A Low-Cost wet Diaper Detector Based on Smart Phone and BLE Sensor

MD Saifur Rahman[1], Chulhyung Choi[2] ,Young-pil Kim[3], Sikyung Kim[4,*] and Jungwan Choi [5]

[1,2,3,4]*Institution: Kongju National university, Department of Electrical, Electronic and Control Engineering #214 office, #8 engineering building,1223-24, Cheonan-daero, Seobuk-gu, Cheonan-si, Chungcheongnam-do, 31080, Republic of Korea.*

[5]*Company: Easycare,Republic of Korea.*

(**Correspondent author:* Sikyung Kim)

[1]*ORCID: 0000-0001-8345-0952*   [2]*ORCID: 0000-0003-1186-9812*
[3]*ORCID: 0000-0002-3232-4136*   [4]*ORCID: 0000-0002-2635-9332*

Abstract

People who have severe retardation or dementia are not able to handle their urination themselves, wet diaper detection is very important for them. Wet diaper creates several types of rashes such as irritation, candidal infection, allergic reactions, Seborrhea etc. As a result, guardians always need to check whether the diaper is dry or wet. Though there are several system and sensor for detecting wet diaper, they are expensive and complex. In this paper, a low-cost smart care system is designed to detect wet diaper based on Smartphone and Bluetooth low energy (BLE) transmitter. The flexible conductors placed into the most urine absorption area into the diaper. The wetting of the diaper decreases the resistance between two terminals which are connected with conductors. As a result, terminals resistance fall down below the pre-define resistance value and BLE transmitter send the warning alarm to the Smartphone application and the phone starts ringing.

Keywords: BLE, Smart Phone, nRF51288, wet detector, NPN Transistor.

INTRODUCTION

Due to the recent rapid ageing of the population, there is an increasing tendency for dementia patients. There is a growing interest in safety management, health and welfare improvement for demented and severely ill patients. Such as an intractable patient living in a general hospital, a nursing hospital, or a nursing home, a patient suffering from brain death, a disabled person who is unable to urinate, or an elderly person with dementia, their caretakers need to check their diapers are wet or not. Wet diaper spread many kinds of rashes and dermatitis [1], [2] which is dangerous for infants. The doctor tries to prevent this dermatitis using diaper cream or gel. However, these kinds of gel or cream [3] have some side effects. This is inconvenient to check diaper time to time for a nurse or patient family member. This is the inconvenience of manually checking the diaper of the patient from time to time. There are many systems for wet detection based on radio frequency (RF) transmission [4]–[6]. Most of these methods are very complex and highly expensive. One of the researcher design a wet diaper detector [7] based on mobile call GSM alarming system. However, this system is very complex and costly for the customer. One of the methods to detect wet diaper based on printed color changing. However, diapers printed with specific colors are one-time ones that cannot be used as ordinary diapers or undergarments and the caregiver has to check the undergarments of the elderly, patients, and the like while peeling them off. In order to overcome such a hassle, there has been developed a wetness sensor for detecting wetness which is mounted on the diaper and a warning sound is emitted when the urine is sensed. Since a separate device is required to operate the sensor which makes difficulties to wear the diaper. The sensor is contaminated due to the moisture and the sensor does not work. In addition, there is a problem that the elderly or the patient can give a shame due to a warning sound and the guardian always has to wait. The disposable diaper having a warning device is disadvantageous in that it is inconvenient to attach the device to the body and the price of the product is increased and the manufacturing is complicated.

In this study, a low-cost and convenient wet diaper detection system is proposed using smart phone application and BLE sensor. The proposed system automatically detects wetness of the diaper and sends a warning alarm to the smart phone via BLE communication.

