IOT based Post Activity Monitoring System

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***Abstract**-In this fast-moving world due to lack of bone mineral density people are facing a lot of health issues. In humans' knee being a vital part of our body, which has to be taken with atmost care. A lot of pressure has been imposed on our knee while walking, running, jumping can cause high pressure on our knees on daily basis and lack of care can lead to knee replacement. So, for a knee replacement Total Knee Arthroplasty is beneficial and proven to be successful and most commonly used for osteoarthritis. So, after the knee replacement there has to be a proper device for the patients to monitor the knee movement continuously. For the continuous monitoring system through our proposed system, we can continuously monitor the patient's implant by using multiple sensors. The whole system is controlled with the help of an advanced microcontroller by using IOT.*

Keywords- kinematics, wearable device, rehabilitation, retractable, neuromuscular.

1.INTRODUCTION

Accurate monitoring of joint angles in the ambulatory setting could provide important information regarding the progress of rehabilitation in patients with neuromuscular and musculoskeletal disorders, such as stroke, Parkinson's disease, osteoarthritis (OA), anterior cruciate ligament injury, and rotator cuff injury. Traditionally, kinematic analysis has been performed within laboratory settings using optoelectronic motion capture systems—the gold standard for human kinematic analysis—which utilize an array of infrared cameras to capture the positions of reflective markers placed on predefined anatomical landmarks to create a three-dimensional (3D) skeletal model. These systems are useful in clinical and research environments, but the availability of well-equipped gait laboratories in clinical settings is often lacking, and is limited by cost and technical expertise. Most importantly, assessments restricted to laboratory settings provide a narrow snapshot of function and do not capture natural free-living gait patterns, thus representing a severely under-sampled view of patients' conditions. Frequent, longitudinal monitoring of kinematic parameters in ambulatory settings could provide an objective assessment of physical function and disease progression, allowing the development of personalized treatments and rehabilitation programs to cope with dynamically changing functional performance levels. Much effort has been made to develop wearable sensors that can facilitate real-time, continuous joint health and movement monitoring in free-living conditions, including approaches that leverage near-infrared spectroscopy, bio-acoustics, electrical bioimpedance, and kinematic modelling. In particular, a wide range of sensing methodologies have been studied to enable kinematic modelling, such as inertial measurement units (IMUs), radio frequency, however, few wearable systems support a comprehensive solution that is 1) power efficient,

2) cost effective, 3) safe, 4) easy-to-use, 5) flexible enough to comply with highly dynamic, heterogeneous human body shapes, and6) accurate enough to support the 5 ∘ estimation accuracy suggested by the American Medical Association for movement analysis in a clinical context, which are important characteristics for long-term field study deployment. This project introduces a reliable, power efficient, and low-cost wearable sensor designed for long-term monitoring of joint kinematics in the ambulatory setting. In particular, this sensor was developed to monitor the knee joint angles of patients with knee OA.

2. LITERATURE SURVEY MahdyEslamy, Felix Oswald, Arndt F. Schilling "A main challenge in the development of active prosthetic knees is how to determine (estimate) the required motion of the missing joint/limb in line with the motion of the remaining biological ones. To do so, a motion planner is required. This study proposes a motion planner for active prosthetic knees. Two inputs are used to estimate the corresponding knee joint positions the motion planner does not require speed estimation, gait percent identification, or switching rules and estimates the outputs (knee joint positions) continuously.

Brandon Oubre, Jean-Francois Daneault, Katherine Boyer, "Accurate monitoring of joint kinematics in individuals with neuromuscular and musculoskeletal disorders within ambulatory settings could provide important information about changes in disease status and the effectiveness of rehabilitation programs and/or pharmacological treatments. This paper introduces a reliable, power efficient, and low-cost wearable system designed for the long-term monitoring of joint kinematics in ambulatory settings. The proposed wearable device can accurately estimate knee flexion/extension angles.

