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ADAPTIVE NEURO-FUZZY INFERENCE SYSTEMS (ANFIS) FOR SUPERVISED CLASSIFICATION OF COMPETENCE IN MIS BASED ON PSYCHOMOTOR SKILLS

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INTRODUCTION: Objective assessment of motor skills has become an important challenge in minimally invasive surgery (MIS) training. Currently, there is no gold standard defining and determining the residents' surgical competence. To aid in the decision process, we analyze the validity of a supervised classifier to determine the degree of MIS competence based on assessment of psychomotor skills. Chosen classifier is an adaptive neuro-fuzzy interface system (ANFIS).

METHODOLOGY: The ANFIS is trained to classify performance in a box trainer peg transfer task performed by two groups (expert/non expert). There were 42 participants included in the study: the non-expert group consisted of 16 medical students and 8 residents (< 10 MIS procedures performed), whereas the expert group consisted of 14 residents (> 10 MIS procedures performed) and 4 experienced surgeons. Instrument movements were captured by means of the Endoscopic Video Analysis (EVA) tracking system. Nine motion analysis parameters (MAPs) were analyzed, including time, path length, depth, average speed, average acceleration, economy of area, economy of volume, idle time and motion smoothness. Data reduction was performed by means of principal component analysis, and then used to train the ANFIS net. Performance was measured by leave one out cross validation.

RESULTS: The ANFIS presented an accuracy of 80.95%, where 13 experts and 21 non-experts were correctly classified. Total root mean square error was 0.88, while the area under the classifiers' ROC curve (AUC) was measured at 0.81.

DISCUSSION: We have shown the usefulness of ANFIS for classification of MIS competence in a simple box trainer exercise. The main advantage of using ANFIS resides in its continuous output, which allows fine discrimination of surgical competence. There are, however, challenges that must be taken into account when considering use of ANFIS (e.g. training

time, architecture modeling). Despite this, we have shown discriminative power of ANFIS for a low-difficulty box trainer task, regardless of the individual significances between MAPs. Future studies are required to confirm the findings, inclusion of new tasks, conditions and sample population.