

Remote Diaper Monitoring System

by

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Declaration

I, hereby, declare that the work presented in this report is the outcome of the investigation performed by me under the supervision of Dr. Mohammad Salah Uddin, Assistant Professor, Department of Computer Science and Engineering, East West University. I also declare that no part of this report has been or is being submitted elsewhere for the award of any degree or diploma.

Countersigned

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Letter of acceptance

This project entitled “*Remote Diaper Monitoring System*” submitted by Shathi, ID: 2018-1-96-002, to the Computer Science and Engineering Department, East West University, Dhaka-1212, Bangladesh is accepted as satisfactory for partial fulfillment of requirements for the Award of Degree of Master of Science (M.Sc.) in Computer Science and Engineering on December, 2019.

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Abstract

This project presents a development of smart diaper system by applying the concept of Internet of things. The smart diaper system consists of a Do it yourself (DIY) wet sensor developed by us known as wet detector unit, The principle controlling unit of the wet detection system is a low cost wireless micro-controller. The micro-controller creates a bridge between cloud and the wet detection system. A mobile application has been developed for facilitating the end user. All the sensor data collected from smart diaper is presented to the apps through the cloud. The wet detector sensor is placed between the layers of a diaper. When the wet sensor sensed any wet it knocked the micro-controller to transmit the value to the cloud. The mobile apps pushed a notification based the wet value. Thus the user received a notification from the system and perform the diaper changed operation.

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As it is true for everyone, I have also arrived at this point of achieving a goal in my life through various interactions with and help from other people. However, written words are often elusive and harbor diverse interpretations even in ones mother language. Therefore, I would not like to make eorts to find best words to express my thankfulness other than simply listing those people who have contributed to this project itself in an essential way. This work was carried out in the Department of Computer Science and Engineering at East West University, Bangladesh.

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Chapter 1

Introduction and Overview

1.1 Diaper

Diapers (Nappies) were wonderful invention, controlling infants waste in a relatively, clean, and healthy way. The diaper has several types such as, disposable diapers and cloth, also diaper has different usage, child's diapers, adult diapers and animals diapers [1, 2, 3].

Since most of people now live in apartments, the use of diapers is inevitable. The purpose of a diaper is to absorb moisture and contain mess, so that the wearer can remain dry and comfortable after wetting or soiling themselves. Diapers are used now not only for babies, but also for individuals who are incapable of controlling their bladder or bowel movements or unwilling to use the toilet. These include people with medical conditions such like people who are bedridden, or in a wheel chair. For the same reasons, diapers are now used for home pets [3]. It was estimated that babies will spend about 7000 hours/year in diapers and need about 1500 diaper changes



Figure 1.1: The Diaper.

during the first years of life [4], for sure the other individuals may consume more and more [5]. However, diapers have one major drawback, they cause skin rash [6]. Skin rash develops when the skin is exposed to prolonged wetness. Diapers cause skin rash which develops when the skin is exposed to prolonged wetness, increased skin pH caused by urine and feces, and resulting breakdown of the stratum corneum, or outermost layer of the skin. Skin wetness for prolonged periods is therefore the common denominator underlying the various causes of diaper rash [7, 8, 9, 10].

In an effort to reduce the time during which wet diapers are in contact with a wearer's skin, for example, mother's often adhere to a specific change of diaper schedule wherein a baby's diapers are changed periodically according to a pre-established timetable, same scenario is repeated with other wearers from in charge person. Although such diaper changing schedules are helpful, a real reduction of time during which urine contacts the skin is not often realized because no prescribed time table can anticipate an individual wearers changeable physical constitution. For example,

an infant might wet its diaper immediately after a scheduled change of the diaper and thus, unknown to the mother, be left in a soiled diaper until the next scheduled change of the diaper.

Majority of efforts that used to eliminate the skin rash, such as adding absorbent gel failed to solve the problem [1, 8, 10]. On the contrary, some of these gels create other problems such as irritations, allergy, toxic shock.....Etc.

