AUTOMATED GENERATION OF ANGLE AND HEIGHT MEASURES IN DISTAL RADIUS FRACTURE RECOVERY PREDICTION

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Introduction

As part of a larger effort to use machine learning to predict the need for resurgery following reduction of distal radius fracture [1], multiple pre- and post-reduction measures of the relative position and orientation of the radius, ulna, and wrist bones (carpals) have been found to be of high predictive value. Typically, such anatomical quantities are obtained through manual computer-based measurement performed by experienced radiologists or orthopaedic surgeons, which is often a time consuming and error prone process. As a first step towards developing faster, more robust gathering of this information, this project demonstrates how state-of-the-art segmentation models can be used to automatically generate accurate measurements.

Methods

ALGORITHM:

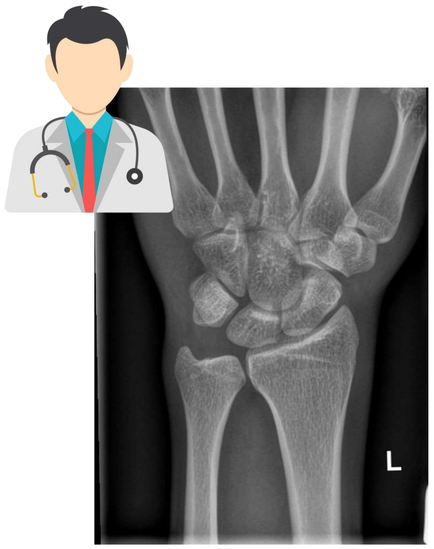
First, an automated segmentation model (Sam-med2D [3]) obtains the outline of each of the wrist bones (e.g., radius, ulna, carpals), thereby providing spatial masks for the bones of interest.

Second, the matching squares algorithm from scikit-image [4] is used to create a smooth, continuous outline (boundary) for each of the spatial masks generated previously. These boundaries are then used to calculate values for each of the desired clinical measurements, based on established definitions [5,6].

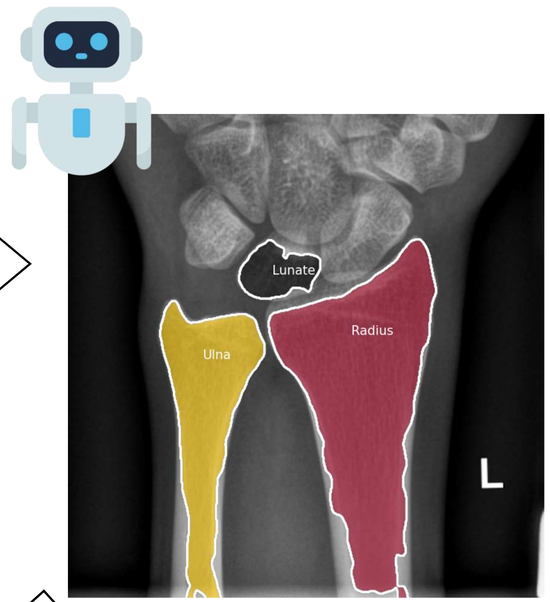
DATA: Wrist radiograph taken from example left wrist radiograph on (Radiopaedia [2]).

Results

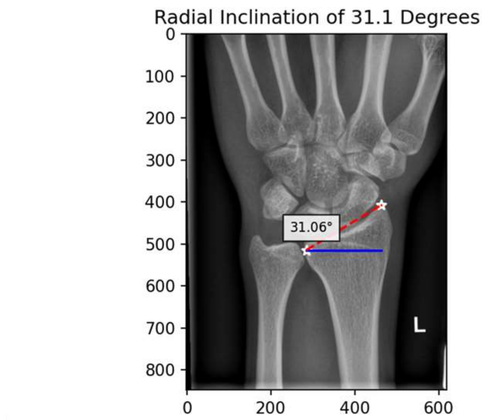
Wrist radiograph in PA view is given

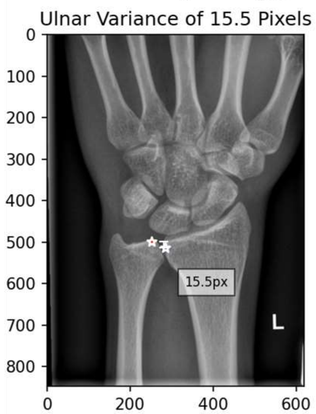


Segmentation model outlines individual bones



Bone outlines are used to calculate measurements





Measurements Taken

- ***Radial inclination*** is the slope of the articular surface relative to the long axis of the bone, obtained as the angle between a line perpendicular to the radius and a line drawn along the superior surface, from the radial styloid to the ulnar border.

- ***Ulnar variance*** is the difference between the length of the distal articular surface of the ulna and that of the radius, obtained following automated detection of the width of each indicated surface.

- ***Radial height*** is the height of the radial styloid, obtained as the vertical difference (in an AP radiograph) from the top of the radial styloid to the superior-most point

Future Directions

This research shows the promise that segmentation models can have in automating the data collection tasks that physicians often have to do when diagnosing a patient. Future and ongoing work on with this project involves:

- ***Training and testing on real patient data:*** Currently, work is being done by physicians at the University of Cincinnati to collect and annotate real patients to improve and determine the accuracy of measurements made by these segmentation models
- ***Gathering more wrist measurements:*** Other important metrics, such as *palmar tilt, teardrop angle,* and *articular step* aren't currently calculated through this process but could also be informative for physicians.
- ***Generalizing these methods beyond wrist radiographs:*** The focus of this research was primarily on wrist radiographs, but the methods shown here could easily apply towards radiograph and ct images taken on other parts of the human anatomy, such as the head, chest, or lower body.

References

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[5] Radiopaedia. (2019). Radiopaedia.org, the wiki-based collaborative Radiology resource. Radiopaedia.org. https://radiopaedia.org/?lang=us

[6] Blakeney, W. G. (2010). Stabilization and treatment of Colles' fractures in elderly patients. Clinical interventions in aging, 337-344.

[7] Graphic elements of the main diagram in the poster were made using resources from Flaticon.com