Design e_Hat for autism people using IoT

Marwa Abdullah Said Al Zidi[1], Khoula AlHarthy[2]

16F15742@mec.edu.om, Khoula@mec.edu.om

Student, Senior lecturer

Department of computing

Middle East College, Muscat, Oman

Abstract

Internet of things which are known as IoT has become the most important specialty of the future and has already begun to spread widely today. The Internet of Things is involved in various economic, political, health, and social sectors. It is known that people with Autism Spectrum Disorder (ASD) exhibit many behaviors resulting from increased electricity in their brain. There are many problems that people face with this category, such as aggression and self-harm, social communication problems, Psychiatric disorders: such as depression, anxiety, and attention deficit hyperactivity disorder. The main problem lies in the difficulty of dealing with autistic patients and protecting them from the risks that they may be exposed to.

This project aims to propose e-hat for autistic people using IoT solutions. This project helps in monitoring the autistic person, understanding the movements of the injured person before performing them and thus avoiding their effects, and helping officials and families provide full care for their injured. The main objectives of the project are:

- To design an e-Hat for autism people to monitor their movement.

- To analyze the nerve signals and sudden movements before they happen to avoid their impact.

- To investigate the causes which increase Attention deficit hyperactivity disorder.

- To evaluate the proposed system to prove the efficiency

The basic idea of the proposed solution is to help parents control their autistic children and protect them from sudden dangers that they may be exposed to. This solution is based on the invention of the electronic hat that works with a special system, the hat consists of a group of sensors connected to the movement centers in the brain and thus senses movement and sends signals to the application, which in turn sends notifications to a guardian of the movements of

his son/daughter. It also contains a GPS sensor to locate the child and send signals if the affected child exits the pre-defined area.

The methodology using in this project is a modified waterfall model.

Keywords:

IoT, Autism, Sensors, OAS, ADHD

Introduction:

There is increasing usage of the Internet of things which is known as IoT. IoT has become the most important specialty of the future and has already begun to spread widely today. The Internet of Things is involved in various economic, political, health, and social sectors. However, Oman start adopting IoT solutions in developing smart cities. Especially, in the health sector.

However, it observed today in Omani society the spread of autism among children, which calls for the presence of many rehabilitation centers in various governorates to follow this category behaviourally and therapeutically. It is known that people with autism suffer from an excess of electricity in the brain, which causes sudden nervous reactions that are aggressive to them and those around them.

The idea of this project is to employ the Internet of Things in the health and social sector by creating a smart electronic cap for autistic patients. This hat contains sensors mounted in a specific way so that the motion sensor presses the movement center in the brain (such as the hand and foot movement center, etc.). It also contains a sensor that measures electricity in the brain, a sensor that measures the heartbeat, and a position sensor. This idea helps rehabilitation center workers and families in charge of this category to better follow up with them.

Similar study:

In 2016, the Sensor and Cellular Systems Research Center at the University of Tabuk, Saudi Arabia, created a system called AMAS to monitor children with autism. The idea of this system is to put a network of small wireless sensors so that the affected child can wear them

to monitor his behavior and the various vital signs of the child. The system collects and analyses information, and then signals officials.

Some parts of this system are also designed to be worn by the patient, such as a manual watch, which helps the system to recognize the nature of the place in which the victim is located so that he can sense non-peaceful movements such as a sudden bend or fall. The system also issues a wireless signal to the administrator's device if the victim exits the previously defined safe zone in the system.

It is worth noting that a patent application for this system has been submitted at the United States Patent and Trademark Office.

The objective of proposed research:

- To design an e-Hat for autism people to monitor their movement.

- To analyze the nerve signals and sudden movements before they happen to avoid their impact.

- To investigate the causes which increase Attention deficit hyperactivity disorder.

- To evaluate the proposed system to prove the efficiency.

Research Methodology:

Modified Waterfall Methodology:

This model was created to solve the problems observed in the pure waterfall model despite its advantages. This model is based on the same phases but allows them to overlap when needed. The modified waterfall can also be divided into a sub-project in the post-design phase. To reduce the risks before the cascade stages, spirals can be added at the top. It can also be modified further by using the prototype options, JADs or CRC, etc. to collect the requirements that are made in the overlapping stages.

