Device Placement Confirmation System Aims to Bring AI into Clinical Setting

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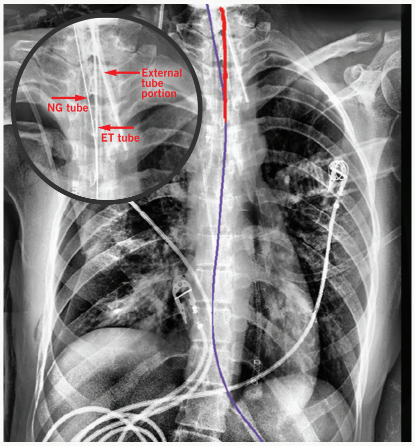
Researchers developing artificial intelligence systems at UCLA are giving special priority to projects that can improve patient care in the near term. "While we're interested in publishing academic papers on the performance of artificial intelligence and recognize the importance of doing so, our primary focus is in getting the technology into clinical practice where it's helping physicians and it's helping patients," explains Matthew Brown, PhD, professor and director of the UCLA Center for Computer Vision & Imaging Biomarkers. Despite the groundswell of interest in medical applications of artificial intelligence, most radiologists do not make use of it in their everyday practice.

Among the current Center for Computer Vision & Imaging Biomarkers efforts that aim to address that focus is a chest X-ray device detection and placement confirmation project. A very large number of chest X-rays are performed each day to check the placement of endotracheal tubes and nasogastric tubes to confirm that they are in the correct position. Physicians need to know immediately when the placement is incorrect because of the significant morbidity and even mortality associated with incorrect placements. The high volume of these X-rays and the challenge of getting busy radiologists to review films quickly makes this application ripe for enhancement with artificial intelligence.

Two artificial intelligence knowledge representations used

The project employs a deep learning technique that applies neural networks to learn through the analysis of large amounts of data. Hundreds of endotracheal and nasogastric tube images have been annotated as training samples to facilitate that learning, and ultimately thousands more will follow to build an algorithm that can analyze new images with a high degree of accuracy. While hundreds of annotated images may suffice to develop the basic functionality of an algorithm, squeezing additional performance out of the model takes progressively larger numbers of training samples. The nearer the model approaches perfect accuracy, the more difficult are the additional gains.



Automated AI detected ET and NG tubes in a complex image with superimposed external leads and tubes.

The system must learn to identify the tubes and analyze their relationship to key anatomical landmarks to confirm that their placement is within the targeted area. The neural network builds its model by encoding image features into a large network of nodes, where the weights between nodes are learned from training samples. This type of machine learning is very powerful, but its workings are not visible to the researchers developing the AI tools, making it in some ways difficult to interpret and also to directly enforce known anatomical relationships. The UCLA team countered that weakness using the novel arrangement of embedding the neural network in a semantic network that can described anatomic relationships. For example, they used the semantic network to specify target boundaries for correct placement of the tip of the endotracheal or nasogastric tube relative to anatomic landmarks, rather than relying on the neural network to correctly learn these boundaries on its own. In a number of ways, the semantic network layer adds assurance that the analysis will not be derailed by basic errors of interpretation on the part of the neural network.

Adding artificial intelligence to the existing workflow

Dr. Brown and his colleagues plan to introduce their placement confirmation tool directly into the existing X-ray workflow by integrating it into the PACS. "If you run the algorithm on a separate workstation, fewer physicians will make the time to use the tool," states Dr. Brown. "By integrating it into the PACS, we can run the analysis automatically for every chest X-ray at the time it is archived and make the results immediately available to the physician when they first review the image." Another advantage of this integration is that the AI algorithm can be implemented simultaneously throughout the health care system, there's no need to roll out new workstations in each clinic location.

The system's findings, including alerts if the tube is misplaced, are overlaid on the X-ray image, making it easy for the physician who placed the endotracheal or nasogastric tube to preliminarily confirm its placement even before the radiologist reviews the film. The AI tube location overlay is also visible to assist the radiologist in interpreting the image. Should the radiologist discover an error in the algorithm's analysis, the image is flagged and fed back as a training sample, further refining the algorithm over time. The AI system can also identify images in which the neural network has lower certainty in its output, and can move them to the top of the radiologist's queue for immediate review. R