone, fully automated, partially automated, general audience, amateur, professional, browser, social networking, online conferencing, TV/DVD/streaming, free, commercial + demo, commercial, monolingual, multilingual, and multilingual (without Romanian language support). Due to their development, it is possible for different programs to switch from one category to another over time.

The brief description of each category of software as well as their illustration with concrete examples not only provides a structured and clear knowledge of the field but also allows the researcher to understand the future development directions of these programs. The structured knowledge about the tools used in the field of AVT can also be useful as a teaching tool in the training of subtitlers.

5. Bibliography

1. Álvarez, Aitor, A. d. Pozo and A. Arruti. 2010. "APyCA: Towards the automatic subtitling of television content in Spanish," *Proceedings of the International Multiconference on Computer Science and Information Technology*, Wisla, Poland, 2010, pp. 567-574, doi: 10.1109/IMCSIT.2010.5680055.
2. Álvarez, Aitor, Carlos Mendes, Matteo Raffaelli, Tiago Luís, Sérgio Paulo, Nicola Piccinini, Haritz Arzelus, João Neto, Carlo Aliprandi, Arantza Pozo. 2006. "Automating live and batch subtitling of multimedia contents for several European languages", *Multimedia Tools and Applications*, Volume 75 Issue 1801 September 2016, pp 10823–10853 <https://doi.org/10.1007/s11042-015-2794-z>.
3. Ando, Akio, Toru Imai, Akio Kobayashi, Haruo Isono, K. Nakabayashi. 2000. "Real-time transcription system for simultaneous subtitling of Japanese broadcast news programs". *IEEE Trans. Broadcast*, 46(3): 189-196 (2000).
4. Bartoll, Eduard. 2008. *Paràmetres per a una taxonomia de la subtitulació. Tesi doctoral*, URL: <http://hdl.handle.net/10803/7572>.
5. Bartoll, Eduard. 2012. *La subtitulació. Aspectes teòrics i pràctics*, Vic, Eumo Editorial, 2012, 215 pp.
6. Boulianne, G., Boisvert, M., Osterrath, F. 2008. "Real-time speech recognition captioning of events and meetings." 2008 *IEEE Spoken Language Technology Workshop*, pp. 197-200.
7. Damper, Robert, Lambourne, A., Guy, D. 1985. "Speech input as an adjunct to keyboard entry in television subtitling." Shackel, B. (ed.) *Human-Computer Interaction---INTERACT'84*. pp. 203-208.
8. Boulianne, G., J.-F. Beaumont, M. Boisvert, J. Brousseau, P. Cardinal, C. Chapdelaine, M. Comeau, P. Ouellet, F. Osterrath. 2006. "Computer-assisted closed-captioning of live TV broadcasts in French", *Interspeech Sep.*, pp. 17-21.
9. Dejica, Daniel & Carlo Eugeni, Anca Dejica-Cartis (eds.) 2020. *Translation Studies and Information Technology - New Pathways for Researchers, Teachers and Professionals*. Timișoara: Editura Politehnica, Translation Studies Series.

10. Gao, J., Zhao, Q., Li, T., Yan, Y. 2009. "Simultaneous Synchronization of Text and Speech for Broadcast News Subtitling". Yu, W., He, H., Zhang, N. (eds) *Advances in Neural Networks – ISNN 2009*. ISNN 2009. Lecture Notes in Computer Science, vol 5553. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-01513-7_63
11. Pirelli, Giuliano. 2004. "Storia del respeaking – Evoluzione del progetto europeo VOICE", Lambourne, Andrew & Ltd, Sysmedia & Riverdale, & Hewitt, Jill & Lyon, Caroline & Warren, Sandra & Hewitt@herts, J & Uk,. *Speech-Based Real-Time Subtitling Services. International Journal of Speech Technology*. 7. 269-279. 10.1023/B:IJST.0000037071.39044.cc.
12. Meinedo, H., D. Caseiro, J. Neto, and I. Trancoso. 2003. "AUDIMUS.media: a Broadcast News Speech Recognition System for the European Portuguese Language", *Proceedings of PROPOR'2003*, Faro, Portugal.
13. Neto, João, H. Meinedo, M. Viveiros, R. Cassaca, C. Martins, D. Caseiro. 2008. "Broadcast news subtitling system in Portuguese," 2008 IEEE International Conference on Acoustics, Speech and Signal Processing, Las Vegas, NV, USA, 2008, pp. 1561-1564, doi: 10.1109/ICASSP.2008.4517921.
14. Karakanta, Alina, Negri, Matteo, Turchi, Marco. 2020. "MuST-Cinema: a Speech-to-Subtitles corpus", in *Proceedings of the 12th Conference on Language Resources and Evaluation (LREC2020)*, pp. 3727–3734.
15. Marks, M. 2003. "A distributed live subtitling system". *BBC R&D White Papers*, WHP 070, London. [url=<http://www.bbc.co.uk/rd/pubs/whp/whp-pdf-files/whp070.pdf>]http://www.bbc.co.uk/rd/pubs/whp/whp-pdf-files/whp070.pdf[url]
16. Meinedo, Hugo, Caseiro, Diamantino, Neto, João, Trancoso, Isabel. 2003. "AUDIMUS. (MEDIA): A broadcast news speech recognition system for the European Portuguese language". 9-17. 10.1007/3-540-45011-4_2.
17. Melero, Maite, Oliver, Antoni, Badia, Toni. 2006. "Automatic Multilingual Subtitling in the eTITLE project", *TC 2006; Linguistics*, pp. 1-16.
18. Ortega, A., Garcia, J.E., Miguel, A., Lleida, E. 2009. "Real-time live broadcast news subtitling system for Spanish." *Proc. Interspeech 2009*, 2095-2098, doi: 10.21437/Interspeech.2009-600
19. Pozo, A.D., Aliprandi, C., Álvarez, A., Mendes, C., Neto, J.P., Paulo, S., Piccinini, N., & Raffaelli, M. 2014. "SAVAS: Collecting, Annotating and Sharing Audiovisual Language Resources for Automatic Subtitling". *Proceedings of the Ninth International Conference on Language Resources and Evaluation (LREC'14)*, Reykjavik, Iceland, pp. 423-435.
20. Trmal, J., Pražák, A., Loose, Z., Pšutka, J. 2010. "Online TV Captioning of Czech Parliamentary Sessions". Sojka, P., Horák, A., Kopeček, I., Pala, K. (eds) *Text, Speech and Dialogue. TSD 2010. Lecture Notes in Computer Science*, vol 6231. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-15760-8_53.

Notes:

¹ It is important that intralinguistic subtitling should not be confused with subtitling for the hearing impaired (SDH). The former is one category of captioning, while the latter is a specific type of intralinguistic subtitling. For a classification of subtitles see Bartoll (2012, 2008) <http://hdl.handle.net/10803/7572>.

² Due to our research interest in Romanian, we have decided to create this category in order to point out to Romanian translators in the AVT field which automatic subtitling programs are not working into this language.