INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 7 ISSUE 4 (2021) PAGES 22 - 27
RECEIVED : 17.06.2021 PUBLISHED : 23.06.2021
July 24,2021

EARLY DETECTION OF NEURODEVELOPMENTAL DISORDER IN INFANTS USING IoT BASED AUTOMATIC POSTURE AND MOVEMENT TRACKING WEARABLE SENSOR

[1]Abira Bright B, [2]Hemalatha K, [2]Sharvini R, [2]Sheela K

[1]Assistant Professor, Bio Medical Engineering,SALEM COLLEGE OF ENGINEERING AND TECHNOLOGY, INDIA-636 111.

[2]UG scholar, Bio Medical Engineering,SALEM COLLEGE OF ENGINEERING AND TECHNOLOGY, INDIA-636 111

Abstract

Early detection of infant with a typical motor developmental disorder for those infants who have abnormalities or neuro cognitive disorders, so we describe the development of an infant wearable, multi-sensor for analysis of infant movements using this suit we record to the movements approximately 7-12 months age infants. These data were processed and compared to the data set and this processed data were uploaded through IOT. Machine learning classification algorithms are used to take inertial movement from wearable sensors placed on the infant for a day and predict, thus further establishing the connection between early movement and developmental trajectory. Background accelerometer is widely used to measure sedentary time, physical activity energy expenditure and sleep related behaviors. However, data collection and processing criteria have evolved in a myriad of ways out of the need to answer unique. Accelerometers or gyroscope are used into one of pre-defined actions. Recently CNN has established itself as powerful technique for human activity recognition. We conducted a search of electronic databases using Web of Science, Pub Med, and Google scholar. The data were manually annotated for based on the infant posture and movements. Different sensor configuration also shows that four-limb recording leads to the best performance in posture and movement.

Keywords – Neuro cognitive disorder, multi-sensor, data set, IOT

1. INTRODUCTION

Early detection of children who may inherit lifelong neuro cognitive disorders is a major global healthcare concern. Neonatal medical adversities such as prematurity, birth asphyxia, stroke, metabolic derangements, and intrauterine drug exposures, more than one out of every ten infants is considered to be at neurodevelopment risk.

PREMATURITY-A baby born before 37 weeks of pregnancy is considered premature or born too early. Prematurity is defined as: Babies born at or below 32 weeks. Extremely preterm. Babies born at or below 28 weeks. BIRTH ASPHYXIA- Asphyxia means lack of oxygen and blood flow to the brain. Birth asphyxia happens when a baby's brain and other organs do not get enough oxygen and nutrients before, during or right after birth.

METABOLIC DERANGEMENTS- Metabolic syndrome is a cluster of conditions that occur together, increasing your risk of heart disease, stroke and type 2 diabetes. These conditions include increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels.

INTRAUTERINE DRUG EXPOSURE- When a woman takes drugs or drinks alcohol during pregnancy, changes can occur in the body and brain of her baby causing long-term effects. Drugs that may affect fetes during development can be illegal or prescription medications, including: Alcohol.

Characterizing an infant's normal pattern of change in various postures and movement activity over time may be used as a method for early screening of infants at risk for neurodevelopment problems. In an ideal world, such a device would provide an easy-to-use recording setup suitable for home use, as well as after that, for objective and quantitative evaluation, an automated analysis pipeline is used.

For the evaluation of spontaneous movements in neonatal and early childhood, widely used observation protocols have been developed. They aren't completely quantitative, and they don't allow for longitudinal monitoring beyond four months of age. Although wearable devices have been successfully used to diagnose neuro cognitive disorder, they have not been validated when used to diagnose infants who are at risk of developmental delay in general.

Due to advancements in techniques such as smart mobile devices, wireless communication networks, and machine learning, human behavior recognition has recently attracted a lot of attention in different areas such as ubiquitous, mobile, and context aware computing. It's possible that preparation is the key to effective human The output of these features was compared to a smaller subset of the results, which corresponded to 5-minute duration. This subset of data was selected for its temporal similarity to traditional mobility tests conducted in a clinical setting. Such as the Observer coding software to investigate the impact of postural dominance on hand behavior and child reaching behavior in relation to hand choice Accelerometers have been used to analyze infants' involuntary upper and lower extremity movements, but they don't provide postural data. Pattern detection is an example of an observational method that uses data from multiple sensors on the body to identify movement patterns (such as leaping, walking, or running). This procedure entails extracting data from participants as they perform a set of organized tasks, and then analyzing the signal for general characteristics.

Support-vector machines (SVMs, also known as support-vector networks are supervised learning models that interpret data for classification and regression analysis. SVMs, which are built on mathematical learning models, are one of the most accurate prediction approaches.

An SVM training algorithm creates a model that assigns new examples to one of two groups based on a series of training examples, rendering it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM is a machine learning algorithm that maps training examples to points in space to maximize accuracy.

As a result, we investigated the use of support vector machines (SVM) as an alternate approach for our applications. In order to improve prediction accuracy, we introduced an SVM-based approach in this study. The multi-class SVM model was first created to classify a beetle species from elytra fragment photographs.

Following that, a novel approach was used, in which binary class SVM was used to differentiate between beetles with similar appearances, particularly those belonging to the same genus. We have enhanced the CNN model that we previously reported to the SVM process. In order to increase the precision of the CNN process, we extensively optimized its parameters and architectures.