Mohammad Fazel Rabbi, Nuculanid Arshad, Kamrul H. Ghazali "Knee pain often disrupts the performance of Islamic prayer (Salat). Development of rehabilitation tool for Muslim population with knee pain has become an increasing demand. Electromyographic (EMG) activity of knee muscles may be an assessment tool of such rehabilitation technology. Our results suggest that, overall, all four muscles are affected due to the knee pain and thus show abnormal activity in standing and knee flexion. It has also been found that, hamstring muscles were more affected than thigh muscles while performing knee flexion.

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Knee osteoarthritis is commonly treated through total knee arthroplasty (TKA) or unicompartmental knee arthroplasty (UKA) and therefore the assessment of postoperative differences in functional capabilities between TKA and UKA patients appears of primary importance. Outcomes of this study could help to gain further information about functional recovery after different knee arthroplasty procedures, in order to improve the choice of rehabilitative treatment.

3. METHODOLOGY System description:

This project constructed a system for real-time monitoring of knee extensor muscle training motion with flexible sensors. Knee extensor muscle is classified to three levels according to their skin stretch and corresponding change in electrical resistance measured by flexible sensors. The area with the largest skin stretches corresponds to the sensor location that measures the largest change in resistance.

Hardware description: Mems Sensor:

Fig.1.changing the axis of mems sensor

When the mems sensor is bend or touched, it shows certain values in the lcd display. The sensing element is manufactured using a dedicated micro-machining process developed by STMicroelectronics to produce inertial sensors and actuators on silicon wafers.

Fig.2. Displaying the value in the LCD display

When the mems sensor is bend or touched, it displays certain values in the lcd display.

Fig.3. Sensor values are displayed in the blynk application

The values which were displayed in the LCD are shown in the bylnk application.

Force Sensor:

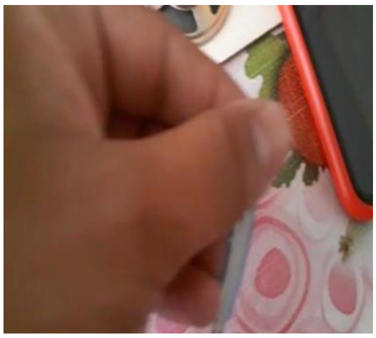

Fig.4. Pressure applied on force sensor

Force-sensing resistors consist of a conductive polymer, which changes resistance in a predictable manner following application of force to its surface.

Fig.5. Displaying the values in the LCD Display

When the pressure is applied, the values are displayed.

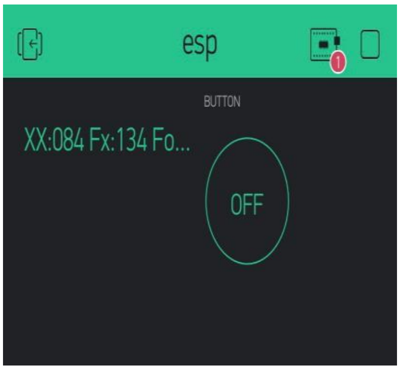

Fig.6.Sensor values displayed in blynk application speaker

Fig.7. The final output sound from the

The values are noted

Algorithm Used:

In order to verify the values an algorithm named K-Nearest Neighbour (KNN) Algorithm is used in the proposed method. It is the process of identifying algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories.

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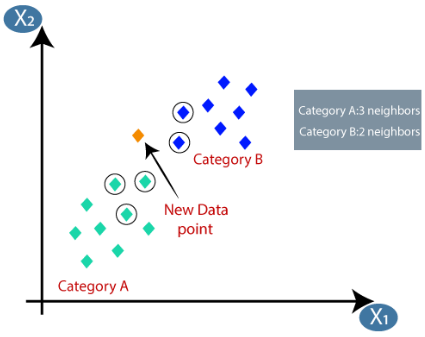

