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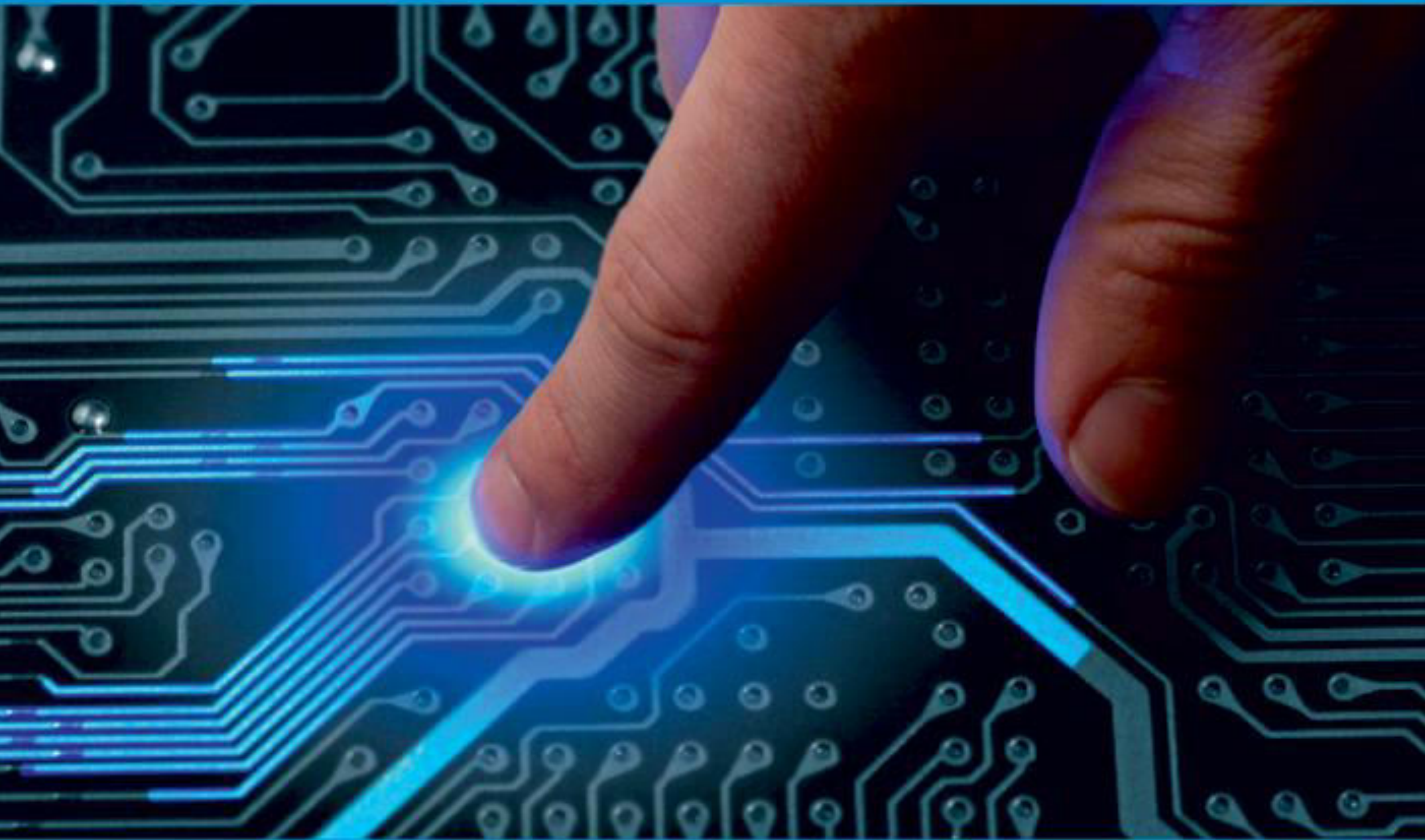

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Intelligent Sitting Posture Classifier for Wheelchair Users

