

## A Smart Wearable Sensor Device Forinfants with ASD

<sup>1</sup>J. Lidwina Jennifer and <sup>2</sup>S. Jayanthi

<sup>1</sup>Student M.E., Embedded System Technologies, Sri Ramakrishna Engineering College, Coimbatore, India

<sup>2</sup>Professor, Department of Electronics and Communication Engineering,  
Sri Ramakrishna Engineering College, Coimbatore, India

---

**Abstract:** Smart wearable's gears up the health wellness management. A myriad of infants are diagnosed with ASD, proactive care and treatments improvises the health of the child. In this paper we propose a system design for ubiquitous health monitoring based on an IoT enabled sensor wearable system for monitoring health and emotional status of children with autism. Networked sensors are worn by the child, makes possible to collect the vital information for analysis and preservation of data in a repository for Increasing the efficiency of health service care with an adequate referral and remote consultation with alert facilitated system. The sensor data is collected and processed by Raspberry Pi a low cost yet powerful microcontroller and the information is transmitted to the server through Wi-Fi to be analyzed. Parents and medical team have a real time access to the collected information through a web application.

**Key words:**

---

### INTRODUCTION

Early intervention is the key for better development. Help in early detection of children with ASD for successful intervention is necessary. Children with ASD may have difficulties in social interaction and communication, they may also have some behaviors that are repetitive and stereotypic. In alarming rate raises concern and needs intimate individual and collective data collection method to understand, observe and study the child's neurodevelopment. High quality early health analysis and services can change a child's developmental level and enhanced outcomes for children, families and communities. With the advent of smart wearable technology a plethora of applications have bloomed in the health industry. Smart tech togs for babies promises to ease the condition of gathering information not only streaming critical data like heart rate, skin temperature, body position and motion to any iOS or Android device, but also providing parents with handy information like current health status. Cloud storage can provide efficient access to near limitless volumes of patient data as well as transferring electronic health records and cloud storage, retrieval and access to records, are leading to better care coordination and a more efficient healthcare system. Communication between IoT sensor device and cloudlet

is realized through Wi-Fi interface. In the proposed paper, an IoT enabled sensor wearable system is designed and developed for monitoring health and emotional status of children with autism by using wearable sensor are attached to the child's body to collect the bio-signals. The signals are analyzed and provide real time feedback to maintain an optimal health and emotional status. Using Wi-Fi, the data are stored in repository for analysis and storage of medical record for future reference.

This assessment will include reviewing the results of the evaluation, personal observation of the child health and identifying his or her needs in each developmental area. If there observed any health and emotional imbalance indicated by the varied values from normal scenario. An immediate alert is informed to the parent by sending status of the child. An APP is also developed in addition to web server to facilitate parents to check the health details and attend the emergency alert.

**Prior Work:** To understand the problem and to analyse the present scenario of sensor devices and smart application for health care and management. Some related works were surveyed to understand the technique implementation. According to the Authors [1] new improvements in technologies of wireless networking, medical sensors and interoperability software

create exciting possibilities for improving the way for providing emergency care. They designed a system based on wearable sensors associated with Pre-hospital patient care software with algorithms and a secure web portal which can facilitates collaborative and time-critical patient care in the emergency response community. For instance, the authors of the study [2] proposes a system that recruits wearable sensors that can transmit the gathered information to a gateway server through a Bluetooth connection. The gateway server turns the data into an Observation and Measurement file and stores it on a remote server for later retrieval by clinicians through the Internet. Utilizing a similar cloud based medical data storage, a health monitoring system is presented in [3] in which medical staff can access the stored data online through content service application. The authors [4] proposes a MobiHealth project which proved a health service platform based on a mobile phone as a base station for the wireless sensors worn on the body. It forwards their measurements wirelessly using UMTS or GPRS to a service center, it provides three services: collecting and storage of the received data, forwarding of data to a doctor or medical center and analysis of the data received and the sending of feedbacks to a predefined destination using SMS. According to the authors [5] a system that focuses on integrating the multi-domain expertise work can provide a common holistic architecture & platform to work with sensor driven convergence of application for special children. They suggested a sensor wearable device to collect the discerned data component and upload it to a cloud for further processing for machine learning, analysis & better deep understand, discovery of a fine model or human guided fuzzy logic model. In reference to the above designs and other papers referred, on integrating the merits the proposed system was designed to develop an IoT enabled sensor wearable system for monitoring health and emotional status of children with autism and to enable parents and the medical support to examine the status of the child's health condition as well as providing real time monitoring and extended remote support in case of any urgency.