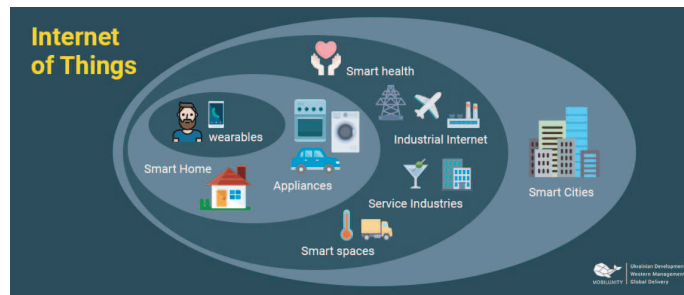


Figure 1.2: The Internet of Things (IoT).

1.2 Internet of Things

Internet of things (IoT) is a cover arranging system which is used to send data or information through any contraption to a split and a specific essential authority process or count is associated with control any device in perspective of that data or information. Monitoring objects is a true use of Internet of Things (IoT). In this system every one of the items or utensils are interconnected through a system. A three layer architecture of IoT is presented in Figure 1.3. More details technical information of IoT are nicely elaborated in [11, 12, 13, 14, 15].

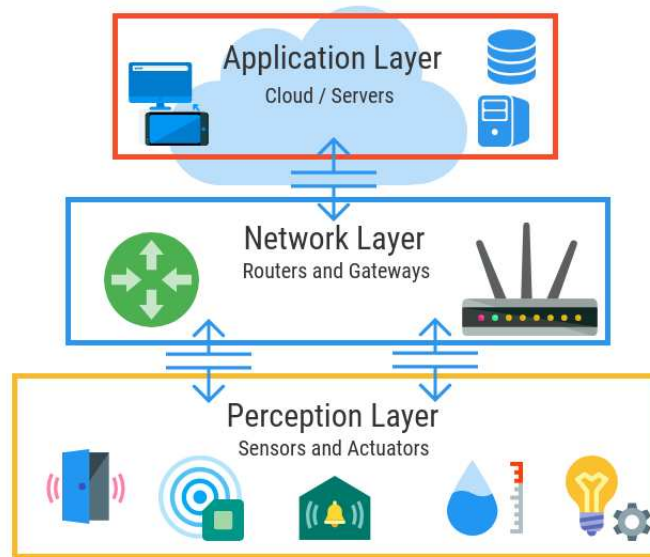


Figure 1.3: The three layer architecture of IoT.

1.2.1 Problem Statement

1.2.2 Objectives

The main objectives of this project are listed below:

- To develop smart Diaper monitoring system.
- To monitor monitor the diaper in terms of wetness and heating.
- To make our daily life easier.

Chapter 2

Literature Review

Some closely related works are listed in this chapter.

2.1 Patient Monitoring System

A real time patient monitoring system based on internet of things is presented in [16]. Here the authors described a sensor connected system for monitoring psychological parameters such as temperature, humidity, blood pressure, Oxygen level of blood, heart rate, body movement etc. Several sensors are used for monitoring those properties. The system is connected with cloud as a result the doctors and the relatives of the patient can monitor the situation of the patient remotely. All the monitoring operation has been done by using a mobile application. The hospital authorities performed the monitoring operation for all patient by using a web application. The block diagram of the system is presented in Figure 2.1.

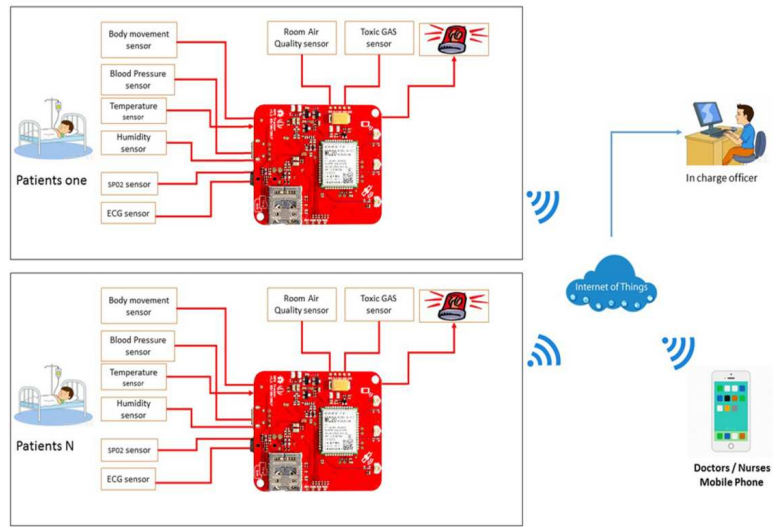


Figure 2.1: The real time patient monitoring system.