Fig.8. KNN Algorithm working principle

Random forest algorithm

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

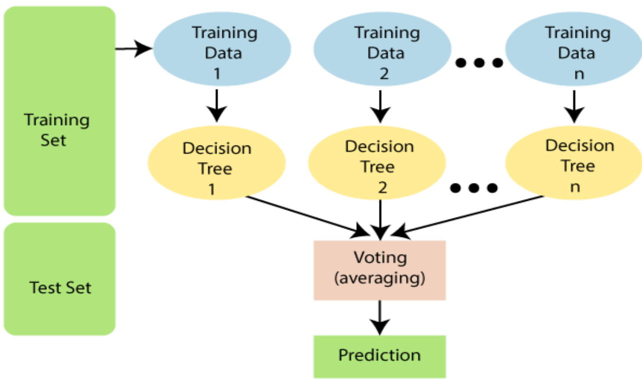

Fig.9.Random forest working principle

4. RESULTS

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test=train_test_split(X,Y,test_size = 0.1, random_state=1)
from sklearn.ensemble import RandomForestClassifier
# Random Forest
random_forest = RandomForestClassifier(n_estimators=100)
random_forest.fit(X_train,y_train)

Y_prediction = random_forest.predict(X_test)
print(Y_prediction)
random_forest.score(X_train, y_train)
acc_random_forest = round(random_forest.score(X_train, y_train) * 100, 2)
print(round(acc_random_forest,2,), "%")
```

```
[0 0 1 0 0]
100.0 %
```

Fig.10.Accuracry obtained through random forest algorithm

The Random Forest algorithm is applied and the accuracy is obtained.

```
from sklearn.neighbors import KNeighborsClassifier
X_train,X_test,y_train,y_test=train_test_split(X,Y,test_size = 0.1, random_state=5)
# KNN
knn = KNeighborsClassifier(n_neighbors = 3)
knn.fit(X_train, y_train)

Y_pred = knn.predict(X_test)
print(Y_pred)
acc_knn = round(knn.score(X_train, y_train) * 100, 2)
print(round(acc_knn,2,), "%")
```

```
[1 1 0 1 1]
68.18 %
```

Fig.11. Accuracy obtained through KNNalgorithm

The KNN algorithm is applied and the accuracy is obtained, that identifies the similarities between new case data.

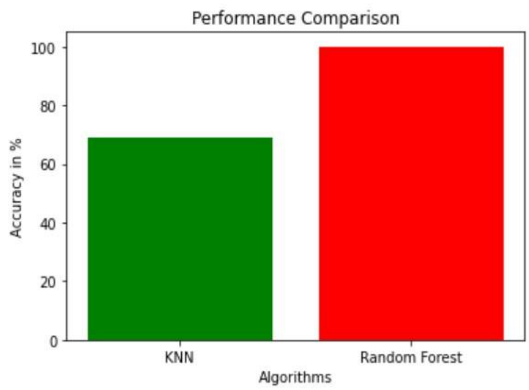

Fig.12. Overall accuracy obtained

The overall accuracy is shown between KNN and Random Forest algorithm.

Parameters Analyzed for KNN Algorithm

	Precision =TP/(TP +FP)	Recall =TP/(TP+FN)	F1-score =(2*Precision*Recall)/ (Precision+Recall)	Support
0	1.00	0.25	0.40	4
1	0.25	1.00	0.40	1
Accuracy			0.40	5
Macro avg	0.62	0.62	0.40	5
Weighted Avg	0.85	0.85	0.40	5

FIG.13 PARAMETERS OF KNN

This study facilitates real-time measurement and can evaluate angle, angular velocity, and dynamic exercise or static isometric exercise of knee motion during training process, simultaneously.

Parameters analyzed for random forest algorithm

	Precisi on =TP/(	Recall =TP/(TP+FN	F1 score 2*(Precisi on*Recall	SUPP OR T
0	0.25	0.50	0.33	5
1	0.00	0.00	0.00	3
Accu rac y			0.20	5
Macr o	0.12	0.25	0.17	5
Weig hte d	0.10	0.20	0.13	5

Fig. 14 Parameters of random forest algorithm

5. CONCLUSION

This study successfully constructed a real-time monitoring system of motion for knee extensor muscle training. During 25 repetitions of knee extensor muscle training, the six muscles involved could be divided into three levels according to their corresponding changes in skin stretch and the resistance measured by the system's sensors. The methods employed in this study confirmed the correlations between knee bending angle, skin stretch, and change in resistance. Moreover, the system developed in

6. REFERENCES

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