

Wearable Rehab Technology for Automatic Measurement of Patients with Arthritis



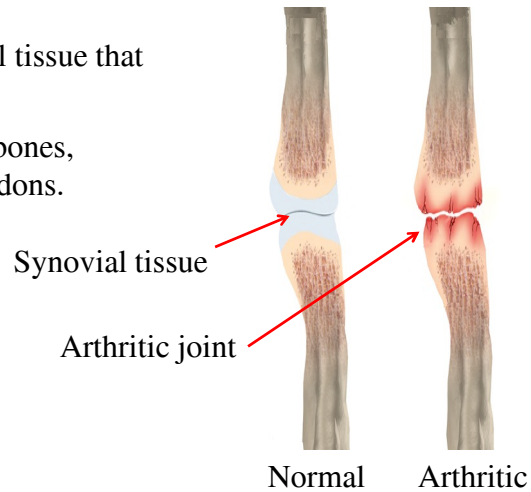
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- Rheumatoid Arthritis (RA) is a disease that attacks the joints of the human skeleton.
- In 2010, RA affected up to 500,000 of the UK population and starts between the ages of 40-50.
- RA is currently diagnosed by clinicians and therapists using x-rays and manual evaluation methods.
- Manual methods are open to observer bias.
- This project focuses on an accurate hand measurement tool to detect hand Range of Motion (ROM) and joint stiffness.

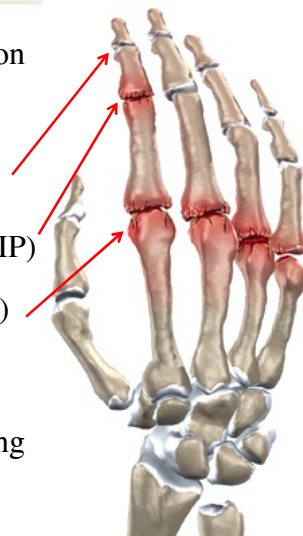
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- RA affects the synovial tissue that lubricates the joints.
- This condition affects bones, joints, muscles and tendons.



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- Stiffness, swelling and deformity are common symptoms.
- Joints affected are:
 - Distal interphalangeal (DIP)
 - Proximal interphalangeal (PIP)
 - Metacarpophalangeal (MCP)
- Swollen joints cause clicking sounds during movement and 'trigger finger'.



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Swelling and inflammation of the DIP and PIP joints cause both joints to bend. This creates:

- Boutonnière or hyperextended deformity
- Swan-neck or hyperextension deformity



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- Occupational Therapists (OT) quantify joint range and determine hand function using the following methods and techniques.

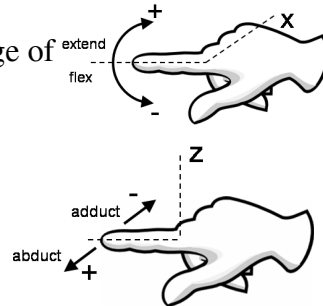
Goniometer

- Measures flexion, extension, abduction and adduction of finger joints.
- The stationary arm of the goniometer is placed resting on the top of each finger
- Fingers are bent towards the palm with the second goniometer arm. Flexion is measured in degrees.
- This is repeated for each finger and thumb.



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- Measures finger flexion and extension - range of forward and backward digit movement.
- Measures abduction and adduction of finger joints.
- This is repeated for each finger & thumb.
- Goniometric measurement techniques have changed very little over the past 80 years. Average results within 7° in 62%-72% of trials.



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- A Health Assessment Questionnaire (HAQ) determines a patient's ability to perform daily tasks.
- A Grip Strength Dynamometer measures the patient's grip of the intrinsic and extrinsic in kg.
- Tape measure – measures thumb-index finger web space and distal phalanx-palm distance in centimetres.
- Kapandji Score – grades the range of movement of the patient's thumb against each finger tip.



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- Outcomes are easily influenced by clinicians training and experience.
- All measurements are recorded in handwritten form.
- HAQ can be answered solely by patient or with a clinician. Answers may be more positive when answered with a professional.
- Joint stiffness is currently unmeasured.
- Current process is time consuming.

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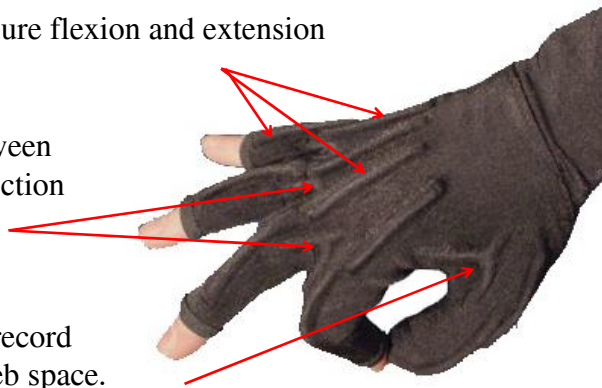
This project will provide the clinician with a ROM tool measuring:

- The degree of deformity of the hand and stiffness of the moving finger joints.
- Detection of creaking joints during movement.
- A shift in the position of the fingers in relation to the direction of the thumb by measuring web space.
- Recording the minimum, maximum and average values of a number of tests.
- Analysis of joint movement data to identify areas for Joint Protection benefits.