2.2 Smart Vehicle Monitoring System

A smart anti-theft vehicle monitoring system developed by the authors in [17] for monitoring the vehicle location in real time. Users of this system visualize their vehicle location by using a mobile application. Near field communication based security layer was included with this system for providing extra layer of security. Without the authentication of NFC tag, Nobody cannot able to start the vehicle.

2.3 Smart Pill Reminder Box

To make our life easier there is another great technological invention is smart pill reminder box. This is a very useful tool for those who take regular medicine or their care giver. The older patient often forget to take pills timely and that can be cause serious health issue to them. They can also have the overdose of medicine in

subconscious mind and harm themselves irrecoverable. so the box will alarm when it is the time of taking medicine and wont stop until the right portion of the box is taken where the pills are ready to take. With the alarm there is also light that is the indicator which box have to choose for this time. After getting the right pill box there is another button “next alert” that have to press, it is the set of alarm for the next time. It is also not an app but a smart box itself. Also commercially available in market. Figure 2.2 shows the smart pill reminder box and details are available in [18]

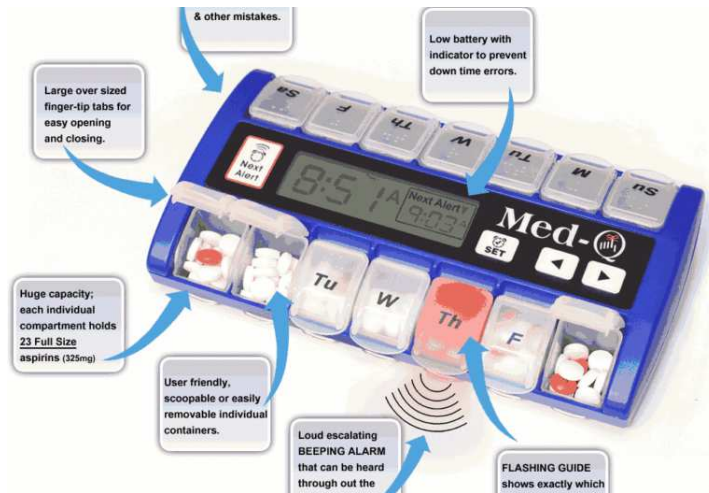


Figure 2.2: The Smart Pill Reminder Box.

2.4 Smart Egg Box

The sensible egg tray [19], shown in Figure 2.3, permits us to know how many eggs we ’ve got left within the electric refrigerator when we are out of the home or in the food market via its inherent Wi-Fi property (Driven by the electrical Imp

card) and therefore the Wink smartphone app. There is a sensor put in in every egg slot that may assist us or to keep track of suggested expired dates based on they were initial placed within the tray and a inherent diode to warn us to the freshest eggs remaining within the last batch. Currently within the final evaluation stages of development the merchandise plan was originally submitted to the gang developed product website by Rafael Hwang and has had over one,266 Community influencers shape the ultimate product throughout its creation.



Figure 2.3: The Smart Egg Box.

Chapter 3

Proposed System

3.1 Hardware Components

3.1.1 Micro-controller

Arduino is an open-source stage utilized for building hardware ventures. Arduino comprises of both a physical programmable circuit board (regularly alluded to as a microcontroller) and a bit of programming, or IDE (Integrated Development Environment) that keeps running on your PC, used to compose and transfer PC code to the physical board.

The Arduino stage has turned out to be very well known with individuals simply beginning with gadgets, and in light of current circumstances. Not at all like most past programmable circuit sheets, the Arduino does not require a different bit of equipment (called a software engineer) with a specific end goal to stack new code onto the board you can basically utilize a USB link. Also, the Arduino IDE utilizes an improved rendition of C++, making it less demanding to figure out how to program. At last,

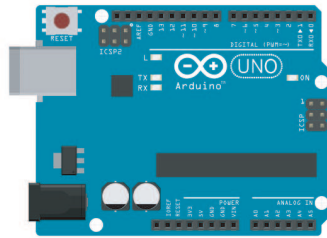


Figure 3.1: Arduino Uno microcontroller.

