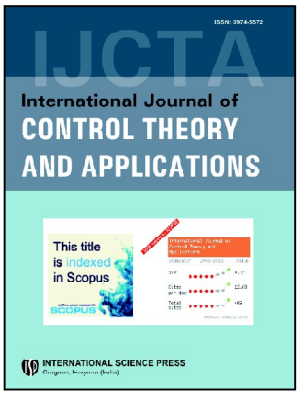

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SIDS Monitoring Using Lily Pad Arduino

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Abstract: SIDS which means 'Sudden Infant Death Syndrome' is a syndrome that occurs in infants. Most of the SIDS cases happen in infants below 1year of age. Infants death occurs mostly in non parental care i.e. may be in granny's care or may be in other caretaker's care. Especially there are few estimated causes which shows abnormality results such as sleeping position, temperature and respiration of the baby. SIDS can only be prevented but cannot be cured as there is no known proper reason to SIDS. To prevent the SIDS, the smart wearable monitoring device is designed using 'LilyPad Arduino' which monitors the infant continuously. Lilypad Arduino is an Arduino programmed microcontroller which is used for e-textiles as this is very flexible. In this infant monitoring, the smart wearable device is designed using Lilypad Arduino and special Lilypad sensors. Conductive thread is used instead of wires to connect sensors to the Lilypad Arduino main board. The main aim of SIDS monitoring is to monitor the condition of the infant and give the alert messages to the parent if there is any abnormality occurs in the baby's sleeping position, temperature and respiration. In this smart wearable device, Lilypad Arduino 328V main board, Lilypad acceleration, temperature and respiratory sensors and GSM module are used. The gathered information from the sensors is sent to GSM module from where it sends alert messages to parent's mobile.

Keywords: Infant monitoring; Smart wearable device; Lilypad Arduino; Conductive thread; Alert messages; GSM module.

1. INTRODUCTION

SIDS is a sudden infant death syndrome that cannot be explained with proper explanations. The death of a baby occurs without any suspect of the health issue. When the infant dies, the post mortem reports as everything is normal. So no one can explain the proper reason to the death of an infant. The death of the infant happens mostly below one year of age. There are many numbers of factors that are to be estimated as the cause of the infant's death. Those factors are as follows:

i) Baby's sleeping position

ii) Baby's body temperature

iii) Loose objects around the infant

iv) Firm mattress

v) Co sleeping with parents

These are some of the factors that cause risk to the infant. Parents should concentrate on these factors to avoid the sudden infant death syndrome. According to the study of AmericanAcademy of Paediatrics (AAP) [1], The most of the cases of SIDS had happened were due to thesleeping position of the infant. The infant shouldn't sleep towards his back side i.e. the baby shouldn't sleep towards his stomach down to the surface. Whenever the infant sleeps towards his/her stomach downside to the surface, the baby may suffocate which results in difficulty in breathing [2]. The other cause is temperature. The infant sometimes suffocate due to over coving of blankets in winter which may later lead to suffocation of the infant. If the baby suffocates then the temperature increases more than the threshold value which may leads to infant's death. The other recommendation to prevent SIDS is to avoid co-sleeping with the infant. The baby must be in the same room as of the parents share but shouldn't share the same bed [3].

Tintinalli *et al.* [4] said this SIDS can be classified into two types. They are as 'Extrinsic' and 'Intrinsic' factors that causes the risks of SIDS. If the risk of the SIDS is classified into two categories then SIDS can easily be prevented. Extrinsic factor deals with the external circumstances such as baby sleeping position, suffocation of the baby, firm mattress, smoking near to the baby, any loose objects in the crib of the infant etc. These are the extrinsic factors that cause risks in SIDS. Whereas intrinsic factors consists of prematurity of the infant, heredity (if any family member contains SIDS), and poverty. These reasons come under the risk of Intrinsic factors.

Many of the SIDS cases occurred in non-parental care. It may happen in nanny's care or may in other caretaker's care. So this paper comes with the solution to prevent the SIDS as prevention is better than cure. To alert the parents, the smart wearable device is attached to the baby's suit that consists of some sensors for every risk factor so that if any abnormality occurs the parent of the infant can be alerted.

The main contribution in this paper is to provide a detailed description of the Lilypad Arduino [5] which is an e-textile micro controller that helps in monitoring the infant. The sensors that are being used to monitor the infant are also Lilypad sensors.

Here, the GSM 800L module is used instead of Wi-Fi module. This GSM 800L modules is used in such a way that it sends the messages to the parent if there is any abnormality occurs in the sensors which helps to monitor the baby frequently.

