Efficient radiology reporting using the script editor
Autohotkey

Poster No.: C-2254
Congress: ECR 2015
Type: Educational Exhibit
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Keywords: Computer applications, Experimental, Efficacy studies, Workforce
DOI: 10.1594/ecr2015/C-2254

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Learning objectives

1. To demonstrate the potential of the macro script editor Autohotkey to carry out different tasks in order to increase the efficiency of the radiologist’s work in a digitalized radiology environment.

2. To demonstrate different script designs that overcome tedious repetitive mouse movements and keyboard strokes.

3. To review the literature where Autohotkey has been used in a variety of ways involving radiological images or data.
Background

A fully digital radiology environment has led the radiologist to be in front of the computer for most of his working hours, mainly viewing images and writing reports. In addition, other tasks have also been incorporated digitally, such as recording interesting cases, searching through medical literature and browsing through help guides.

Unfortunately, available commercial software does not always take all these simultaneous tasks into account in order to make them agile, personalized and user-friendly.

Authotkey [1] is an open-source software based on the programing language C++ that creates macro scripts, these are, small programmes that automate mouse movements and keyboard strokes in Windows operating systems. Autohotkey is also able to create window programmes using graphic user interphases (GUIs) and carry out calculations. Scripts are written in plain text files which are read by Autohotkey [2]. Scripts can be compiled (converted) to ".exe" applications without the need of installing Autohotkey to run them.

In this presentation we describe different scripts that can help the radiologist's workflow be more efficient with less effort. All scripts were created in our department, except for the Case list script, which is a modified (with permission) version of an AdressBook script from a teaching Authotkey book guide [3].

The presentation will introduce parts of scripts with a simple explanation of the programming language and script design (explanations of each line will follow after a semicolon which is text that Autohotkey ignores). Although Autohotkey does require some programming knowledge, our experience is that useful scripts are created or modified, to suit personal requirements, with little effort.
Findings and procedure details

CHAPTER 1 SCRIPTS DIRECTLY INVOLVED WITH REPORTING

1.1 Hotstrings

The most known feature of Autohotkey is text editing through auto-replace. Autohotkey uses hotstrings to do this. Hotstrings are a combination of characters that are recognized by Autohotkey and are replaced by a chosen text.

Table 1 shows a list of examples of hotstrings. In example 1, if "nmf" is typed it will automatically be replaced by "no more findings ". Hotstrings can be case sensitive as shown in this example.

Hotstrings can be used in radiology reports to write frequent words or phrases in a much faster way (like segments of the lung, example 2, Table 1), or to explain acronyms that clinicians or patients may not be familiar with. For example, we often use the acronym PIRADS followed by a value 1-5 when reporting prostate MRI. This score has been recently described and some patients might not be aware of its meaning. Creating a hotstring for each value saves time when reporting, like in example 3 (Table 1) where by typing only 2 characters (p1) Autohotkey will automatically write 63.

<table>
<thead>
<tr>
<th>Example</th>
<th>Code</th>
<th>Hotstring</th>
<th>Text replaced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>nmf: no more findings</td>
<td>nmf</td>
<td>no more findings</td>
</tr>
<tr>
<td></td>
<td>Nmf</td>
<td>No more findings</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>sfr: superior segment of right lower lobe</td>
<td>sfr</td>
<td>superior segment of right lower lobe</td>
</tr>
<tr>
<td></td>
<td>NMF</td>
<td>NO MORE FINDINGS</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>p1: PIRADS 1 (very low probability of a clinically significant lesion)</td>
<td>p1</td>
<td>PIRADS 1 (very low probability of a clinically significant lesion)</td>
</tr>
</tbody>
</table>

Table 1: To create a hotstring, the abbreviation must be preceded and followed by two colons, with the text wished to be replaced inserted at the end. The hotstrings are case sensitive, so if we write "Nmf" the text will be replaced by "No more findings " and could be used at the start of a phrase.

References: Hospital St Joan de Reus - Reus/ES

An additional use of hotstring is spell checking. A script is available online that corrects (auto-replaces) 4700 common English spelling mistakes [4].

We can write a hotstring to substitute a longer text using a slightly different code format (Figure 1 in sidebar). When "lkp" is typed the letters are automatically replaced by the
complete text. This text can be freely modified in order to change or add more details to the report, such as kidney size.

1.2 Hotkeys and graphic user interfaces (GUIs)

Hotkeys are like hotstrings but the difference lies in that, instead of writing an abbreviation, you press a certain key or combination of keys (for example CTRL-D) and a certain action previously programed is executed. Hotkeys can be used to open Graphic User Interfaces (GUIs) while we are reporting. GUIs are window programs that can be opened for various reasons. They are loaded easily (with just a keystroke), open fast, waste hardly any computer memory and occupy a small part of the screen. They can be utilized to enter data such as numbers or words, or to carry out quick calculations without having to open a calculator or leave your keyboard. GUIs require a bit more programing knowledge.

One useful application is calculating RECIST (Response Evaluation Criteria In Solid Tumors) percentage change, which measures the tumor burden difference between two studies. Figure 2 in sidebar shows a script that can carry out this task. With a combination of keystrokes, such as "ctrl+d", the window immediately appears; the size of the lesions are introduced easily using the Tab button to move through the boxes and after pressing OK the window disappears and the result is introduced in the report Figure 3.
Fig. 3: The RECIST script (RECIST 1.1 Window) is loaded with a keystroke. The numbers are introduced in a fast way. When the OK is pressed the program closes and the text is added to the report (arrow).

References: Hospital St Joan de Reus - Reus/ES

GUIs can be further utilized to create full reports by answering specific questions in a step by step manner. We can introduce information using a check box when data is mutually not exclusive or radio buttons when data is mutually exclusive. The script detects whether a radiobox or a checkbox is ticked or not and writes a phrase accordingly. After writing the text we still have the opportunity to edit any information we may need to.