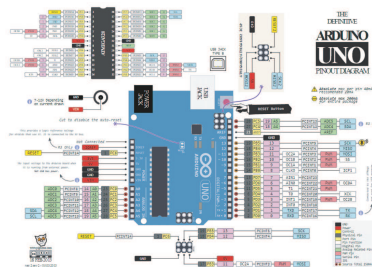


Figure 3.2: Arduino Uno pin diagram.

Arduino gives a standard frame factor that breaks out the elements of the small scale controller into a more available bundle. The Arduino equipment and programming was intended for craftsmen, architects, specialists, programmers, beginners, and anybody inspired by making intuitive articles or conditions. Arduino can connect with catches, LEDs, engines, speakers, GPS units, cameras, the web, and even your advanced cell or your TV! For everything from robots and a warming cushion hand warming cover to genuine fortune-telling machines, and even a Dungeons and Dragons dice-tossing gauntlet, the Arduino can be utilized as the brains behind any gadgets venture. Arduino makes a few distinct sheets, each with various capacities. What's more, some portion of being open source equipment implies that others can change and deliver subordinates of Arduino sheets that give considerably more frame elements and usefulness. We are using Arduino UNO for our project.

3.1.1.1 Technical Specifications

1. Microcontroller: AT mega328
2. Operating voltage: 5V
3. Input voltage (recommended): 7-12V
4. Input voltage (limits): 6-20V
5. Digital I/O pins: 14(of which 6 provide PWM output)
6. Analog input pins: 6
7. DC current per I/O pin: 40mA

8. DC current for 3.3V pin: 50mA
9. Flash memory: 32KB of which 0.5KB used by bootloader
10. SRAM: 2KB (ATmega328)
11. EEPROM: 1KB(ATmega328)
12. Clock speed: 16MHz

3.1.2 Sensors

3.1.2.1 Aluminum Foil

Aluminum foil (or aluminum foil in North America), often referred to with the misnomer tin foil, is aluminum prepared in thin metal leaves with a thickness less than 0.2 mm (7.9 mils); thinner gauges down to 6 micrometres (0.24 mils) are also commonly used.[1] In the United States, foils are commonly gauged in thousandths of an inch or mils. Standard household foil is typically 0.016 mm (0.63 mils) thick, and heavy duty household foil is typically 0.024 mm (0.94 mils). The foil is pliable, and can be readily bent or wrapped around objects. Thin foils are fragile and are sometimes laminated to other materials such as plastics or paper to make them more useful. Aluminum foil supplanted tin foil in the mid 20th century. Aluminum foil is produced by rolling sheet ingots cast from molten billet aluminum, then re-rolling on sheet and foil rolling mills to the desired thickness, or by continuously casting and cold rolling. To maintain a constant thickness in aluminum foil production, beta radiation is passed through the foil to a sensor on the other side. If the intensity becomes too high, then the rollers adjust, increasing the thickness. If the intensities



Figure 3.3: The Aluminum foil.

become too low and the foil has become too thick, the rollers apply more pressure, causing the foil to be made thinner.

3.1.2.2 Temperature Sensor

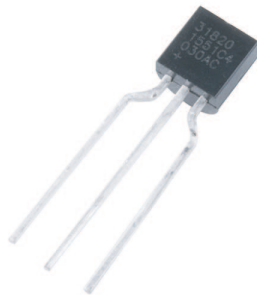


Figure 3.4: The temperature sensor.

A temperature sensor is a device, usually an RTD (resistance temperature detector) or a thermocouple, that collects the data about temperature from a particular source and converts the data into understandable form for a device or an observer. Temperature sensors are used in many applications like HV and AC system environmental controls, food processing units, medical devices, chemical handling and

automotive under the hood monitoring and controlling systems, etc.

The most common type of temperature sensor is a thermometer, which is used to measure temperature of solids, liquids and gases. It is also a common type of temperature sensor mostly used for non-scientific purposes because it is not so accurate.