(Munassar, 2010)

The below figure shows the process of the modified waterfall methodology and its phases:

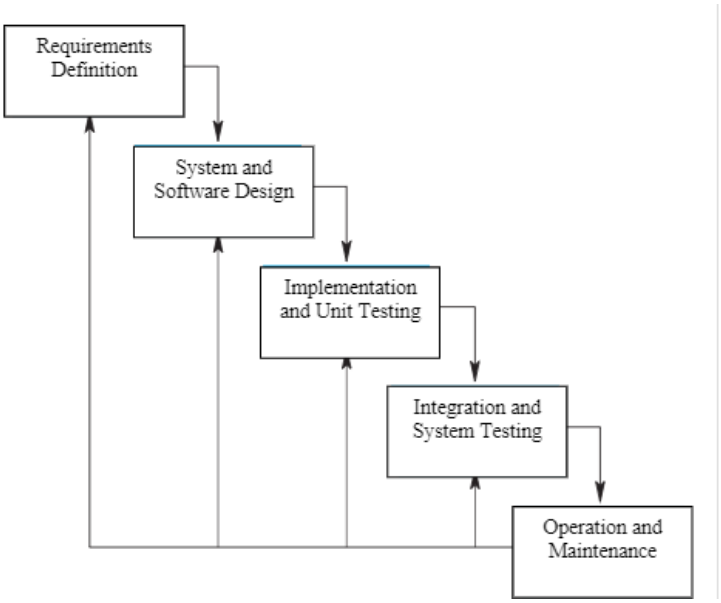


Figure 1.1: Modified waterfall methodology
(Munassar, 2010)

Advantages of modified waterfall methodology:

1) More flexible.
2) The easy stages can be executed without waiting for the other difficult stages.

Disadvantages of modified waterfall methodology:

1) The contours are more mysterious than the pure waterfall.
2) Poor communication in activities carried out in parallel.

This model is the best one for this research because I need to manage my project and avoid risks as much as I can. This method will help to ensure if the project is working properly from the early stages that's help to do the project with high quality. Also, it is more flexible so I can do the easy stage until the difficult stages are done. I didn't select others because many reasons, Spiral is more complex and difficult in time management. The waterfall is too expensive and with high risk. Also, I didn't select incremental because the total cost is higher.

Framework and design of proposed solution:

Logical design of the network

A network logic design illustrates the communication mode that connects two computers connected to a network. It consists of a flow of data between two systems. Network

communication in the actual sense depends on the logical design of the network. The physical layout design is also anchored using Logic Design.