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This project will initially use the 5DT data glove to measure joint ROM.

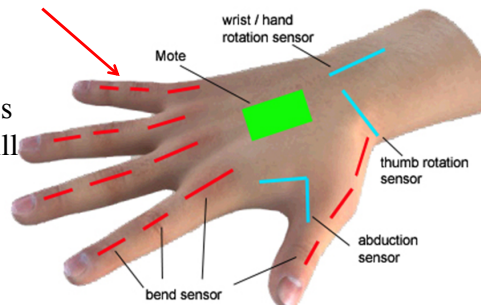
- Bend sensors will measure flexion and extension of each digit.
- Abduction sensors between fingers will detect adduction and abduction range.
- Abduction sensor will record Thumb-index finger web space.



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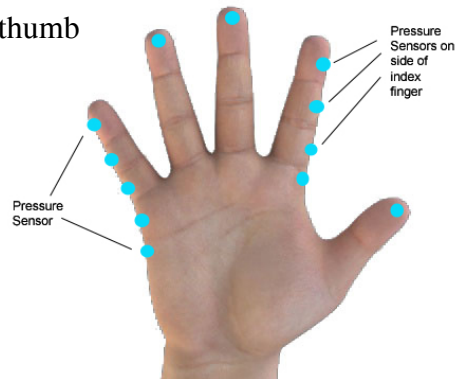
A new glove is currently under design with added functionality.

- Additional bend sensors will measure flexion and extension on the three joints of each digit and detect Boutonnière and swan neck.
- Mote will store sensor data onto a flash card and will include wireless connectivity. An accelerometer will measure forearm supination and pronation.
- Wrist and thumb rotation sensors will measure ulnar and radial deviation.



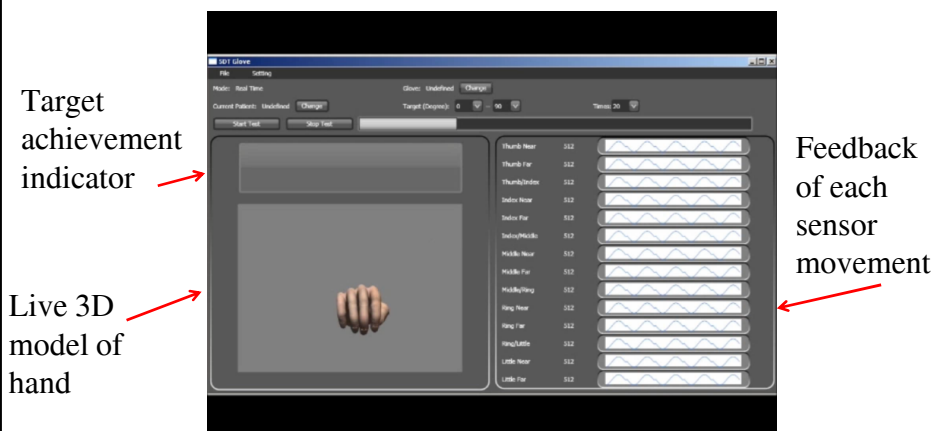
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- Pressure sensors will measure Kapandji index.
- The patient attempts to touch their thumb against various points on the hand.
- Kapandji score increases as each point is touched.



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Bespoke system under development.



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Additions to the software system will measure

- Minimum and maximum flexion and extension ranges of each digit.
- Adduction and abduction range for each digit.
- Thumb-index finger web space.
- Amount of joint stiffness for each digit.
- Recording, storage and analysis of patient data.
- Analysis of historical patient movement.

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- The new system will be a data collection and playback tool.
- First ambulatory system to record joint stiffness at home
- System will simultaneously record angles from multiple fingers and detect previously unidentifiable movement patterns.
- Record data offline for future analysis and playback.
- Problematic combinations of joint movement will be detectable and the benefits of Joint Protection recommended to patient.
- Glove system may be used in conjunction with emerging research in Mirror Imagery (MI) and Motor Imagery (MoI).

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- To date, Clinicians use manual, time consuming techniques to quantify hand limitations.
- Current methods have the capability to detect hand ROM, with some issues.
- The proposed system will provide an automatic hand ROM measuring tool capable of measuring joint movement, joint stiffness and comparison analysis of historical movement data.
- Future work will provide additional joint movement for each finger and offline recording of movement at home.
- A new e-textile glove will provide a glove with low-weight, comfort, and high flexibility.

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Questions?

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