**Proposed System Design:** The IoT based wearable sensors systems are generally build on three tier system. The first is a wearable sensor that collects the health details, a communication device generally a wireless networking enabled the design. Finally a cloud based online repository for long term storage of patient's biomedical information as well assisting health professionals with diagnostic information. A number of sensors are used for collected the physiological signals

for sensing & uploading, many of the sensor are utilized the detecting the emotions state of the child by comparing the sensors data with the predefined normal scenario values. The following figure 1 shows the three tier system architecture.

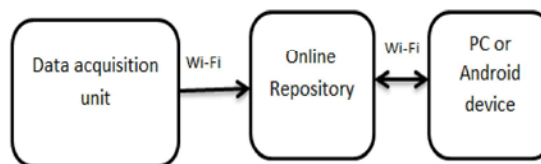


Fig. 1: Three Tier System Architecture

Sensors s are used for monitoring the child's healthcare such as Pulse sensor, Accelerometer sensor, Skin temperature sensor, Skin Moist level indicator sensor which can directly communicate with microcontroller are attached to the child's body forms an array of sensor clusters to collect the bio-signals. The Raspberry Pi2 microcontroller is used for processing since this is compact in size and the power consumption is too low. The signals are analyzed and provide real time feedback to maintain an optimal health and emotional status Using Wi-Fi interfaced with the USB port of the RPi, the data are stored in repository. The repository will be having the predefined values for normal scenario, analyses is made and the new values are checked and updated. This assessment will include reviewing the results of the evaluation, personal observation of the child health and identifying his or her needs in each developmental area. A webpage is developed to storage and retrieval of data online and additionally an APP is also developed in order to provide the data in a customized format. In case of emergency, the values varies as it indicates of the autonomic activity of physiological arousal. An immediate alert is informed to the parents of autistic children who want to simply monitor stress, status of the child is reported and alarmed if critical.

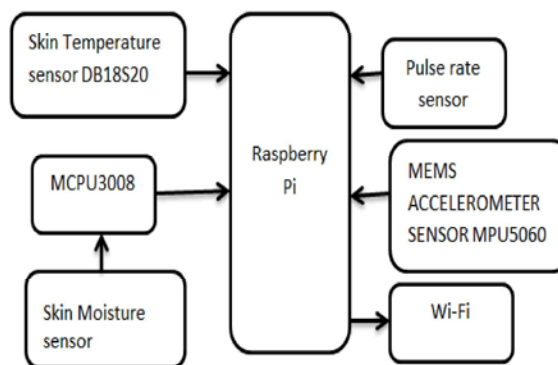


Fig. 2: Block diagram of the Prototype system

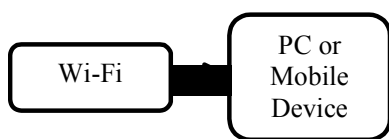


Fig. 3: Block diagram of Receiver section

In the figure 3 the block diagram of the Receiver section is given. In this section a mobile phone or a personal computer can be used to access the Web server where we can store and retrieve the data when required.

**Raspberry PI:** The Raspberry Pi 2 microcontroller is used since this is compact in size and the power consumption is too low. Broadcom chip BCM2836 SoC is placed in it and it has a memory of 1GB RAM with 900MHz frequency. Raspberry Pi 2 board is selected because it is fast when compared to the earlier versions. It has 40 GPIO pins and 4 USB ports also which allows us to connect our Wi-Fi module etc. The hardware description of Raspberry Pi which is shown in Figure 4. It uses 16GB SD for installing the Raspbian OS and for storage. The USB port is used for connecting keyboard, mouse, dongle and pen drive. The power supply is given through USB connector while prototype modeling.