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Intelligent wearable with integrated sensors may be one choice for tracking infant movements at their homes. Intelligent wearable's for sports and leisure apparel in adults have made substantial progress recently. However, we are not aware of any guidelines or open solutions for activity identification.

2. METHODOLOGY

We used a Multi-modal data (accelerometer and gyroscope) share weights for entire input signals in convolution layer (full weights sharing), and extract same features without distinction of modalities, which may cause interferences between characteristics generated by accelerometers and gyroscopes for capturing modality-specific features, which may cause interferences between characteristics produced by accelerometers and gyroscopes for capturing modality-specific features.

a). MEMS sensor

The term MEMS stands for micro-electro-mechanical systems. These are a set of devices, and the characterization of these devices can be done by their tiny size & the designing mode. The designing of these sensors can be done with the 1- 100-micrometer components. These devices can differ from small structures to very difficult electromechanical systems with numerous moving elements beneath the control of incorporated micro-electronics. Usually, these sensors include mechanical micro-actuators, micro-structures, micro-electronics, and micro-sensors in one package.

Fig: MEMS IC

The MEMS IC fabrication can be done with silicon, whereby slight material layers are placed otherwise fixed onto a Si substrate. After that selectively fixed away to leave microscopic 3D structures like diaphragms, beams, levers, springs, and gears.

b). Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means multisensory-based infant movement research. Our current work aims to close this gap by defining a smart jumpsuit that can be used to track and measure key postures and activity patterns of independently moving infants.

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We established a new protocol to visually identify and annotate independent movements of infants who have yet to learn upright posture, in addition to the design of the jumpsuit itself. We also created a machine learning-based classifier that uses sensory data from the jumpsuit sensors to automatically recognize the collection of postures and movements covered by the annotation scheme, including a novel way to deal with inter-annotator inconsistencies that are inherently present in the human annotations used to train the classifier. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

c). Stepper motor

A stepper motor, also known as step motor or stepping motor, is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

d). Liquid Crystal Display

LCD is a type of display used in digital watches and many portable computers. LCD displays utilize to sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. LCD technology has advanced very rapidly since its initial inception over a decade ago for use in lap top computers. Technical achievements has resulted in brighter displace, higher resolutions, reduce response times and cheaper manufacturing process. one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB.

Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

3. RESULT

The efficiency of the classifier is evaluated. The result comparisons for SVM and CNN classifiers in terms of category-specific F-scores for all recordings. The CNN and SVM classifiers have similar posture classification accuracies, but the CNN classifier performs significantly better for multiple movement groups. The CNN classifier has a median F-score for the movement track of about 80%, while the SVM consistently performs 5 to 10% worse.

In terms of the smart jumpsuit's intended use in clinical evaluation, the SVM classifier's biggest flaw is its substantially poor performance in classifying movements that occur in prone posture: crawl commando, crawl proto, and pivoting. displays the confusion matrices in, the CNN classifier's class-specific performance metrics, and the overall performance scores in terms of precision, UAR, UAP, and UAF (for more details, see Supplementary Material). The findings for the complete annotator agreement frames (the frames) are confusion matrices.

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Overall output for posture is very close between the "absolute agreement" and "all frames" sets, indicating a high degree of inter-rater agreement. The prone-side-supine axis, as well as the difference between crawl and prone, are the most often misunderstood. Confusion in the left-right axis, for example, does not occur with automatic classification, but it does occur due to human error. The confusion matrix created by the classifiers is remarkably similar to the confusion matrix generated by human experts. The most apparent problem occurs when choosing between macro still, crawl proto, and the other types.

LCD Display

The liquid crystals can be manipulated through an applied electric voltage so that light is allowed to pass or is blocked. By carefully controlling where and what wavelength (color) of light is allowed to pass, the LCD monitor is able to display images. A backlight provides LCD monitor's brightness. Over the years many improvements have been made to LCD to help enhance resolution, image, sharpness and response times.

CONCLUSION

This study demonstrates that an intelligent infant wearable with a signal processing pipeline that allows quantitative tracking of infants' independent movement activities with high accuracy can be built. We created a new annotation scheme to categories infant postures and movements into a few key categories, and we showed how an automatic classifier can achieve human-like consistency in movement and posture recognition.

In addition, we described a probabilistic approach based on principles to exploit inter-rater inconsistencies in the human annotations used to train the classifier. Finally, we showed that for optimal movement classification performance, a multi-sensor setup is required. Our current study adds to previous adult studies23 by showing that clinically relevant movement monitoring and quantification can be done in infants as well.The current study goes beyond previous research by designing and proving the feasibility of the first multi-sensor infant wearable that allows for non-intrusive, low-cost, and technically feasible measurement of infants' posture and independent movements. As a result, a complete smart jumpsuit system has been developed that could be used in out-of-hospital recordings, at least in clinical trials. As a result, a complete smart jumpsuit system could be used in out-of-hospital recordings, at least in clinical research. From a technical standpoint, our results show that an SVM classifier based on standard signal-level features can track posture and detect some types of movement. The SVM, on the other hand, has trouble identifying certain important infant motor patterns, such as crawling posture and pivoting, which are critical milestones in normal neurological development.

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