2. SYSTEM HARDWARE

For any system architecture, there will be the hardware that play very important role behind the application. There are many hardware components that have taken place in this smart wearable device. Here, the system design is consists of following hardware components

- Lilypad Arduino ATmega328V – Microcontroller
- Conductive thread
- Temperature sensor
- Three axis accelerometer sensor
- Mic used for infant's cry
- Respiratory sensor
- SIM800L GPRS GSM Modem

a) Microcontroller: In this paper, the system architecture is designed in such a way that the wearable device is made up of Lilypad Arduino. Lilypad Arduino is an e-textile microcontroller which has 22 pins out of which 20 pins are IO pins and remaining two are +ve and –ve pins. The wearable device is designed with Lilypad Arduino because the device which is going to monitor the infant is attached to baby suit. The Lilypad Arduino is consists of a microcontroller ATmega168 and ATmega328v. In this paper, ATmega328v microcontroller is used for high power and it has more number of ports compared to ATmega168v. The operating voltage and input voltage required for Lilypad Arduino ATmega 368v is 2.7-5.5v. Hence only limited amount of power supply is required. There are 14 digital I/O pins which are used for monitoring the infant. There are 6 pmw (pulse width modulation) channels and 6 Analog channels. The flash memory in this ATmega328V is of 16KB in which 2KB is used by boot loader. The clock speed is 8MHz frequency. The below figure shows the Lilypad Arduino ATmega328V.

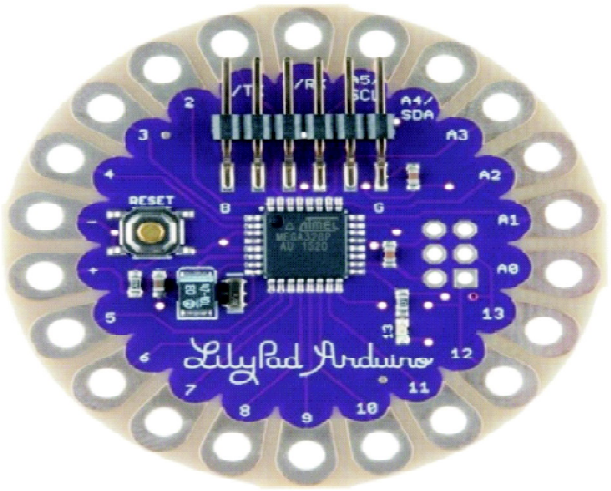

Figure 1: Lilypad Arduino ATmega328V

b) Conductive Thread: The sensors are stitched to the ATmega328v into these ports using 'Conductive thread'. It is a silver yarn like structure. As the Lilypad Arduino is an e-textile component, using conductive thread instead of wires makes more compactable and more flexible. This conductive thread acts as conductor so they can be used in the place of wires. The Lilypad Arduino ATmega328V board has to be sewed to the baby suit using this thread. Stitching can be done from the tabs on the Lilypad board to tabs on the components like sensors and GSM module. Make sure that the stitching has to be strong enough at least by stitching each tab with three times. This conductive thread can be available in Lilypad e-sew kit. The below figure shows how Conductive thread is stitched to Lilypad board on textile.

Figure 2: Lilypad sewn to textile using conductive thread

c) Temperature sensor: Here the temperature sensor is used to detect the temperature of the infant. The sensor type that is being used here is also the Lilypad sensor that supports the Lilypad main board 328v. In this, the wearable device is designed in such a way that it sends the alerts if there is any abnormality in the baby's temperature. This sensor is as small as that of a small coin and very portable. The Lilypad temperature sensor is as shown below