3.2 System Implementation

Arduino Uno micro-controller is used here as a main controller of our system. all the other sensors such as temperature and wet detector sensors are directly connected with micro-controller. The main controller transmit all the sensing data to the iot-cloud via Internet. The wifi shield is used here for accessing Internet. The top view of our system is shown in Figure 3.5 and Figure 3.6 shows the circuit diagram of the system. We have also developed a cloud connected mobile application for visualizing the real time data. The screenshot of our application is shown in Figure 3.8. The application provides push notification based on wet threshold value.



Figure 3.5: Top view of our system.

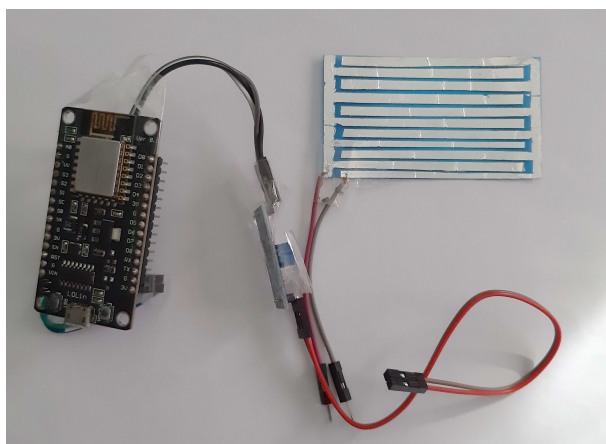


Figure 3.6: The partial view of the system.

3.2.1 System Design

3.2.1.1 Wet Detection Sensor

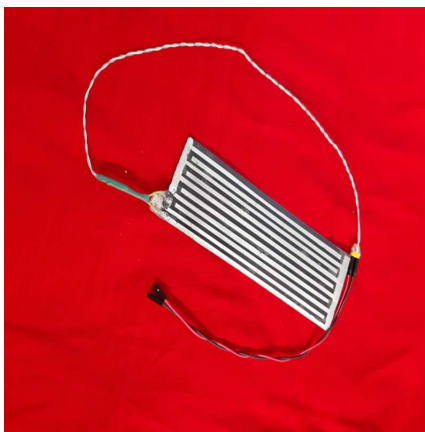


Figure 3.7: Wet detector sensor based on aluminum foil.

The sensor works on the basic principle of conduction. The sensing bricks have

independent conducting lines connected to a weak pull-up resistor. The tracks are connected to the power source and are tested for the shorted network. As soon as a liquid droplet falls on tracks of the brick, they get shorted and the same is detected using the circuit. In analog mode, larger the amount of liquid, more will be the voltage produced at the output and hence, the same is observed and can be used to detect the level of liquid in an overhead tank by either using multiple sensors or by increasing the length of the tracks (by soldering conducting wires through them). This item has low power consumption, and high sensitivity, which are the biggest characteristics of this module. So, we can easily find out the liquids weight. We developed this wet detection sensor by using aluminum foil. We parallelly placed the foil on a flexible plastic sheets shown in Figure 3.7. Two separate wire is connected with this sensor for transiting signal to micro-controller.

3.2.2 Mobile Application

A platform independent mobile application has been developed for receiving and visualizing the sensors data. The mobile apps collect the data from cloud. The mobile apps provides notification based on the sensor data. The screenshot of the mobile apps are given in Figure 3.8.

3.2.3 Information Security

These days, all Internet of Things stages out there are essentially servers to store data from gadgets. It is very regular to see "IoT stages" that are depending on a similar Web innovation utilized amid the most recent decade, however now to speak

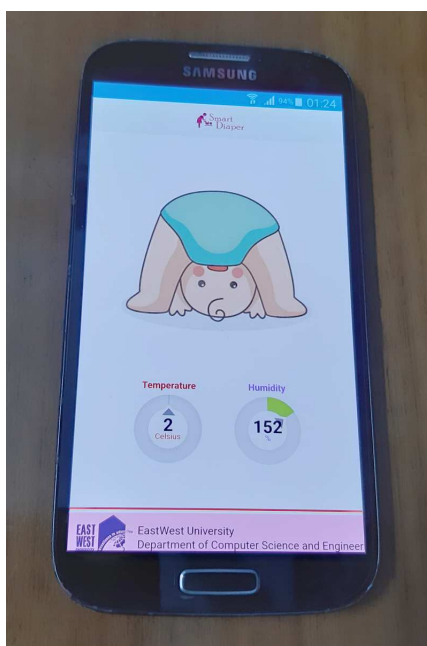


Figure 3.8: Mobile application for data visualization.