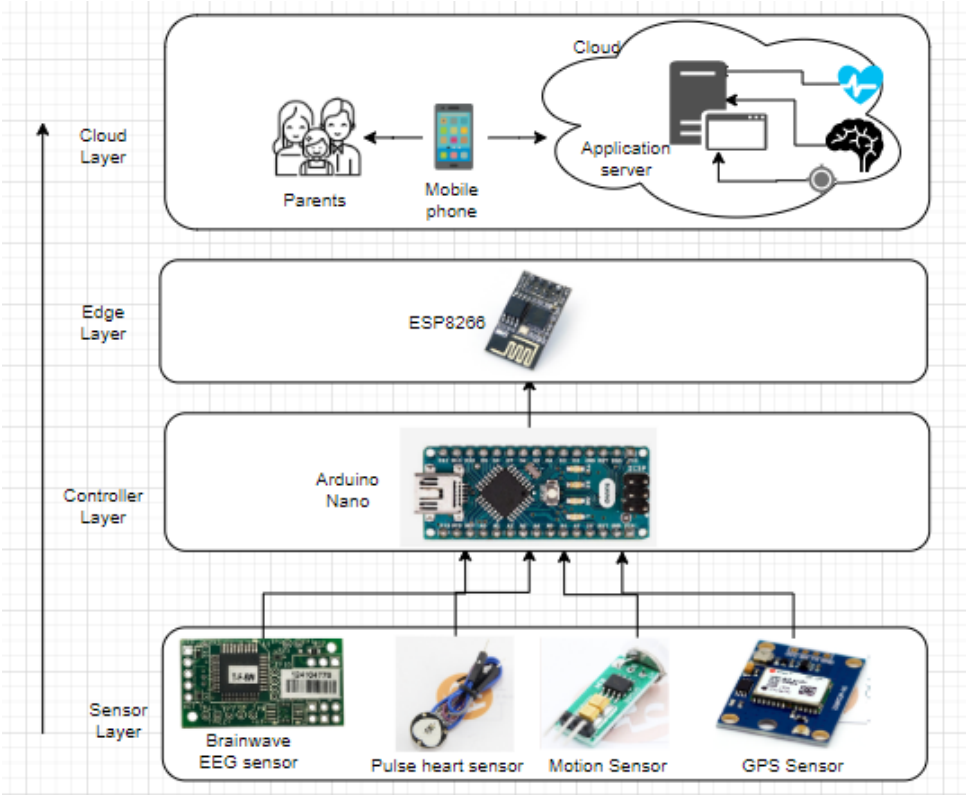
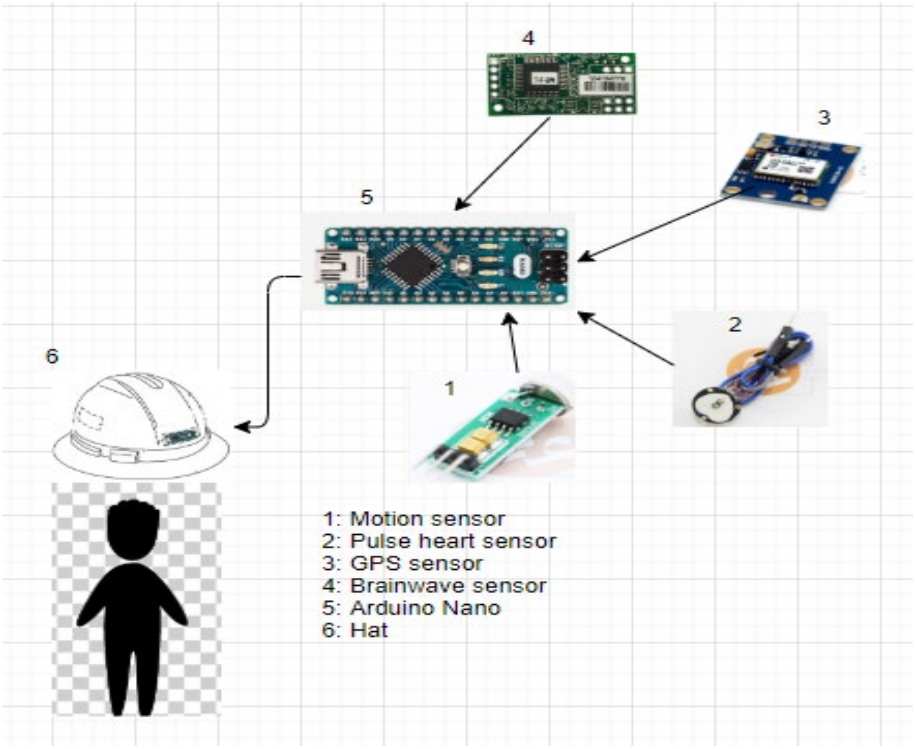


Figure 2: Architecture layers

1) Sensor/ physical layer: This layer consists of sensors or restrictive devices, whether sensors or actuators. Restricted devices fall into three categories. The sensors may be wearable or implantable to record signals, whether continuous or discrete. The device layer, which consists of the RFID reader or sensor networks. This layer is responsible for the raw data that is generated by the sensors.
2) Network/ Controller Layer: The layer responsible for publishing and routing messages. Where it can carry out the communication according to the requirements through the basic systems. One of the most important functions of this layer is to measure, control, and process data in the first stage of the layer.
3) Edge / Transfer Layer: The interface is used between the lower device surface and the upper application surface. It is the layer responsible for hardware and information management, data processing, access control, and semantic analysis.

4) Application/ cloud layer: The user interfaces responsible for providing applications to users in the Internet of Things, which increases its scope by increasing the use of RFID technology in applications. Creating sessions and designing the interface for application users are also functions of this layer.

The physical design of the network:



Sensors:

1) Motion sensor: Also called a motion detector, it is an electronic device designed to detect and measure motion. Motion sensors consist of three main components which are the sensor board, the embedded computer, and the mechanical component; Which differ in size and composition.
   Motion sensors are divided into two types: Active motion sensors that contain a transmitter and a receiver to sense movement by measuring changes in the amount of sound or radiation that is reflected the receiver, when the sensor field changes, the electrical pulse is sent to the coupled computer and thus interacts with the component. The Mechanic.

HC-SR505 Mini Motion sensor: It is based on infrared technology. It is characterized by its small size and low power which enable it to automatically control itself with high reliability and sensitivity. It is widely used in automatic electronic equipment.