THE PROPOSED WET DETECTOR SYSTEM

Our proposed system is divided into five major parts. Firstly, analog wet detector circuit detects the status of the diaper such as if the diaper is wet sent signal to the ADC (analog to digital converter). Secondly, signal conversion for BLE communication using ADC. After that BLE transmitter sent the warning signal to the pair smart phone. The fourth part is smart phone receiver and starts alarming sound and upload alert signal into the server for other responsible people. Finally, server sent notification and alarm to the other users. Figure 1 illustrates the block diagram of our proposed system.
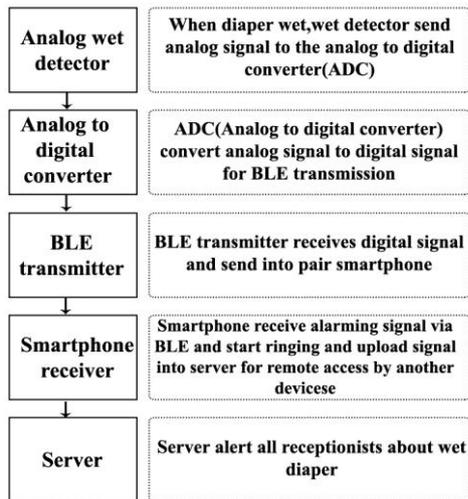
Figure 1: Proposed system block diagram

Circuit Diagram for Analog Wet Detector

In this study, in order to conveniently detect the status of the diaper, the printed six conductive tags are attached on the diaper and six conductors are connected with two terminals of the wet detectors sensor based on odd and even index using pressing studs which is shown in Figure2.Designed new conductors tag can detect the small amount of water or urine on the diaper. This design increased the sensitivity of the developed wet detector.
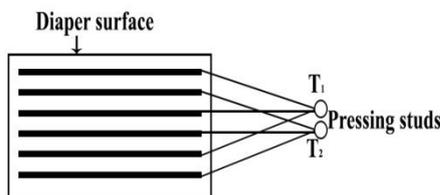
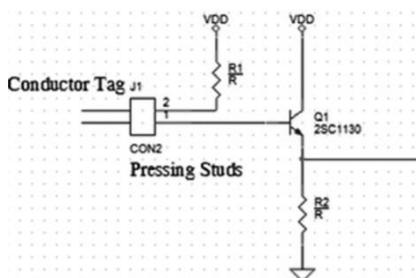**Figure 2:** Parallel printed conductors on the Diaper surface


Figure 3: Wet detector circuit diagram

Figure3. shows the circuit diagram of our proposed system. Two terminals are labeled by T_1 and T_2 .For circuit current circulation 3.3(V) dc current source supply. When two terminals T_1 and T_2 contacted with urine, the resistance between two conductors falls down through the R_2 resistor. As a result Transistor, T_r works as a forward bias and produce an analog signal for alarm generation.

Circuit diagram for BLE transmission

The proposed circuit is consisting of nRF51822 BLE chip and analog signal circuit. Analog wet detector generate analog signal and send to nRF51822 ADC (analog to digital converter) .P0.01 is the nRF51822 ADC pin number and GND is the ground pin. Then nRf51822 BLE chip transfer digital to pair smart phone for warning massage and sound .Figure 4.(a) shows the BLE transmission schematic and (b) printed board of wet detector sensor.
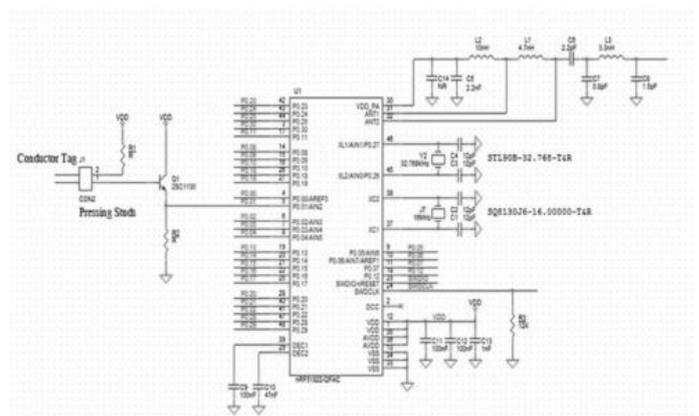
(a)
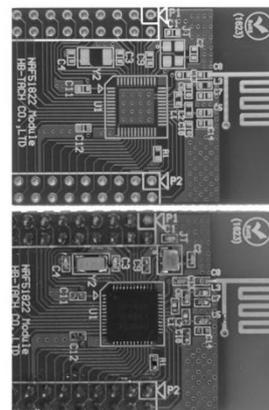
(b)