with the IoT gadgets. In this structure, the little gadgets simply push information to this sort of servers by simply doing customary and wasteful HTTP POST asks. Other minor options depend on utilizing more proficient conventions like CoAP, or MQTT, as they have been particularly intended for IoT, or M2M applications. In this way, fundamentally, the majority of the IoT stages has been considered simply like an information distribution center for the putting away and showing detected data from our condition. In the contrary way, the Thingier.io stage began as a stage for detecting and activating over gadgets continuously, something that is absent in numerous IoT stages. In our stage you can simply turn on and off things over a dashboard, a cell phone or show diagrams plotting data immediately from the devices. This innovation has incalculable advancements in the engine to limit information data transfer capacity, handling power, code size, or server adaptability, as all the bi-

ological community was completely composed sans preparation in present day C++, utilizing multithreaded ASIO for the server side, and not simply stock Web servers. Confidential data are exchanged with server and devices by internet. In this whole process if someone set up a false server and get this important information than security of data threatening positioning this situation we can use HTTPS protocol which is known as adjustment of the Hypertext Transfer Protocol (HTTP) for secure correspondence over a PC organize, and is generally utilized on the Internet In HTTPS, the correspondence convention is encoded by Transport Layer Security (TLS), or once in the past, its ancestor, Secure Sockets Layer (SSL). The convention is consequently likewise frequently alluded to as HTTP over TLS or HTTP over SSL

The main inspiration for HTTPS is validation of the got to site and insurance of the protection and trustworthiness of the traded information. It ensures against man-in-the-center assaults. The bidirectional encryption of correspondences between a customer and server ensures against listening in and altering of the communication. By and by, this gives a sensible confirmation that one is imparting without obstruction by aggressors with the site that one planned to speak with, rather than an impostor.

Endorsement specialists and open key testaments are important to confirm the connection between the declaration and its proprietor, and also to produce, sign, and direct the legitimacy of authentications. While this can be more useful than checking the personalities by means of a web of trust, the 2013 mass reconnaissance exposures attracted regard for endorsement specialists as a potential frail point permitting man-in-the-center attacks. An essential property in this setting is forward mystery, which guarantees that encoded correspondences recorded in the past can't be recovered and unscrambled should long haul mystery keys or passwords be traded off later. Not all

web servers give forward secrecy.

A site must be totally facilitated over HTTPS, without having some portion of its substance stacked over HTTP for instance, having contents stacked shakily or the client will be powerless against a few assaults and observation. Likewise having just, a specific page that contains delicate data, (for example, a sign in page) of a site stacked over HTTPS, while having whatever is left of the site stacked over plain HTTP, will open the client to assaults. On a site that has touchy data some place on it, each time that site is gotten to with HTTP rather than HTTPS, the client and the session will get uncovered. Correspondingly, treats on a site served through HTTPS need to have the safe quality enabled.

Chapter 4

Conclusion and Future Work

Diaper rash is a nightmare for diaper wearer and the people who is in charge for those wearers. In this project, the development of wet detector system has been tested in real diaper. A clear push notification is provided based on the wet condition of the diaper. Cost wise the designed system is not costly, the aluminum based wet conductors sheet may cost maximum from 0.1 to 0.2 USD. In addition the wet detector unit is decoupled from diaper for reuse. Although this system may look a little bit expensive for the parents, but the diaper's wearer health are the most important. On the other hand, considering other applications, such as patients in incentive care, bedridden, disabled, people who are unable to move, nurseries in hospitals how they are suffering from the diaper rash and suddenly bleeding, in these situations the cost is not the main factor. In order to guarantee babies comfort, the detector unit can be fabricated in a very small reusable board with minimum cost, owing to the design simplicity of both the wet detector.

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