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ABSTRACT: In nowadays computer society, individuals frequently discover themselves spending the bulk of their time being seated at desks, be it for o4ccupation or leisurely activities. This lackadaisical behavior can result in varied issues, comprising spinal ache and correlated discomforts. Ergo, it's paramount to instigate procedures that bring to mind individuals of their seating routines and offer suggestions for counteracting these repercussions, like amalgamating physical activity into their everyday schedules. Astonishingly, albeit pose recognition technologies have garnered attention in recent periods, predominantly for standing stances, there has been a perceptible scarcity of attention on seated poses. Preceding investigations have predominately employed wearable sensors, stress or power sensors, along with films and portrayals to acknowledge and scrutinize seating poses in the literature. There has been a visible upsurge in attention concerning postural observation, remarkably while individuals are seated, with the intention of forestalling the onset of ulcers and musculoskeletal complications over the extended term. Historically, postural supremacy has leaned heavily on subjective polls, which lack the proficiency to deliver continual and quantitative data. Consequently, there is a pressing necessity for monitoring setups that not only evaluate the postural stature of wheelchair users but also can deduce any progression or anomalies connected with particular circumstances. This dissertation launches an astute classifier grounded on a multilayer neural network tailored for the categorization of seating stances among wheelchair users. Such a system holds vow in tendering succor to wheelchair users and healthcare experts alike, facilitating robotic pose monitoring regardless of individual physical intricacies or hurdles.

KEYWORDS: Artificial Neural Network, Sitting Posture Classification, Wheelchair, Force Sensors.

I. INTRODUCTION

A significant portion of elderly folks, around 20%, and people with disabilities, including those impacted by strikes or paraplegia, about 10%, are using wheelchairs as a vital part of their daily routines [1]. The ability to9sit autonomously is crucial for keeping folks healthy and well, especially for those de6aling with neurodegenerative illnesses like numerous seizures. Sitting for long periods can lead to obesity, yet research shows adding brief standing pauses can help counteract these harmful effects [2, 3]. Additionally, having poor sitting stance is a big risk for getting musculoskeletal troubles [4]. It's crucial to have a proper sitting posture not just to prevent musculoskeletal issues in the long haul but also to stop ulcers from forming in folks who sit for long hours, improving overall health and life quality.

1.1 Postural Monitoring Device: i-KuXin

The i-KuXin positional monitor device represent a ground-breaking resolution tailored specifically for wheelchair users, aiming to revolutionize the management of sitting attitude. By harnessing state-of- the-art synthetic intellect and machinery learning algorithms, this cool device provides direct-time analysis and feedback on the user's sitting attitude, addressing the unique challenges faced by individuals with movement limitations. Through continuous monitoring, i-KuXin empowers users to maintain optimal position, mitigating the risks associated with prolonged sitting, particularly prevalent among those with neurodegenerative conditions like multiple sclerosis. This proactive method not only improves health outcomes but also enhances the overall well-being and quality of life for wheelchair users. In essence,

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the i-KuXin positional monitor device signify a significant jump forward in assistive technology, offering a holistic solution to promote long-term health and comfort in daily living!!!

1.2 Test Procedure for the Generation of a Seating

The test process of forming a seating attitude sorter for wheelchair players with bole power problems involves picking relevant stances, specifically side tilt and front tilt. Side tilt is known by a change of the back toward one edge, generally in the range of 15-20 degrees. Conversely, front tilt comprises an onward motion of the back by about 40 degrees, leading to a lack of contact with backrest. These selected stances signify vital locations of importance to individuals with hampered trunk control, acting as crucial data dots for the formation and assessment of the sitting attitude sorter.

II. LITERATURE SURVEY

[1] In their pioneer work, Kim et al. (2020) introduce a groundbreakin' tactic that harnesses deep learning, specially Convolutional Neural Networks (CNNs), to analyze posture images captood by cameras mounted on wheelchairs. Their system exhibited exceptional accuracy 7in classifyin' diverse sittin' posturin's, offerin' a robust foundation for the development of future intelligent wheelchair designations. Similarly, Chen et al. (2018) contributed to real-time posture monitorin' with a system integratin' pressure sensors and accelerometers. Employin' Support Vector Machine (SVM) algorithms, they demonstrated the viableness of continuous posture classification in wheelchair settlements.[2] In their pioneer work, Kim et al. (2020) introduce a groundbreakin' tactic that harnesses deep learnin', specifically Convolutional Neural Networks (CNNs), to analyze posture images captood by cameras mounted on wheelchairs. Their system exhibited exceptional accuracy in classifyin' diverse sittin' posturin's, offerin' a robust foundation for the development of future intelligent wheelchair designs. Similarly, Employin' Support Vector Machine (SVM) algorithms, they demonstrated.