Figure 4: Designed of (a) schematic and (b) PCB for wet detector sensor

Smart phone protocol for BLE communication

In this study, BLE based Android smart phone application used for making alarm system for our designed wet detector. Firstly user needs to connect with our wet detector sensor via BLE. After that Android application always read the sensor data, S and compare with the threshold value, P. When the diaper is wet by urine, sensor data fall down than the threshold value. At this moment smart phone starts ringing and upload warning message to the server. The server sends messages the entire user who wants to know the condition of the diaper. Fig.5. shows the flowchart of the proposed system.
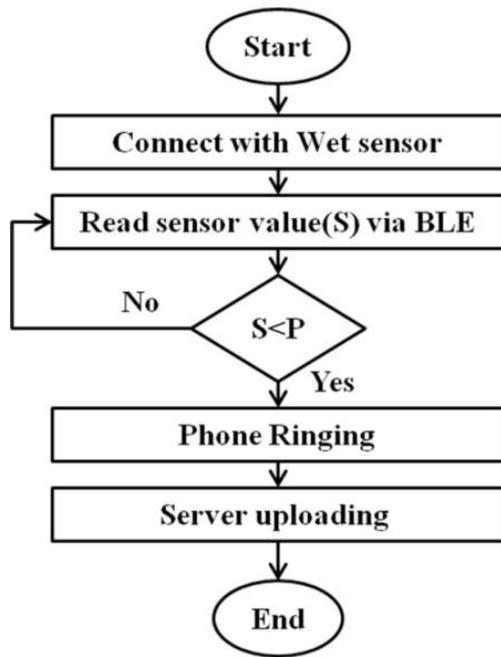
Figure 5: Flowchart for receiver-side

EXPERIMENTAL RESULTS

The viability of the proposed wet detector was tested. Developed wet detector connects with printed conductor tag which is placed inside the diaper. The sensitivity of the wet detector is adjusted by observing Arduino serial monitor voltage which is coming from ADC. Depending on the quantity of urine inside the diaper, the voltage drop shown in Fig.6.We used water instead of urine. The performance of the wet detector is tested by six different diapers based on 1ml, 2ml, 3ml, 4ml, 5ml and 6 ml of water inside the diapers. The wet detector attached with diaper using pressing studs which makes the connection between the wet detector and printed conductor place inside the diaper shown in Fig.8. The user can easily change the separate the wet detector by pressing studs and reuse the wet detector.


(a)
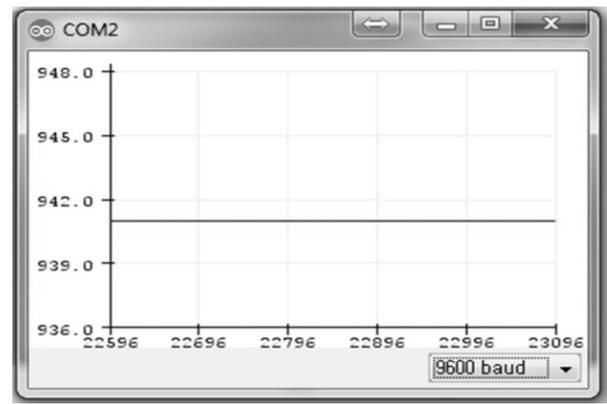
(b)
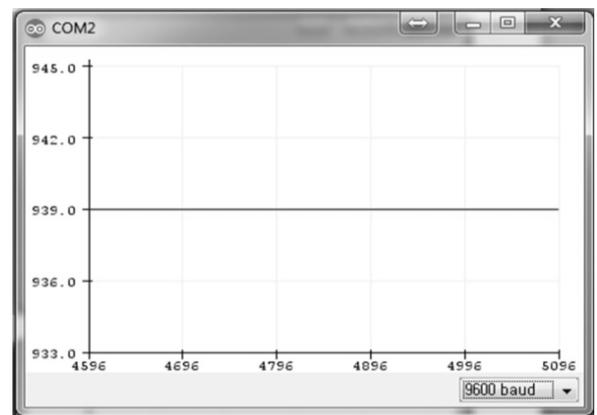
(c)

