Surgical Skill Assessment from Laparoscopic using Graph-Based Modelling

-Using the JIGSAWS Dataset for Skill Evaluation

Estd : 2008

INTRODUCTION:

- Manual evaluation of surgical skills is **time-consuming** and **subjective**.
- This project introduces an **AI-based model** that automatically assesses surgeon skill from **motion (kinematic) data**.
- The system combines **Graph Convolutional Network (GCN)** and **Long Short-Term Memory (LSTM)** to capture both **spatial** and **temporal** motion features.
- The goal is to make **surgical training assessment faster, objective, and data-driven.**

PROBLEM STATEMENT:

- Current surgical skill assessment relies on experts manually reviewing videos.
- These evaluations are:
- Time-consuming
- Inconsistent across evaluators
- Lacking automation
- **Challenge:** Develop a system that can **automatically recognize gestures** and **predict skill level** from robotic surgery data.

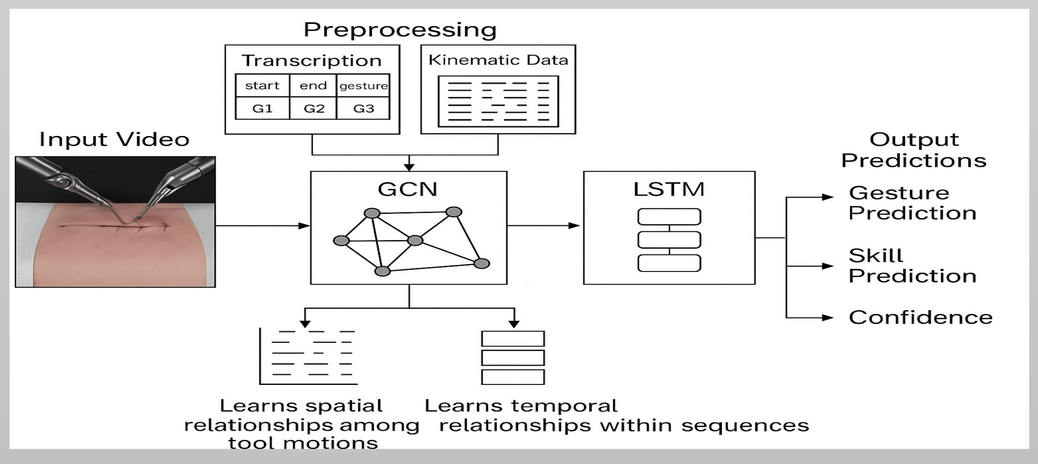
OBJECTIVES:

- Collect and prepare motion (kinematic) and gesture data from the JIGSAWS dataset.
- Build a deep learning model that combines GCN and LSTM.
- Train the model to recognize gestures performed during surgery.
- Evaluate the model's performance using accuracy and loss graphs.
- Discuss challenges and propose improvements for future work.

DATASET – JIGSWAS:

- **Full form:** *JHU-ISI Gesture and Skill Assessment Working Set*
- Tasks: **Suturing**, **Knot Tying**, **Needle Passing**
- Data includes:
- **Kinematic data:** 76 features of tool motion
- **Gesture transcriptions:** gesture start & end times
- **Video recordings**
- 15 gesture classes (G1–G15) performed by 8 surgeons (A–I).

MODEL ARCHITECTURE:



OBSERVATIONS & CONCLUSION:

- GCN–LSTM effectively captures tool motion and gesture transitions.
- System reduces subjectivity in skill assessment.
- Stable training behavior indicates good learning capability.
- Dataset inconsistencies affected final accuracy.
- The model demonstrates that **AI can evaluate surgical skills objectively**.

CONCLUSION:

- Combining **GCN** and **LSTM** enables both spatial and temporal analysis.
- The system forms a **foundation for automated surgical training** tools.
- Future improvements can make it suitable for **real-time skill evaluation**.

FUTURE WORK:

- Train on **GPU** for improved performance.
- Add **real-time video-based prediction**.
- Use larger, cleaner datasets.
- Develop an **interactive web interface** for users.
- Include **surgeon ID-based** automatic skill prediction.

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