



AMRITA
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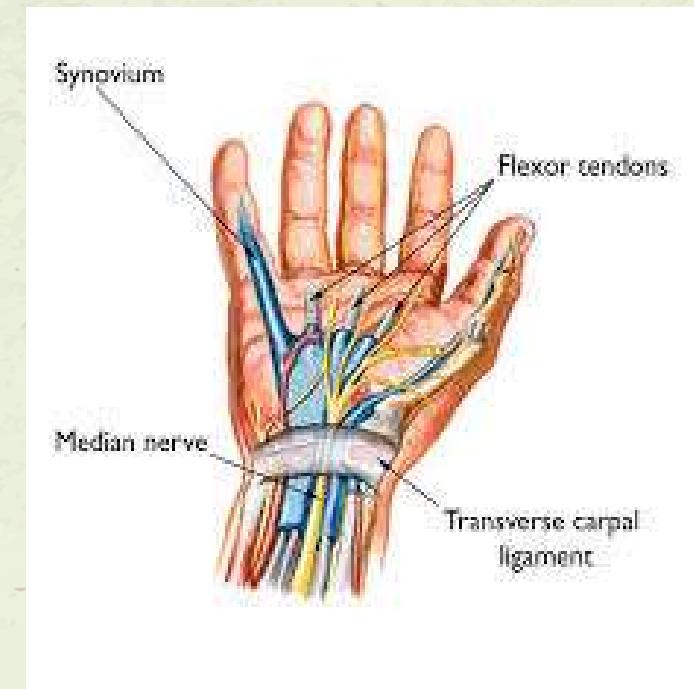
Wrist Rehabilitation System

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Review 1 OverView

- CTS - A disease that affects wrist movement in patients due to the compression in the median nerve within the carpal tunnel of the wrist.
- CTS is caused by non-neutral wrist postures and abnormal muscle activity. There is a need for non-invasive tool to determine CTS and provide therapy.
- Online simulation of servo mortro, MPU6050, and ESP32 was done to show the movement of a Servo motor,
- Used FNN for data Pre-Prorocessing.
- It includes Class filtering, Binary label creation, filling issing valuses, Feature extraction, and Splitting the data in 70-20-10 for training, testing and validation.



RNN

- Recurrent Neural Networks, a class of deep learning models, are specifically designed to process sequential data.
- They have a memory that captures information from previous steps in sequence making them ideal for tasks where the order of inputs matters.
- The same set of weights is reused across all time steps, enabling the model to generalize across variable-length sequences.
- Pre-Processing:
 - Raw EMG data prepared for analysis,
 - 1, 3, 4 classes are used.
 - Binary labels are created.
 - Moving average is used for filling the missing values.
- Windowing: to help analyze patterns over time,
- Feature Extraction: For each Window, variance is calculated across the 3 EMG channels.
- Threshold-Based Detection:
 - 75th percentile threshold a cutoff where 75% of variances are below it is normal if exceeded then CTS detected.
 - Combining Labels.

- Normalization:
 - Standard Scalar scales features to ensure all input values are of same range.
- Train/Validation/Test split:
 - 70% for training.
 - 15% to tune hyper parameters.
 - 15% to evaluate final performance.
- RNN Model Architecture:
 - 1st layer: passes full sequence of outputs to next layer(64 neurons)
 - 2nd layer: returns only final output(64 neurons)
 - 3rd layer: Dense layer with sigmoid activation function for binary classification.
- Training:
 - Epochs: iterations over the training data.
 - Batch size: 32 processed at once.

- Conversion of model to TensorFlow Lite:
 - Trained RNN model is saved as rnn_model.h5 and loaded into memory.
 - Keras model is taken and prepares it for TFlite conversion.
 - Optimization:
 - Quantization reduces the precision of numbers.
 - Pruning removes unnecessary parts of the model.
 - Converted model is then saved, ready for deployment.
- Setting up of cloud server by Flask API:
 - Arduino reads EMG sensor
 - Normalizes data
 - Sends HTTP POST to local server.
 - Server returns prediction.
 - Arduino shows results on OLED display.

HARDWARE COMPONENTS

Arduino UNO



-> An open source computing platform that is used for constructing and programming electronic devices

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Digital I/O Pins: 14 (6 PWM)
- Analog Input Pins: 6
- Flash Memory: 32 KB (0.5 KB used by bootloader)
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Communication: UART, I2C, SPI

EMG Sensor



-> Detects electrical activity generated by muscles.

- Operating Voltage: 3.3V to 5V
- Output Voltage: 0 – 3.3V (analog signal)
- Electrode Type: Three dry electrodes (Reference, Signal, Ground)
- Gain: Adjustable gain amplifier
- Noise Filtering: Bandpass filter (removes DC and high-frequency noise)
- Interface: Analog output

Servo motor (DS5160)



-> Produces torque and velocity based on the supplied current and voltage.

- Operating Voltage: 4.8V – 7.4V
- Torque: 60 kg·cm (at 7.4V)
- Speed: 0.16 sec/60° (at 7.4V)
- Control Signal: PWM (50Hz)
- Angle Range: 0° to 180° (or continuous rotation mode)
- Gears: Metal gears for durability)

OLED display SSD1360



- Resolution: 128×64 pixels
- Display Type: Monochrome OLED
- Interface: I²C (4-pin) or SPI (7-pin)
- Operating Voltage: 3.3V – 5V
- Power Consumption: Low
- Driver IC: SSD1306

-> Detects electrical activity generated by muscles.Organic Light-Emitting Diode display uses the powerful single-chip CMOS OLED driver controller, the SSD1306.

3D Design