(Jost, 2019)

Features	Specification
- Automatic Control - Minimum size - Repeatable Trigger - Wide range of operating voltage - Low-power - Output high signal	- Operating voltage range: DC4.5-20V - Quiescent Current: <60uA - Trigger: reusable trigger (default) - Delay Time: The default 8S + -30% - Board Dimensions: 10 * 23mm - Induction angle: <100 degrees cone angle - Sensing distance: 3 meters - Working temperature: -20 to +80 degrees - Sensor Lens Dimensions: Diameter: 10mm

2) Pulse heart sensor: Monitoring your body temperature, pulse, and aborting the blood circulation are important to maintain health. A heart rate sensor is an electronic tool for determining the pulse, such as the speed of the heartbeat. This sensor works using an image scaling diagram so that changes in the volume of blood in an organ are estimated through the change in the strength of the light passing through it.
   - How the pulse heart sensor exactly works: The heart rate sensor has two sides, the first in which the LED is placed with the light sensor that surrounds it and the other side is placed the circuits responsible for the work of amplification and noise cancellation. The LED indicator located on the front side of the sensor is placed on the vein, either the tip of the finger or the tip of the ear. If blood flow is detected, the ambient light sensor captures the light and reflects it by the blood, then analyses the change in the light emitted over time to determine the heart rate.
   - Features of pulse heart sensor:

- Biometric Pulse Rate or Heart Rate detecting sensor
- Plug and Play type sensor
- Operating Voltage: +5V or +3.3V
- Current Consumption: 4mA
- Inbuilt Amplification and Noise cancellation circuit.
- Diameter: 0.625”
- Thickness: 0.125” Thick

3) GPS sensor:

GPS, which stands for Global Position System. The system contains satellites and ground control installations. The GPS sensor consists of a surface-mounted chip that processes signals from GPS satellites using a small rectangular antenna, often mounted on top of a GPS chip.

A GPS unit is a small board on which a GPS sensor is installed along with additional components. A GPS receiver is a device that includes a data display and other components such as a data storage memory in addition to a GPS unit.

In this project, I need a GPS sensor to locate the area in which the autistic person is to avoid his exit to the unsafe area.

4) Brainwave EEG sensor:

EEG, which is an electroencephalogram, is an electrical process that records the electrical activity of the brain. The EEG measures changes in the electrical activity of the resulting brain. The voltage changes come from an ionic current within and between certain brain cells called neurons.

An EEG test evaluates the electrical activity of the brain by conducting EEG scans by placing EEG sensors, which are small metal discs also called EEG electrodes, to capture these electrodes and record the electrical activity in your brain. The collected EEG signals are amplified and digitized and then sent to a computer or mobile device for storage and data processing.

Features:

- Arduino-compatible
- Voltage differential measurement
- 3- or 2-lead electrode cable operation (only one REF is needed when using multiple EEGs)
- Gain: 40000

- Range: ±40uV
- Bandwidth: 0.8-49Hz
- CMRR: 110dB
- Input impedance: 100GOhm

Arduino Nano: is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3. x). It has more or less the same functionality as the Arduino Duemilanove but in a different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.

Arduino Nano physical components

1) Microcontroller: In Arduino Nano 2. x version, still used the ATmega168 microcontroller while the Arduino Nano 3. x version already used ATmega328 microcontroller.
2) ATmega168 Microcontroller: ATmega168 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture.

Arduino Nano: The Arduino is designed in an easy way to get started with microcontrollers and handle connections. Let's start by powering the board.

Powering the Arduino Nano: There are three ways to power a Nano:

1) USB jack: Connect the micro USB jack to the phone or computer charger through a cable to draw the power required to operate the board
2) Vin Pin: The Vin Pin can be supplied with 6-12V unregulated to power the board.
3) + 5V Pin: If you have + 5V regulator source, you can provide this directly o Pin + 5V from Arduino.