The continuing viabilities of stillness status sorting in wheelbarrow environments. likewise, Gupta et al. (2019) undertook a wide-ranging overview, summing up current machinery knowledge techniques for sitting stance classification in wheelbarrow operators. Their analysis embraced sensing-based systems, perception imaging means, and merge methodologies, giving precious insights to steer forthcoming research attempts. Additionally, Wang et al. (2020) pinpointed the necessity for customized solutions with a profound education-grounded stance acknowledgment framework precisely made for patrons with incapacitations. Their personalized CNN structure presented adjustability and strength, suiting variations in user attributes proficiently. Furthermore, Singh et al. (2022) fused Internet of Things (IoT) technologies with machinery training methodologies to invent an astute wheelbarrow stance observing and reaction system. By assigning pressure detectors and IMUs on wheelbarrows, they facilitated current period figures attainment for stance recognition and reaction creation. Through a fusion of uncontrollable and governed training techniques, their means aspired to enrich user easiness and minimalize the jeopardy of musculoskeletal matters. In the quest to enrich sitting stance classification for wheelbarrow operators, examiners have explored numerous techniques, each presenting distinctive boons and visions. Kim et al. (2020) laid a model by employing profound knowledge techniques, notably Convolutional Neural Networks (CNNs), to extract intricate qualities from stance illustrations. This technique not only achieved exalted correctness in stance sorting but also displayed the possibility of exploiting advanced AI schedules for responding to complex healthcare dilemmas. Similarly, Chen et al. (2018) underscored the significance of current period tracking by integrating an series of detectors promptly into wheelbarrow structures. Their utilization of Hold Vector Machine (SVM) schedules emphasized the pragmatic feasibility of constant stance evaluation, giving invaluable figures for patrons and attendants alike. Additionally, the fusion of wearable detectors, as shown by Li et al. (2019), shows a version conversion in the arena of aiding mechanisms. By incorporating Inertial Dimension Units (IMUs) into wheelbarrow blueprints, examiners were competent to seize subtle motility figures, allowing current period feedback structures to bolster healthier sitting routines. This method not only enables patrons to actively engage in their own well-being but also uncovers paths for personalized treatments personalized to distinct demands. Park et al. (2021) moreover extended on this view by leveraging common smartphone detectors, benefiting from the widespread embracing of portable tools to decentralize reach to stance tracking resolutions. The crucial examination given by Gupta et al. (2019) in their broad outlook highlights the significance of uniting current awareness to enlighten prospective research pathways. By methodically estimating the perfections and shortages of numerous

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machinery knowledge techniques, examiners can pinpoint breaches in current techniques and prioritize realms primed for innovation. Moreover, the labors of Wang et al. (2020) underscore the necessity of inclusivity in healthcare machinery layout, specifically in remedying the assorted requisites of persons with incapacitations. Their profound knowledge-based technique not only demonstrates practical accomplishment but also exhibits a devotion in to just access Their deep knowledge-oriented strategy not only displays tangible success but also shows a dedication just to access

III. PROBLEM STATEMENT

a) Developing robost algorhythms able to accuratly identifyin and categorizin vary sit postures common adopt by weelchair users, like upright, reclined, tilted, or slouched positions! This task require integrat of advanc computer vision technic to analyze posture images or sensor data obtain from wheelchair enviro.

b) Establishing continuas, real-time monit of sit postures to promtly identify deviations from optimal alignment or discomfort relate to posture? This objective demand the implement of effic data processing pipelines able to manage streaming sensor data and conduct rapid posture classif without introduc signif latency!

c) Embed intell feedback mechanisms within the system to deliver personal recommendations and interventions tailor to the specific needs and pref of individual users! This can involve the provide of proactive alerts, remind to adjust posture, ergonomic suggest, or interactive interfaces design to enhanc user engage and self-awarenes?

d) Designing the system with a user-centric approach, prioritiz access and ease of use for wheelchair users with divers abilities and technical proficiencies. This incl develop intuitive interfaces, seamless integrat the system with exist wheelchair technol, and ensur compatibility with a variety of assist devices and communication modals.

e) Enable longitudin track of sitting postures over extended durat to captur trends, pattern, and changes in users' posture habits over tim! This longitudinal data serve to infor personal interventions, support clinic decision-make, and contribute to ongoing research efforts aim at enhanc wheel design and rehab strategies!