CHAPTER 2 SCRIPTS INDIRECTLY INVOLVED WITH REPORTING

In this section we concentrate on tasks that are not directly related to writing a report but are commonly carried out whilst reporting. They involve using hotkeys to launch a script that carries out different tasks by automatizing keyboard strokes, mouse drags and mouse clicks.

2.1 Connecting the PACS with the EMR programme
The first script described is one that opens the patient's clinical data in the Electronic Medical Record (EMR) when working with the Picture Archiving and Communication System (PACS) programme. This is useful when these two systems work independently. In our department this operation involves 6 mouse drags and clicks and entering the patient's medical record number (MRN).

A script can be created that not only opens the images and the reporting tool in the PACS programme, but also obtains the MRN automatically and displays the patients clinical data in the EMR. This saves in our working environment 9 mouse moves and clicks and typing the MRN (Figure 4). In order to do this, the script obtains the MRN from a hidden text embedded in the reporting PACS window. The code for doing this operation is explained in Figure 5 in sidebar.

**Fig. 4:** This figure describes the workflow to view and report the images in the PACS programme and to open the EMR and the patient's clinical data. In each step the number of mouse moves and clicks is shown in brackets. A script was designed to automatize all these steps, making the workflow run faster and with less effort.

**References:** Hospital St Joan de Reus - Reus/ES
2.1 Case list script

This script allows you to record a list of interesting cases whilst viewing the images without leaving your keyboard or opening more complex database programmes. Using a hotkey, a GUI window opens with the details of the current patient as default (which are obtained by the same method as the script described before): medical history number, name, surname, date of study, type of study and a link to the report (Figure 6). The only information needed to introduce would be the reason for saving the case (for example: pulmonary vein variant, atypical presentation of sarcoidosis) and a classification of the case (for example: follow up, ask a colleague's opinion, collect to publish, etc.).

The list of patients saved can be viewed in the GUI window and is also saved in a text file as a backup in a format compatible with database programmes such as Microsoft Excel, where each variable is displayed in a different cell.

![Case list GUI window](image)

**Fig. 6**: The figure above shows the Case list GUI window which opens with two keystrokes. The patient's data can be configured to be by default the current patient being viewed.

**References**: Hospital St Joan de Reus - Reus/ES

2.3 Obtaining large amounts of information from the EMR or PACS

In departments where a full RIS is not installed, Autohotkey can be used to obtain a vast amount of information from your EMR or your PACS programme for research or administrative purposes (for example how many prostate biopsies were performed in the
past 4 years or how many CTs were performed suspecting a pulmonary embolism in the last year).

A script can be created that copies the list of patients on a certain modality and date (CT, Monday 5th of January) and pastes it, for example, to a spreadsheet (Microsoft Excel). The page may include the patient's details, the type of CT study and the clinical information written by the referring clinician (like in our department). Thus, we can programme the script to go back to the EMR but now choose a prior day (CT, Friday 2nd of January) and again copy and paste it into a new spreadsheet in our book. We can create a loop for this task and repeat this action say 300 times to have, at the end of the script (in less than 20 minutes), 300 days of programming of a modality recorded (Figure 7). Microsoft Excel would allow us to search, organize or count a certain item.

![Diagram of workflow](image)

**Fig. 7:** The figure shows the simple workflow used to record vast amounts of information from the EMR into a Spreadsheet for research or administrative purposes.

**References:** Hospital St Joan de Reus - Reus/ES

**CHAPTER 3 REVIEW OF THE LITERATURE**

The different uses of Autohotkey in a Radiology Department have already been described in the past [5-8] as a script editor able to automatize tasks such as viewing images, connecting the PACS to the EMR, creating a case database or helping to write reports. Our scripts are indeed similar to the ones described in the papers above but using different PACS and EMR programmes, emphasising the ability of Autohotkey scripts to work with different softwares and working environments.

In addition, Autohotkey has been used alongside other open source software, such as the Optic Character Recognition (OCR), to instantly recognise characters from an image, automatically generated from quantitative computer tomography studies [9] or from MRI images with ROI data [10]. The scripts extracted specific information (T-score, ROIs...
areas and ROIs maximum/average/minimum values) and then pasted this into report templates.

Autopage was created [11] as an Autohotkey script that sends alpha-pages to referring clinicians while reviewing images with the PACS programme. An automatic alpha page to the referring clinician, which includes the patient's information can be created by Autopage, by pressing only two keystrokes.
Fig. 1: In this figure a hotstring is shown that when executed is replaced by a longer text. This text can be modified freely to add or replace information before the report is validated.

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Fig. 2: This figure shows the code needed to create the RECIST script. It can be divided into 3 sections: the first one creates the window in which the input information is introduced, the second carries out the calculations and the third returns the result in the format we choose. This calculation requires adding up lesion sizes in both studies and finding the percentage change between the old and the new.

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Fig. 5: The figure above describes the algorithm used to obtain the patient’s MRN embedded in a hidden text in the PACS window.

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Conclusion

In this presentation we have shown a wide range of examples where Autohotkey can be useful, in order to avoid repetitive and tedious "tasks" in a digitalized radiology environment. We have also included a review of the literature where Autohotkey has been used in different ways involving radiological images or data.

Not all scripts will fit or indeed be needed in every radiological workflow, but if at least one can help to save time and effort, the authors will have reached their goal with this presentation. For those interested in the full scripts described in this presentation or with any other comment please feel free to contact us.
Personal information

I would like to thank my sister Marta for correcting and improving the english text in this presentation and our IT department for encouraging us to start working on this subject.

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References