A web-based system for the automated analysis of MRI in neuro-oncology

Matteo Ippoliti[1,2], Francesco Guzzi[1,2], Roberto Pugliese[1,2], George Kourousias[1,2]

[1]Elettra Sincrotrone Trieste, Italy

[2]Glioblastoma.IT ODV, Italy

Magnetic Resonance Imaging (MRI) exams provide imaging data of high importance to various medical fields including that of neuro-oncology [1]. Beyond the technological aspect of this imaging technique, the assessment of this data is crucial and specialists are necessary. Recent trends aim at developing software systems for the automation of certain tasks [2]. The advances of artificial intelligence and in specific that of neural networks allowed for the automation of processes like that of segmentation based [3] on modern mathematical instruments, their software implementations and deployment in suitable hardware. Due to their complexity such systems are hard to be accessed by groups of specialists not belonging to the original research team and affiliated institutes. Even at premature stages such systems could provide useful insights to the broader medical community. This is especially the case when cross-facility experiments are necessary and novel approaches to research are implemented like virtual trials [ref]. This short manuscript communicates the design and development of a web-based system [Fig.1 and Fig.2] that allows for easier access to advanced methods of automated MRI assessment [4] while it allows for data management and feedback collection for further research. The system permits the inclusion of multiple imaging methods including systems that provide quantitative information [5] for the automatically segmented data. Last but not least, the outcome of this project suggests that such systems can be prototyped fast and render important radiomic advances [6] available to a larger audience.

[1]contact name.surname@elettra.eu All authors have primary affiliation [1] and secondary [2] as volunteers of the aforementioned non-profit ODV [14/02/2023]. This research is part of the initiative RMN.AI

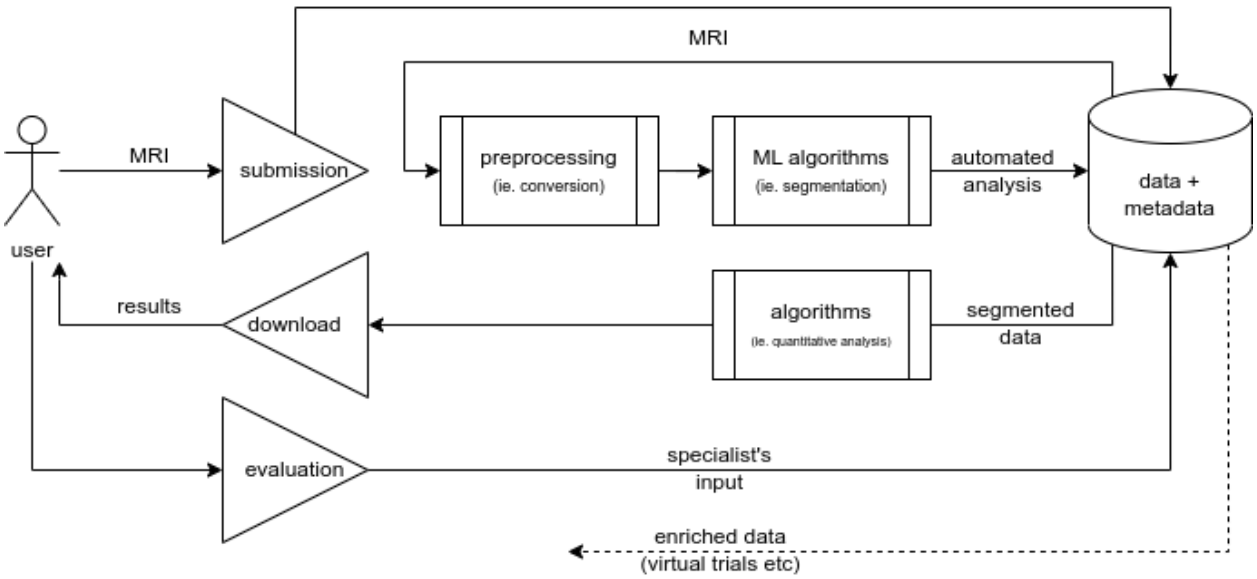

Fig.1 General system architecture. Submission, download and evaluation are web-based and are sequential. Preprocessing, algorithms and data storage are done on cloud resources. The system stores the original data, the processed ones and associated feedback from a specialist.

