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I. INTRODUCTION

- ❖ Adhesive Capsulitis (AC) causes chronic shoulder pain and severely restricted movement.
 - Early diagnosis is essential for timely intervention and successful rehabilitation.
- ❖ This study proposes a vision-based, non-wearable, non-invasive solution for AC detection:
 - Utilizes shoulder abduction movement only,
 - Captured with a single Azure Kinect depth camera,
 - No need for manual joint labeling or wearable sensors.
 - Integrates deep learning (DL) and explainable AI (XAI)

II. MATERIAL AND METHODS

2.1 Experimental Protocol

- ❖ 176 elderly participants (39 healthy, 137 with AC) performed shoulder abduction in 5–10 trials per hand, each with 3–10 repetitions.
- ❖ AC diagnosis : clinical evaluation, SPADI scores, and physical tests for shoulder pain, stiffness, and function.

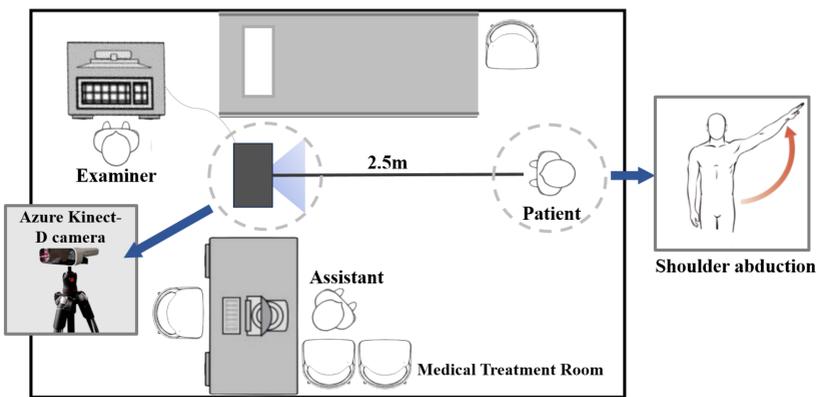


FIGURE 1: SHOULDER MOTION DATA ACQUISITION SETUP.

2.2 Segmentation & Network Architecture

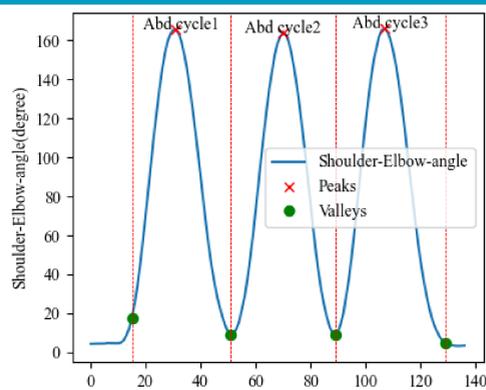


FIGURE 2: SEGMENTATION OF SHOULDER ABDUCTION MOVEMENTS.

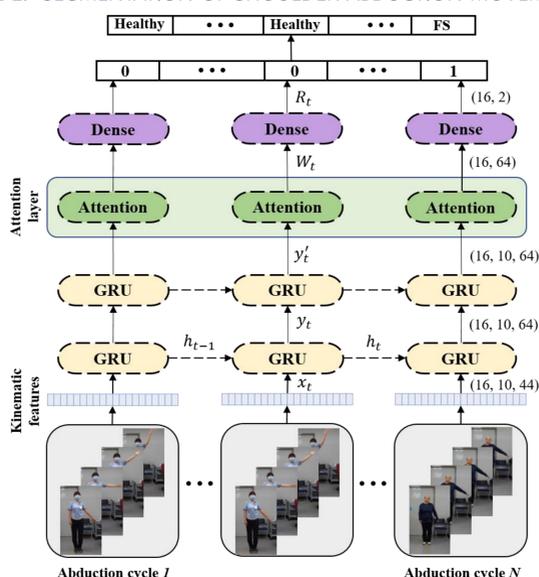


FIGURE 3: THE ARCHITECTURE OF DeepAttGRU.