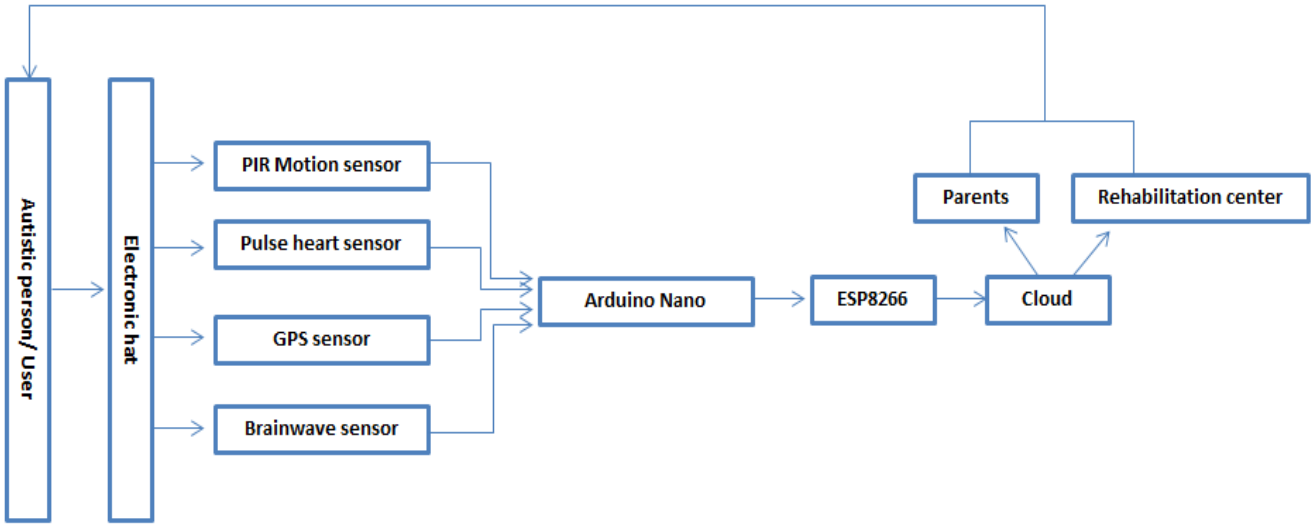
Name	Processor	Operating/Input Voltage	CPU speed	Analog In/Out	Digital IO/PWM	EEPROM / SRAM[kB]	Flash	USB	USART
Uno	ATmega328P	5V / 7-12V	16 MHz	**6 / 0**	14 / 6	1 / 2	32	**Regular**	1
Nano	ATmega328P	5V / 7-12V	16 MHz	**8 / 0**	14 / 6	1 / 2	32	**Mini**	1

Table(): Difference between Arduino UNO and Arduino Nano
(Arduino Nano, 2018)

4.3: Data flow diagram

A data flow diagram, also known as DFD, is used to graphically represent the data flow in a business information system. DFD describes the processes involved in a system to transfer data from input to file storage and report generation

Dataflow diagrams can be divided into logical and physical. A logical data flow diagram describes the flow of data through a system to perform specific functions in a business. While a physical data flow diagram describes the implementation of a logical data flow.



Benefits to society:

For a healthy life and good interest in autism in a society that is witnessing a great revolution in technology and artificial intelligence technologies globally, this project is implemented by designing an electronic hat that contains many sensors that help rehabilitation centers for autistic children and parents in monitoring the autistic child in terms of Different thus ensuring its safety. Also, this project will contribute to spreading sufficient awareness about autism and the need to give adequate attention to this group.

Modified waterfall methodology is more flexible. and easy stages can be executed without waiting for the other difficult stages. But the contours are more mysterious than the pure waterfall. Poor communication in activities carried out in parallel is there.

References:

1) AlMaamari, D. W. (2019).

2) Burhan, M. (2018). IoT Elements, Layered Architectures, and security issues: A Comprehensive Survey. Sensor.

3) Coury, D., Jones, N., Klatka, K., Winklosky, B. and Perrin, J., 2009. Healthcare for children with autism: the Autism Treatment Network. *Current Opinion in Pediatrics*, 21(6), pp.828-832.

4) de la Torre Díez, I. A. (2018). IoT-Based Services and Applications for Mental Health in the Literature. Journal of Medical Systems.

5) de la Torre Díez, I., Alonso, S., Hamrioui, S., Cruz, E., Nozaleda, L. and Franco, M., 2018. IoT-Based Services and Applications for Mental Health in the Literature. *Journal of Medical Systems*, 43(1).

6) Dr. Jennifer Rowley, D. F. (2004). Conducting a Literature Review. Management Research News, 31-32.

7) Galea, D. (2015). SWOT Analysis.

8) Momin Mukherjee, S. R. (2017). Feasibility Studies and Important Aspect of Project Management. International Journal of Advanced Engineering and Management, 98-100.

9) Munassar, N. M. (2010). A Comparison Between Five Models Of Software Engineering. IJCSI International Journal of Computer Science Issues.

10) Rowley, J. and Slack, F., 2004. Conducting a Literature Review. *Management Research News*, 27(6), pp.31-32.

11) Singh, D. (2015). A Comparative Study between Waterfall and Incremental Software. International Journal of Emerging Trends in Science and Technology(IJETST).

12) Software Engineering | Spiral Model. (2018, May 28). Retrieved from GeeksforGeek: https://www.geeksforgeeks.org/software-engineering-spiral-model/

13) Youssef, A. E. (2012). Exploring Cloud Computing Services and Applications. *Journal of Emerging Trends in Computing and Information Sciences*.