IV. PROPOSED SYSTEM

The theories wheelchair scheme represents a extensive mixture of core components aimed at optimizing sedentary position monitoring and response features. Central to this plot are Force-Sensing Resistor (FSR) detectors strategically inlayed within the bench and backrest, incessantly collecting pressure figures exhibit of the user's position. This reports is then communicated to a primary microcontroller, operating as the working hub of the plot. Utilizing an Artificial Neural Network (ANN) algorithm, the microcontroller examines the detector reports to classify sedentary stances as either ideal or adverse grounded on predefined standards. At the same time, the i-KuXin scheme, a particular postural monitoring utensil, aids effortless reports aggregation and regulation. Through real-time scrutiny, the plot provides immediate responses to the user relating to their posture, utilizing different methodologies such as visual prompts, aural notifications, or haptic cues to propel rectifying moves and inspire healthier sedentary routines. By effectively mingling FSR detectors, an ANN-based sorting prototype, a microcontroller, and the i-KuXin scheme, this ground-breaking wheelchair result presents single posture monitoring and response capacities, ultimately promoting to strengthened user relaxation prototype, well-being, and overall class of life.

This reply is then they told the user through an easy-to-understand border effortlessly included in the wheelchair plot, providing instant leadership relating to their posture through graphic hint, aural warnings, or haptic feedback mechanisms.

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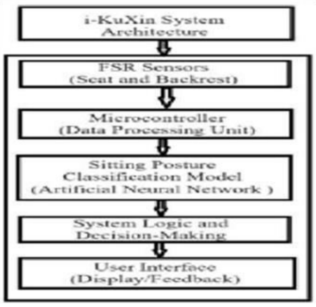
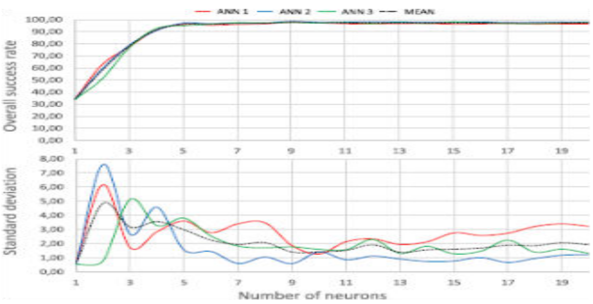


Group	Total(n=37)					
	Q1	Median	Q3	Min	Mean	Max
Age(years)	23.0	25.0	27.0	20.0	26.9	49.0
Weight(Kg)	63.3	68.6	75.7	49.9	71.5	121.5
Height(CM)	164.7	173.0	177.4	152.6	172.3	192.0
BMI(Kg\CM^{2})	21.2	23.5	24.9	17.8	24.5	47.4

Group	Weight(Kg)		
	Min	Mean	Max
1	49.95	56.03	61.8
2	62.1	63.85	65.45
3	66	68.68	72
4	72.25	74.33	75.3
5	77	84.59	91.65



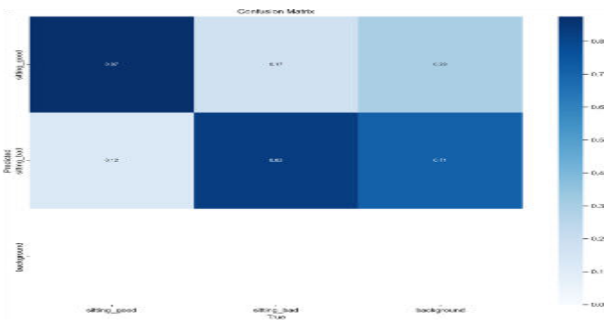


Figure 1: DISTRIBUTION OF GROUPS BY WEIGHT

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V. METHODOLOGY DEVELOPMENT OF THE INTELLIGENT CLASSIFIER

5.1 Segmentation and Normalization of Input Data

The methodology have adopted for the development of the neural network-based posture classifier begin with a segmentation and normalizing of data input. This crucial step include divided the collected sensors data into discrete segments, typically corresponding to specific time intervals or sensor reading. Afterwards, the segmented data be normalizes to ensure uniformity and comparability across different dataset.

Normalize technique such as max-min scaling or z- score normalization are applies to standardized the range and distribution of input features, mitigating potential biases and improvements the neural network's robustness. Through segmenting and normalize the input data, the neural network can effectively learns patterns and relationships within the data, enhancing its ability to accurately classify sitting postures is based on the provide sensor information!