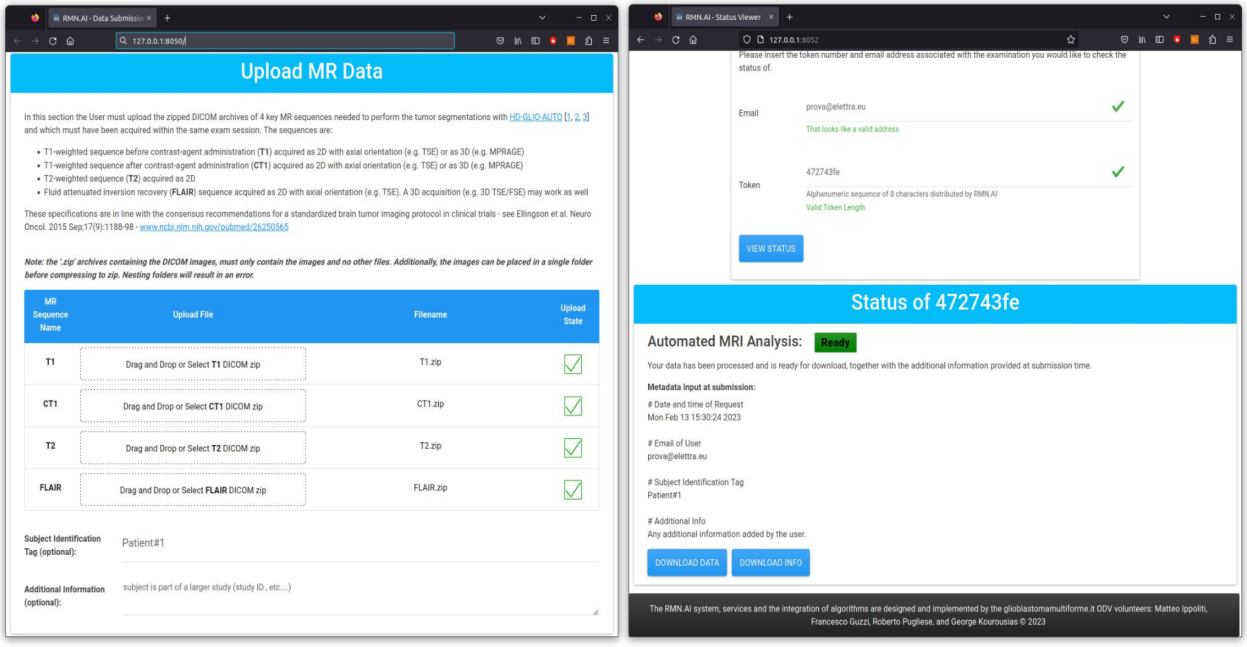

Fig. 2. Partial screenshots of the MRI submission and download of results web forms.

Future versions of this manuscript will include a detailed description of the system and the selected algorithms. It may also provide information on actual use cases and ongoing experiments. Nevertheless, beyond the briefly illustrated architecture [Fig.1] it is noteworthy to highlight the current machine learning automated segmentation method and software choices for the development of the prototype.

In specific the method that was adopted is that of Kickingereder et al. ([4] Lancet 2019) have introduced a deep learning approach which relies on artificial neural networks (ANNs), allowing a fully automated Magnetic Resonance Imaging (MRI) analysis of specific neuro-oncology sequences. The approach managed to provide ways for the quantitative assessment of tumor volume, in order to give an insight to treatment response and/or surgery, in an automatic fashion and in an effort to overcome the potential limits associated with manual tumor segmentation (i.e. time consumption, possible human error). The algorithm has been designed and trained using MRI data from patients with brain tumors that were part of a multi-centre clinical study of 38 institutions across Europe (EORTC-26101 trial).

In regards to the software used for the development of the prototype, the core was done in Python using Dash (Plotly) while for data format DICOM, NIFTI and HDF5 were used with metadata on files and SQLite. OpenCV was used for various pre- and post- processing tasks. Since the main method is ML-based it requires GPU resources which were deployed on cloud and accessed through the latest CUDA APIs.

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