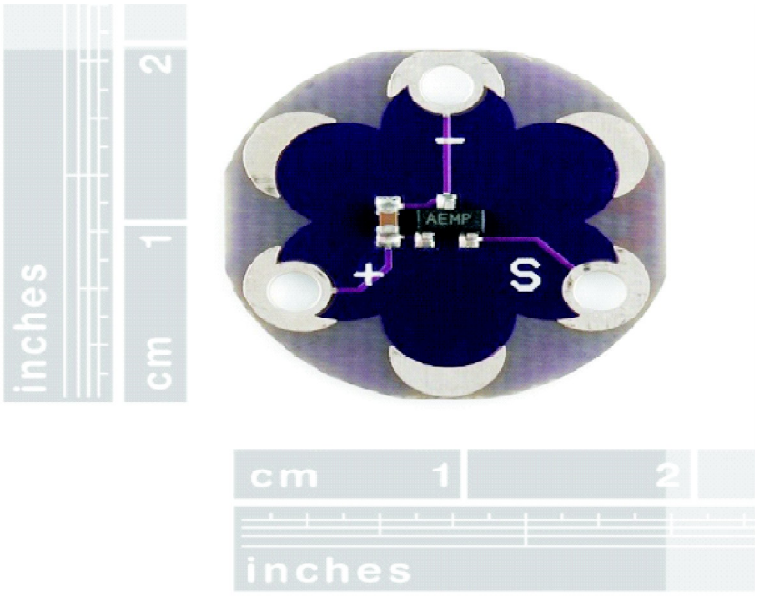

Figure 3: Lilypad Temperature Sensor

d) Three axis accelerometer sensor: Three axis accelerometer sensor is a sensor that is used to monitor the position of the infant. The sensor used in this is also a Lilypad sensor. The position sensor is used as most of the cases that occurred were happened due to the infant's sleeping position. So here, the position sensor plays very important role which helps to prevent the baby from SIDS. The Lilypad accelerometer sensor is as shown

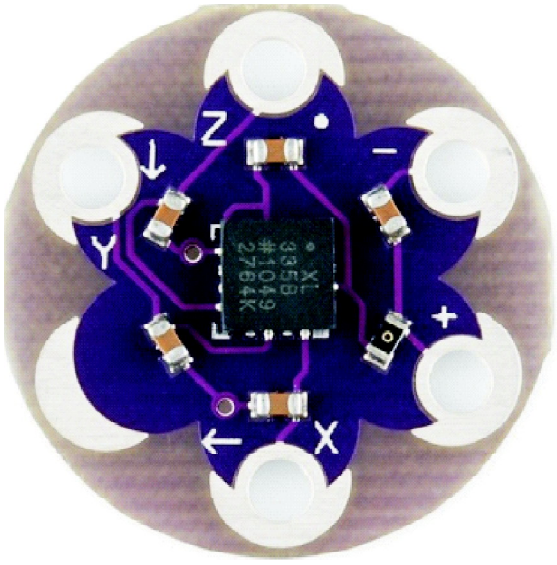

Figure 4: Lilypad Position Sensor/ Three axis accelerometer sensor

e) Mic with amplifier: Here Mic is used as infant's cry detector. If the baby cries continuously for certain time period then the parent who's not nearer to the infant will automatically get alert SMS so that the parent can get alerted. The image is as given below

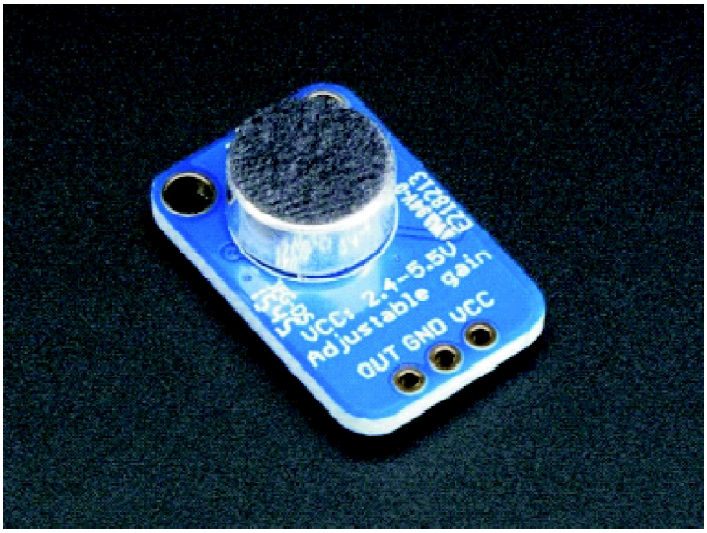

Figure 5: Mic with Amplifier

f) Respiratory Sensor: In this, respiratory sensor is made up from a conductive material also known as velostat or linqstat which is very pressure sensitive material. It will reduce the resistance. This conductive material is like a sheet like structure that is so handy and can make very flexible sensors.

g) SIM800L GPRS GSM Modem: This GSM modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. The sim card is inserted into this module to get the sms alerts to the parent's mobile. The modem can be powered via Lilypad main board. The figure is as follows