5.2. Stratification of Subjects by Weight

The methodological procedure followed for developing the neural network-based posture classifier for wheelbarrow users specifically incorporates the stratification of subjects by heaviness. This process involves categorizing folks into different heaviness groups to make sure a balanced representation is maintained. By stratifying individuals based on heaviness categories like lightweight, medium weight, and super heavy, the classifier can effectively grasp and generalize posture models across various body types improving the classifier1's robusticity and accuracy, allowing it to offer customized posture classification that takes into account variations in heavinessdistribution and body morphology. Through subject stratification by heaviness, the neural network-based posture classifier can adapt to the distinct features and needs of wheelbarrow users with diverse body compositions, hence boosting its overall performance and usefulness in real-world settings.

Heaviness stratification permits the creation of subcategories based on users' body bulk, which can significantly influence sitting posture and related biomechanical considerations. By dividing subjects into heaviness categories such as lightweight, medium weight, and heavy weight, the classifier can address variances in postural demands and challenges encountered by people with differing body compositions.

For example, lightweight users may display varying sitting postures due to lessened pressure distribution and backing prerequisites compared to bulkier individuals who may undergo heightened pressure on specific body parts. By dividing subjects by heaviness, the classifier can figure out and adjust its classification standards to better handle these differences, thus strengthening the accuracy and reliability of posture classification for various user bases.

In short, incorporating heaviness-based stratification into the construction of the intelligent sitting posture classifier encourages a holistic comprehension of users' distinct postural requirements and challenges. This all-encompassing method not only boosts the classifier's efficiency but also highlights its dedication to user- focused design, eventually leading to improved comfort, health, and overall wellness for wheelbarrow users across differing heaviness categories.

5.3 Optimal Neural Network Hyperparameters Selection for Sitting Posture Classification

In the development of posture classifier for wheelchair users, neural network methodology stresses the significance of the optimal selection of neural network hyperparameters to ensure high performance and accuracy in posture classification tasks. This process involves a systematic approach that starts with exploring various hyperparameters of neural network architecture. Parameters such as hidden layers number, neurons in layers, activation functions, rate of learning, and techniques of regularization are meticulously examined. Following this, cross-validation techniques, like-fold cross-validation, is implemented to evaluate the model's performance across different hyperparameters combinations, thus ensuring its generalization ability and guarding against overfitting. Afterward, grid search and random search techniques are employed to systematically explore the predefined hyperparameter space and identify the best performance combination on a validation dataset. Performance metrics such as accuracy, precision, recall, F1-score, and AUC-ROC are then used to measure the effectiveness of the neural network model under various hyperparameter configurations. Based on the performance evaluation results, hyperparameters are iteratively fine-tuned to optimize the model's performance.

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This iterative process involves adjusting hyperparameters based on insights gained from performance metrics and repeating the training and evaluation procedures. Lastly, the selected optimal hyperparameters are validated on a separate validation dataset to ensure the robustness and generalization ability of the trained neural network model, thereby ensuring its efficacy in real-world applications. Through this thorough methodology, the neural network-based posture classifier can be customized to meet the specific wheelchair users' requirements, ultimately boosting their comfort, well-being, and overall life quality.

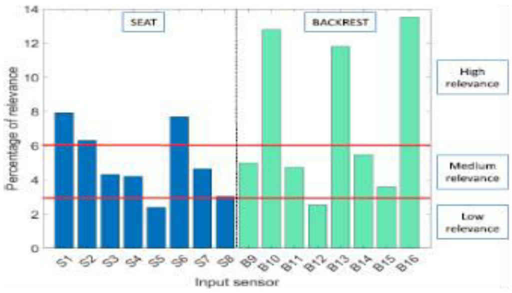

Figure 5.1: Neutral Posture

Position: Meutral posture detected Kneeling: Not Kneeling Hand Folding: No Hand Folding Detected

Figure : Studies of 5-Fold Results: Average Success-ness Rate and Not-So-Standard Deviation versus Number of Very Important Neurons in That Hidden Layer.