III. RESULTS

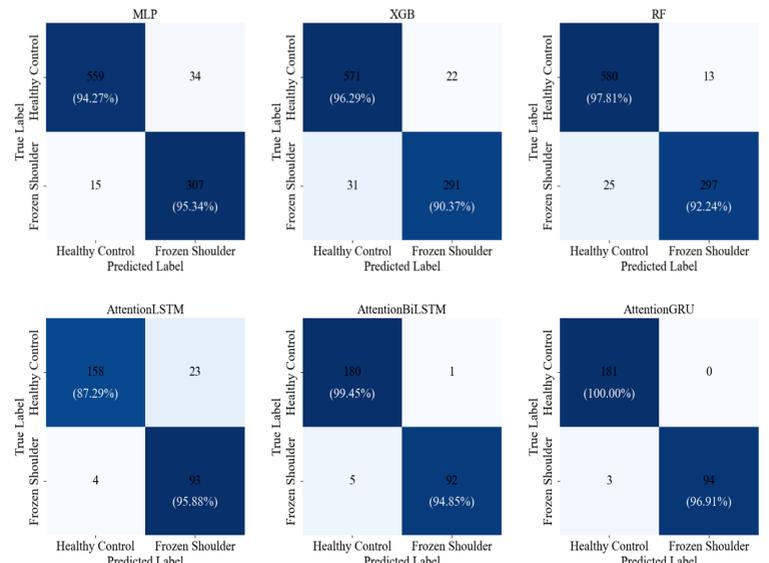


FIGURE 4: CONFUSION MATRICES OF DL MODEL PERFORMANCE.

TABLE 1: COMPARISON OF CLASSIFIER PERFORMANCE IN AC DETECTION.

Model	Accuracy	Recall	F1-score
MLP	94.64	94.80	94.20
XGB	94.20	93.33	93.60
RF	95.84	95.02	95.40
Att-LSTM	90.28	91.58	89.72
Att-BiLSTM	96.84	97.04	97.26
Att-GRU	98.51	98.26	98.85

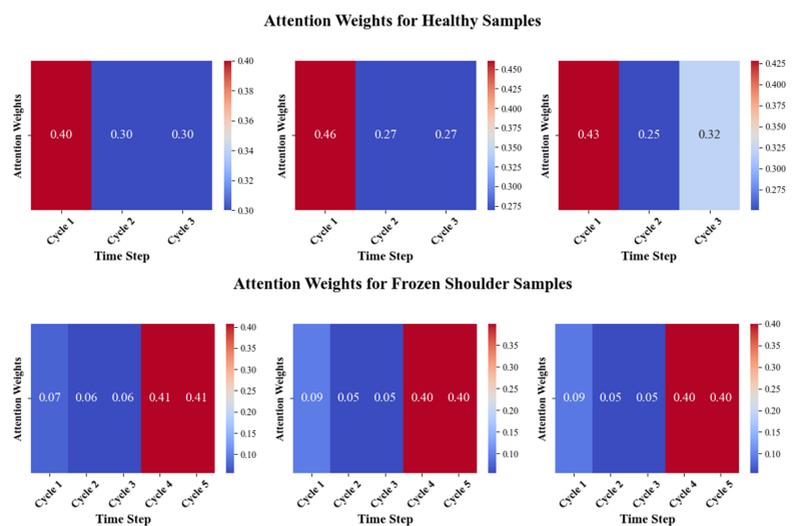


FIGURE 5: ATTENTION WEIGHT VISUALIZATION ACROSS ABDUCTION CYCLES (Att-GRU).

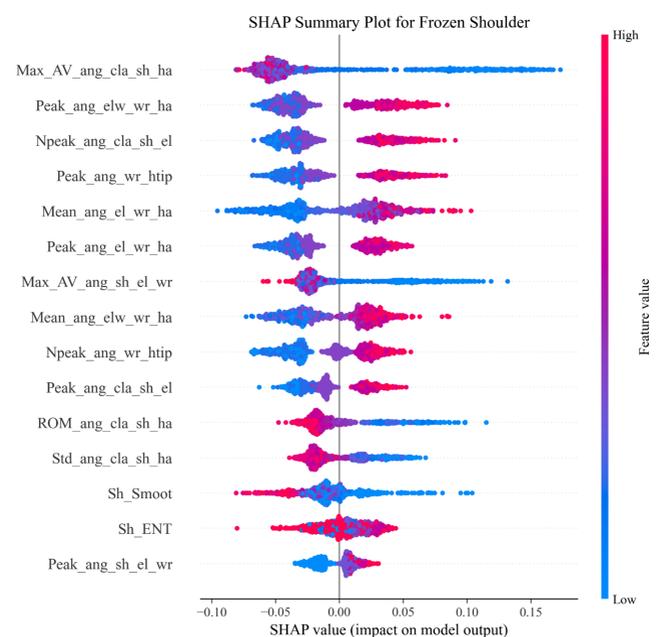


FIGURE 6: SHAP SUMMARY PLOT FOR AC PREDICTION USING DeepAttGRU CLASSIFIER.

III. CONCLUSIONS

- ❖ Developed a vision-based, non-invasive method to detect AC using shoulder abduction.
- ❖ Shapley Additive Explanations (SHAP) revealed key motion features, enhancing clinical interpretability.
- ❖ Provides an explainable, clinically valuable tool for early AC diagnosis and decision support.