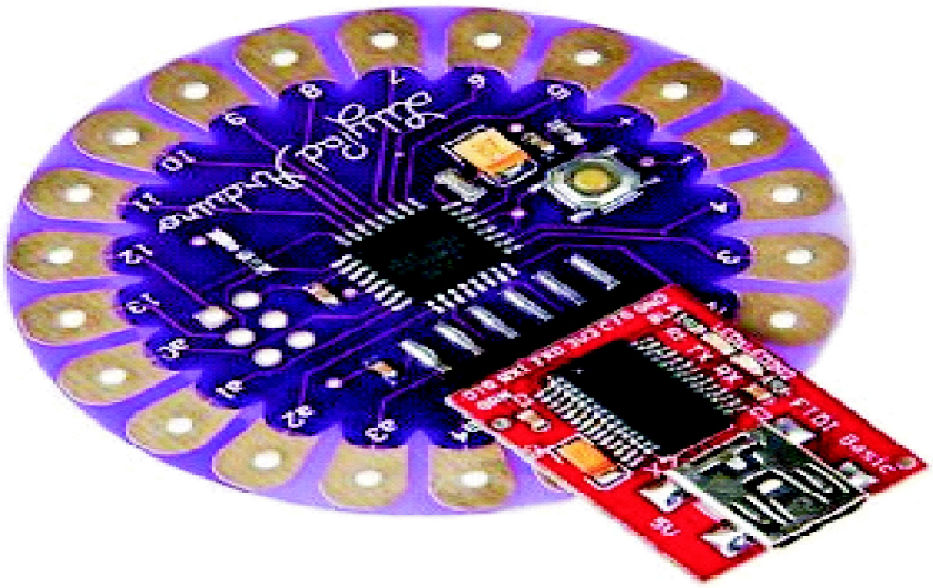

Figure 6: SIM800L GPRS GSM modem attached to Lilypad main board

3. SYSTEM DESIGN

System's design or system's architecture is quite simple. There are many numbers of system architectures in which authors have used different sensors to monitor and different communication modules to send the gathered information. In this paper, the following figure shows the wearable system design.