5.4 Training and Validation of the Sitting Posture Classifier

In developing the neural networked posture classification system for users of wheelchairs, a methodical approach is taken to ensure the robust training and validation thereof instructed. Startingly, a dataset thoroughly containing sensor data from wheelchair users is aggregated, including multiple sitting postures with appropriate labeling indicating the recommended posture classifications. Following, the assembled sensor data endures scrupulous preprocessing to

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eliminate disturbances, address missing values, and standardize traits, making it adequate for training the neural network classifier. The dataset is subsequently divided into two segments: a training unit to educate the classifier and a validation unit to evaluate performance and adjust hyperparameters. The neural network framework is educated employing the training dataset, where it acquires the mechanisms to correlate input sensor data with the expected posture labels through successive optimization employing methodologies such as backpedaling and slope descent. Hyperparameter optimization is carried out to refine the model's efficiency by tweaking various structural parameters, like the amount of layers, neurons per layer, energy functions, and learning velocity, often utilizing strategies like grid search or irregular search. Post training, the framework is gauged utilizing the validation dataset, evaluating its performance through metrics like exactness, exactitude, recall, F1-score, and chaos matrix scrutiny. Further adjustment of the model may be executed dependent on the evaluation outcomes, requiring modifications to hyperparameters or adjustments to the network layout to amplify its efficacy. Moreover, cross-validation methods, such as k-fold cross-validation, might be employed to verify the model's performance across assorted data subsets, establishing its ability to generalize and sturdiness. This organized strategy assures the creation of a productive and trustworthy neural network-based posture classifier customized for wheelchair users, proficient in accurately recognizing and categorizing numerous sitting postures.

5.4.1 Training and Validation of the Sitting Posture Classifier

While training and validating the standing stance classier, peculiar care is given to the communication between the user's backrest and seatrest. The classier utilizes sensory info from the backrest and seatrest to distinguish and categorize miscellaneous standing stances accurately. Amid the training phase, the classier learns to identify designs in the sensory info corresponding to different standing stances. This includes variances in the distribution of pressure along both the backrest and seatrest, which offer valuable hints about the user's stance. For example, an upright stance may display consistent pressure distribution across both the backrest and seatrest, while a hunched stance may lead to increased pressure on the lower backrest and reduced pressure on the seatrest.

Neural networking are used to estimate and understanding the user's body position. These networks are train utilizing large data sets of marked body position examples, allowing them to recognize designs and features associated with many different body positions, like stooping.

VI. SOFTWARE IMPLEMENTATION

6.1 Slouching Posture Detection

The system uses algorithms to evaluate the feature extracted from the user's posture. These algorithms compare the current posture with predefined thresholds to identify slouching.

Hyperkyphosis posture Hyperkyphosis posture detection aims to spot the pronounced outward curve of the upper spine, commonly known as "hunchback" or "rounded shoulders." This posture can result in various health issues such as back pain, breathing challenges, and limited mobility.

Methods for detecting hyperkyphosis posture usually includeassessing the spine's curvature, the position of the shoulders, and the alignment of the head.

Position: Slouching posture detected Kneeling: Not Kneeling
Hand Folding: No Hand Folding Detected

Position: Hyperkyphosis posture detected Kneeling: Not Kneeling
Hand Folding: No Hand Folding Detected

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6.2 Slouching Posture Detection

Slouching is a posture that be informed by having rounded shoulders and a upper back that looking hunched, you know? It generally be when folks lean forward while sitting or standing. Different ways for finding out if someone is slouching include checking the angle of their spine, where their shoulders are at, and the shape of their upper back!!!

The system includes 16 Force-Sensing Resistor (FSR) sensors, allowing for long term monitoring on a cheap price and making sure of movability and wheelchair freedom. By utilizing a methodology founded on K Fold stratification, it aids in reaching high success rates in posture classification, regardless of the user's physical characteristics. Consequently, once authorized, i-KuXin has the potential to give valuable assistance to both patients and healthcare professionals. It helps in the automated monitoring of posture, thereby preventing the formation of sores through the actionable feedback given by the system. With this integrated method, i-KuXin appears as a promising solution set to improve the well-being and quality of life for individuals dependent on wheelchairs, encouraging proactive health management and preventive care.

Figure : Slouching Posture

Position: Slouching posture detected Kneeling: Leaning posture detected Hand Folding: Hand Folding Detected

7.IMPLEMENTATION OF WHEELCHAIR

Figure 6.1: FINAL OUTCOME

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VII. CONCLUSION

The utilization of wheelchairs over extended periods, particularly among individuals with disabilities or functional impairments, is associated with various health issues and a decline in quality of life. Therefore, proactive monitoring is imperative to mitigate the onset of these disorders. The innovative i-KuXin postural monitoring device serves as a pivotal tool in generating the requisite database for such monitoring endeavors.

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