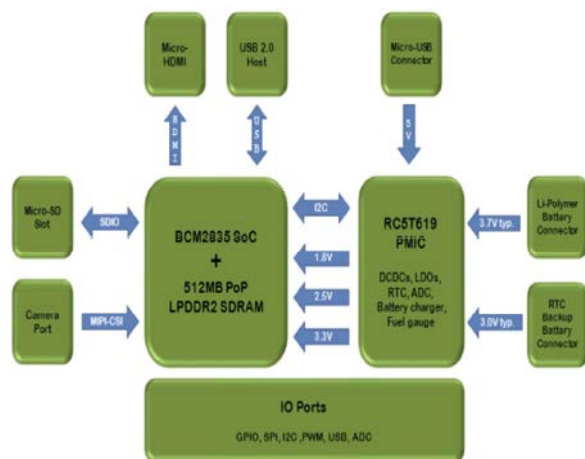


Fig. 4: Hardware Description Of Raspberry Pi

**Sensor Array:** A sensor array is formed to identify the health parameters. Temperature & skin conduction sensor, An integrated MEMS accelerometer, Skin moist indicator sensor and pulse sensor are used for observing stress level, repetitive bodily motions or postures. Body movements are monitored by an accelerometer to determine the child's activities i.e., running, resting, walking and dangerous activities such as falling. The MPU 6050 is an integrated 6-axis Motion Tracking device that

combines a 3 – axis gyroscope, 3 -axis accelerometer and a Digital Motion Processor requires 2.16 to 3.6V supply voltage. It is used to sense the limb movement of the child. Skin temperature can be used to identify the stress level of child as the temperature raises when depressed or anxious. DS18B20 is used for measuring the temperature, it has a unique 1-Wire interface requires Only One Port Pin for Communication. It consist of Integrated Temperature Sensor and EEPROM, that measures temperatures from -55 °C to +125 °C. Pulse sensor is used to monitor the heartbeat of the child, which is used to find whether the child heartrate is normal or abnormal as the heart rate varies with increased physical activity. Heart beat sensor 1157 provides Instant output digital signal for directly connecting to microcontroller to identify the pulse rate.

**Software Implementation**

**Python:** The Raspberry Pi is a Linux based operating system environment with python as the main programming language. Python is preferred since it is a simple and a minimalistic language. It is also a free and an open source software. This can be used in many platforms such as Linux, VxWorks, PocketPC etc. Also, it supports procedure-oriented programming as well as OOPS. The software required for the hardware portion is coded in python programming language.

**PHP AND HTML:** The PHP Hypertext Pre-processor (PHP) is a programming language that allows web developers to create dynamic content that interacts with databases. It is basically used for developing web based software applications and also to manage database, dynamic content, session tracking, even build entire e-commerce sites. PHP5 version was used in this project. HyperText Markup Language is the standard markup language used to create web pages. Html Form is embedded with PHP script to develop a Login webpage. When the Id is typed the information about the user is fetched from the database and shown in the webpage.

**Android Studio:** Android Studio is the official IDE for Android app development, based on IntelliJ IDEA with powerful code editor and developer tools android Studio offers even more features that enhance the productivity when building Android apps. An app named little jingles was developed to get the status and alert information regarding the child's stress level and health condition.

**Experimental Results:** The following are the experimental results of the proposed IoT based wearable sensor device for children with ASD. To evaluate the concept, the prototype was implemented using Raspberry Pi as microcontroller combined with the cluster of sensors for collecting the bio-data from the child with special needs. The figure 5 represents the developed prototype of the system and the figure represents the pulse sensor measurement. When prototype to product, the components can be changed to facilitate the less size and weight.

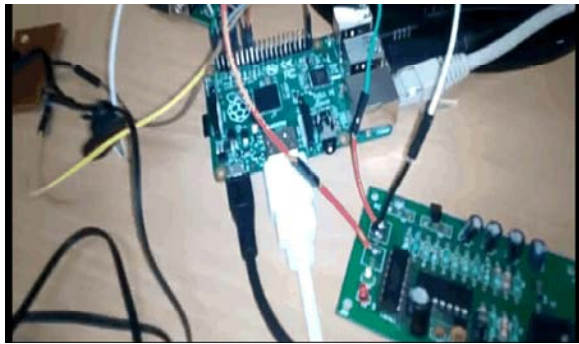


Fig. 5: Prototype of the system

The Pulse Rate Sensor, GSR sensor, Temperature sensor combination provides the method for detection the emotional status such as joy, stress, fear, excitement and contributing in the scenario of developing social interaction in children with special needs. While the MEMS accelerometer sensor is used for sense the limb movement of the child.