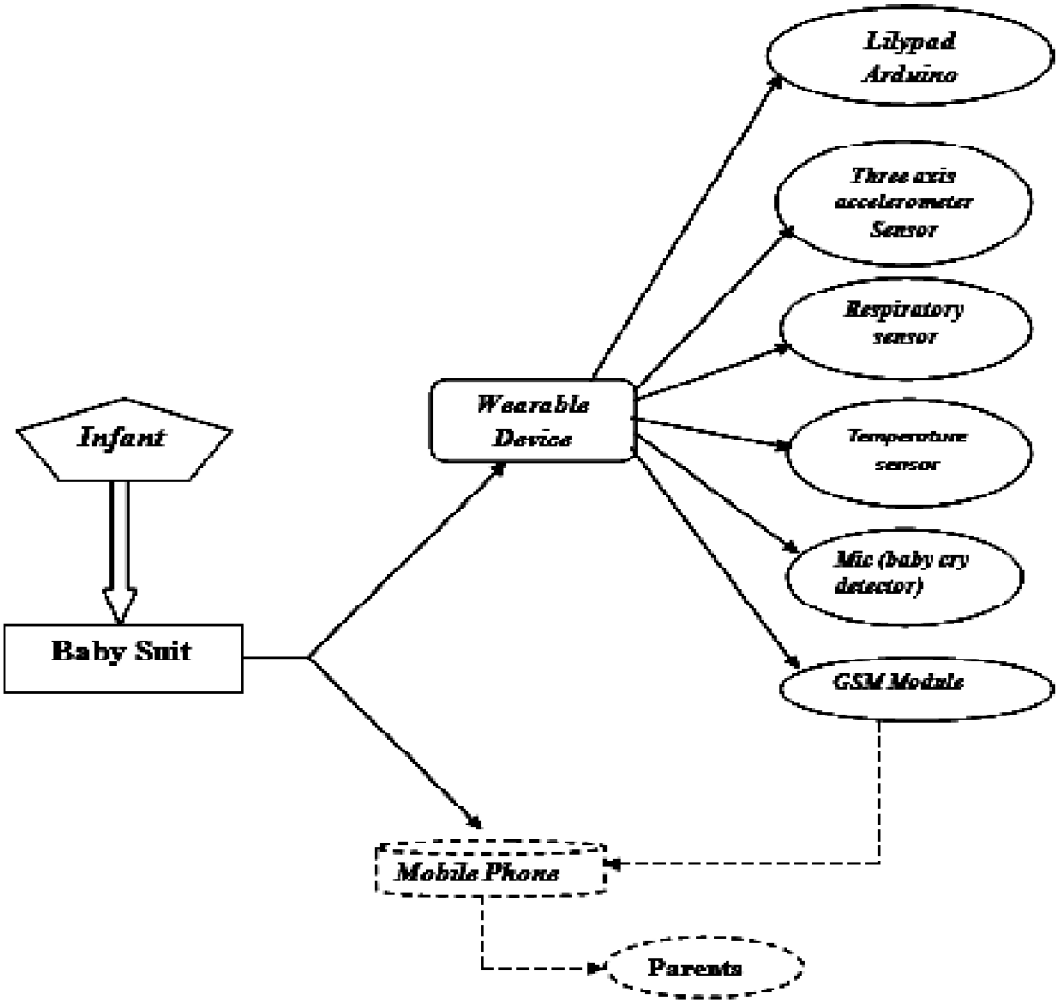

Figure 7: System's Design

The system design is quite normal that can be operated and used by anyone. The infant wears the baby suit to which this wearable device is attached. The wearable device works mainly on the basis of Lilypad Arduino ATmega328V. the Lilypad sensors are attached to Lilypad main board using conductive thread. Also the GSM module is attached to the baby suit so that the results or values that are gathered by the sensors are sending through the GSM module via sms to alert the parent.

4. PERFORMANCE

SIDS monitoring is done using Lilypad Arduino and some Lilypad sensors. With the help of 800L GSM module, the device is communicating with the parent's mobile to warn them if there is any abnormality occurs in the baby. If the abnormality values in the infant are noticed then certain parameter values will be sent to the mobile

to take care of their baby. The performance testing was held to a baby of age 8-12 months and received the results if there is any abnormality in the parameters like temperature, sleeping position and respiration of the baby.

Figure 8: Baby with SIDS monitoring baby suit

5. RESULTS

The main aim of this paper is to monitor and prevent SIDS. The Lilypad microcontroller is programmed in such a way that it consists of all normal values of the parameters. If any parameter in the wearable device crosses the threshold value then it will get the information from the sensors and immediately it buzzes the GSM module. Then the GSM sends the sms to the mobile which was saved in it i.e. to the parent's mobile. The received results are as follows

5. CONCLUSION

The SIDS monitoring using Lilypad Arduino is a wearable device that monitors the baby and prevents him from the sudden infant death syndrome. Lilypad Arduino is a new technology that is used as a microcontroller. Lilypad sensors monitor certain parameters of the baby and if any parameter crosses the threshold limit then the parent can be alerted and avoids the risk of SIDS. In future, this monitoring can be further improved by designing a specific application such that the parent can watch the baby whenever he wants to see.

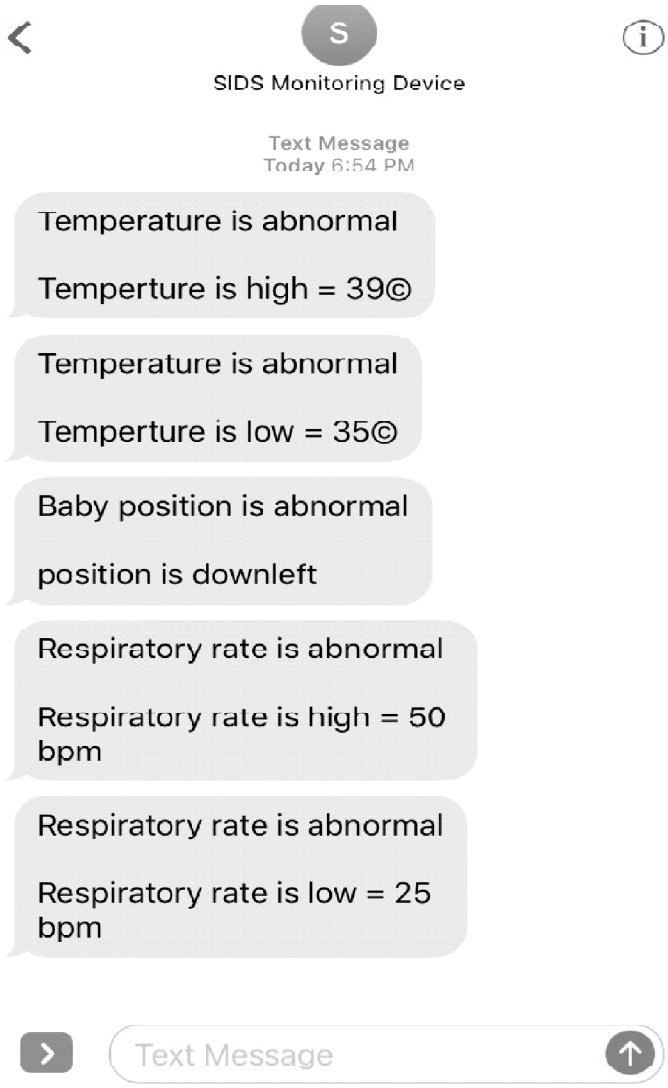

Figure 9: Result for SIDS monitoring using Lilypad Arduino

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