Figure 6: Voltage measurement using Arduino serial plotter for(a)dry diaper,(b)2mL water and (c)6mL water

After getting the experimental result our designed system gives a better response. This wet detector also depicts that any level of water can be detected according to the user requirement. Parallel placement of conductors which is (Fig.2) increases the sensitivity rate than the existing wet sensor. By getting the experimental result, we make threshold voltage to make the alarm system. If the voltage is going down the threshold voltage sensor sent alarm command to Smartphone and phone start ringing.
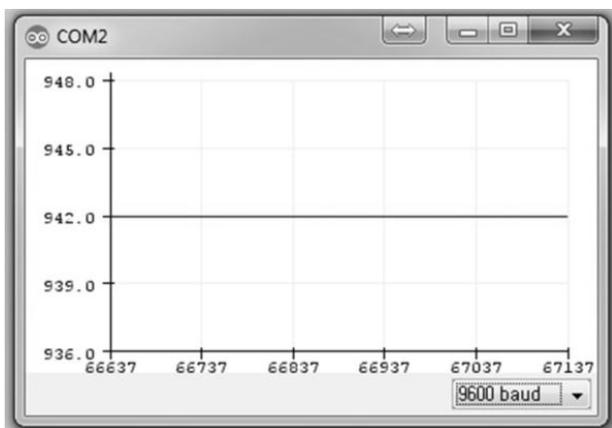
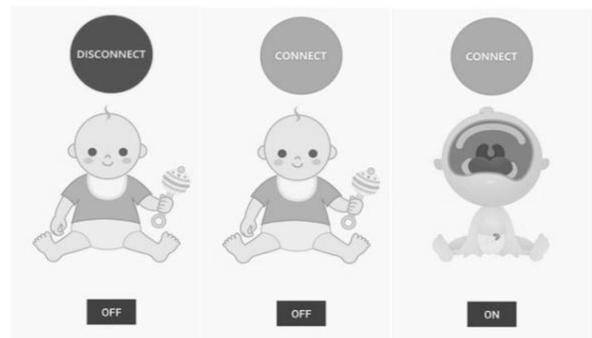**Figure 7.**Different state of wet detector Smartphone application

In Figure 7 illustrated the different status of smartphone application based on wet detector response. Disconnected means wet detector does not connect with Smartphone application, where connect specify that wet detector is connected with smartphone via Bluetooth. We use OFF indicates that alarm is off and stop ringing. When voltage is below threshold value, wet detector send command to Smartphone and Smartphone start ringing that is shown by ON text.

Figure 8. Wet detector fixed with diaper using pressing studs

CONCLUSION

The diaper's wearer health is important for parent and family member. Sometimes Wet diaper causes a dangerous health problem. In this paper proposed a wet diaper detector based on smart phone and BLE sensor. Above experimental results shows that proposed method is very convenient to detect wetness of the diaper. Our system gives a warning using a smart phone. Newsday smart phone is inexpensive and everybody has their own smart phone. Proposed sensor includes resistor, transistor and nRf51822 components which are very cheap compared to other wet detectors. Our development system is appropriate for all kinds of user who is able to use Smartphone.

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