Fig. 6: Pulse rate measurement and Movement measurement.

An APP named little jingles was developed in order to provide the data in a customized format to the parent. This provides the health and emotional status of the child. This app also has an alarm feature that indicates any abnormal or rapid activity of the child movements, that in turn signaling the alert to the parents for quick response and timely care to the child.

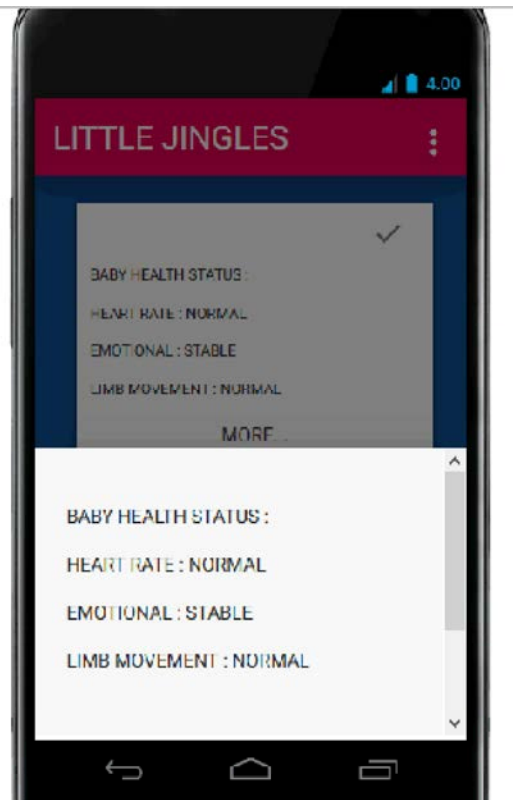


Fig. 7: Mobile app indicating the child's health status.

## CONCLUSION

With rapid growth of smart wearable technology in the health industry have leveraged the level of health care management for individuals with autism, new technologies can improve communication, help in the skill development and enhance the ability to learn. Our proposed framework constitutes of wearable sensors geared with the IoT Technology helps to identify the health and emotional status of the child with ASD. The collected medical data is stored in web server based on multimodal intelligence for further analysis, preservation and retrieval of the data. The smart device can help to alert and clarify needs of the child is struggling with to say. And also the child and the parents may feel less pressure as it provides ubiquitous health care monitoring system.

**REFERENCE**

1. Tia Gao, Dan Greenspan, Matt Welsh., Improving Patient Monitoring And Tracking In Emergency Response project supported by National Library of Medicine.
2. Babu, S., M. Chandini, P. Lavanya, K. Ganapathy and V. Vaidehi, 2013. Cloud-enabled remote health monitoring system Int. Conf. on Recent Trends in Inform. Tech. (ICRTIT), pp: 702-707.
3. Rolim, C., F. Koch, C. Westphall, J. Werner, A. Fracalossi and G. Salvador, 2010. A cloud computing solution for patient's data collection in health care institutions., Second Int. Conf. on eHealth, Telemedicine and Social Medicine, ETELEMED'10., pp: 95-99.
4. Konstantas, D., A. Van Halteren<sup>1</sup>, R. Bults, K. Wac, V. Jones, I. Widya and R. Herzog, 2004. Mobihealth: Ambulant Patient Monitoring Over Public Wireless Networks., Mediterranean Conference on Medical and Biological Engineering MEDICON 2004.
5. Chris Otto, Aleksandar Milenkoviæ, Corey Sanders and Emil Jovanov, 2006. System Architecture of A Wireless Body Area Sensor Network For Ubiquitous Health Monitoring., Journal of Mobile Multimedia, 1(4): 307-326.