System Architecture of Atopic Dermatitis Adjuvant for Children Using Wireless Sensor

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ABSTRACT

Pre schools with state of the art facilities that would provide not just academic excellence but also ensure the safety and provide efficient healthcare to their pupils relative to Atopic Dermatitis with Asthma is the main objective of this research One of the most promising applications of sensor networks is for human healthcare monitoring. Due to recent technological advances in sensor, low power microelectronics and miniaturization, and wireless networking enable the design and proliferation of this wireless sensor networks capable of autonomously monitoring and controlling environments. Thus, this research presents the utilization of such microelectronic sensor and plots the hardware and software architecture of a wireless sensor network system with real-time pupil monitoring that integrates vital sign sensors, location sensor and allergen sensor. This proposed architecture for wearable sensors can be used as active tags which can track pupil's location within the school's premises, identify possible atopic dermatitis with asthma allergens, it would monitor and generate a health status report of the pupil.

Keyword: *adjuvant, atopic dermatitis, micro sensor, health monitoring system*

1. NTRODUCTION

Atopic Dermatitis (AD) is a chronic disease that affects the skin. This most often affects infants and young children and is more common in cooler climates and urban areas. This is associated with asthma and/or hay fever and familial occurrence of these conditions.[1,2]. AD with Asthma is the most chronic skin disease in children [3, 4]]. Approximately 18% of 7 year-old children have or have had AD. In 90% of patients the disease starts before 7 years of age, and for infants usually it start before 1 year of age. The majority of the patients improve before or around puberty, and it is estimated that approximately 2% of the adult population has AD. The atopic dermatitis associated with asthma is common to be higher in children than in adults and was found to depend significantly on their environment. Recently, several large-scale studies of different population in Korea [5] have reported the prevalence ranging from 2 to 13%. As depicted on Table 1 and 2. And further studies in some parts of Asia and Northern Europe have found similar prevalence, with industrialized and westernized nations noting increasing trends of patients with AD and the risk to children than to adults.

Table 1. Summary of Studies documenting the prevalence of Atopic Dermatitis with Asthma in Korea for Children/Adolescence

CHILDREN/ ADOLESCENTS	Number	Population
Son Bk et al.	2,850	Primary school-aged
Lee SI et al.	27,405	6-12 yr
Les SI et al	15,481	12-15 yr

Table 2. Summary of Studies documenting the prevalence of Atopic Dermatitis with Asthma in Korea for Adult

ADULTS	Number	Population
Kim SH et. al	718	Adults, urban Seoul
Kim JJ et. al	17,877	Adult Physician
Kim YK et al.	2,467	Adult, urban, rural and non metropolitan urban

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This pressing issue facing parents and child care provider here is Korea and in other countries revolves around what solution are optimal when children of working parents have Atopic Dermatitis associated with Asthma or other related allergies. And how can an educational institute assure parents that their school can provide a safe environment for these pupils when majority of countries reporting data have a PTR between 10-20 as shown in Table 3 [6] and not all kids have an adult to watch on their every steps.

Table 3. Pupil-Teacher ratio (PTR) by country for Pre schools

Regions	Below 10	10-20	20-30	30-40
Arab States	Saudi Arabia	Kuwait, Yemen, Qatar, Iraq, Lebanon, morocco, United Arab Emirates	Sudan	
Central and Eastern Europe and Central Asia	Belarus, Russian Federation, Estonia, Lithuania, Ukraine, Armenia, Uzbekistan, Republic of Moldova, Azerbaijan [7]	Hungary, Latvia Kazakhstan, FYR, Macedonia, Bulgaria, Slovakia, Czech Republic, Tajikistan, Poland, Slovenia, Romania[8]	Mongolia	
East Asia and the Pacific		Indonesia, New Zealand, Lao PDR	Viet Nam, Fiji, Republic of **Korea,** Brunei Darussalam, Macao, Japan, Cambodia	**Philippines**
Latin America	Saint Kitts and Nevis	Saint Vincent and the Grenadines, Saint Lucia, Turks and Caicos Island, Anguilla, Cayman islands, Dominica, Trinidad and Tobago, British Virgin Island, Montserrat, Grenada, Guyana, Barbados, Costa Rica, Ecuador, Belize, panama, Cuba, Honduras [9]	Aruba, Dominican Republic, Columbia, Chile, Nicaragua, Jamaica, Peru, Guatemala, Paraguay, Uruguay, Mexico[8]	Bolivia
North America and Western Europe	Iceland, Sweden	Finland, Italy, Greece, Luxembourg, Spain, Belgium, Switzerland, Andorra, Austria, Portugal, France, United States, Cyprus, Germany, Turkey, United Kingdom [9,10]		

Given this impending healthcare problem, it is imperative to extend healthcare services ubiquitously thus the ADAC (Atopic dermatitis Adjuvant for Children) using wireless sensor, a wrist computer assistant is proposed. A preventive and monitoring architecture design to alert the primary user for possible allergens and monitor his/her health status that can be used by primary schools as they monitor not just the academic status of their pupils but also generate a health status report of the child while he/she is in the schools premises and would also give the child a full range of motion despite being monitored.

The design of ADAC jointly adopts wireless appliances-Wrist Computer to detect for possible allergens and vital signs monitoring with integrated communication capabilities. (e.g. Wi Fi, WiMax, support GPRS) and the use of RFID to aid in the location sensor. Another important aspect of ADAC is that it enables practical, long-term, context specific continuous monitoring. Continuous monitoring ensures the capture of relevant events and the associated physiology wherever the child is. The data from these sensors can then be used to build a personalized profile of performance and long-term health monitoring over time tailored to the needs of the patient and their healthcare providers. With the development of increasing powerful diagnostic sensing technology, context specific information can be obtained directly, instead of relying on the child's recollection of part events and symptoms which tend to be vague, incomplete and error prone.

2. RELATED WORKS

In recent years, advancement in mobile computing has opened new perspectives in the area of telemedicine [11]. In a hospital environment, patient monitoring is eased by the development of new wireless devices to monitor physiological signals [12]. The management of health records, the sharing of medical information, and the displacement of patients are also favored by the increasing adoption of wireless devices. The adoption of wireless devices in telemedicine in order to extend the reach of given medical treatment and to efficiently monitor a patient beyond the restricted environments in hospital is receiving an increase attention in recent years. In the particular area of cardiology, there are investigations on the applicability of mobile computing to situations such as remote continuous monitoring of arrhythmias in moderate-risk patient]

The mentioned related work applies wireless technology on the medical area to mainly address two issues: (i) to ease the monitoring and healthcare of patient within the hospital environment; and (ii) to provide a continuous monitoring of patient previously identified as being subject to some health risk and has special needs. In contrast, our research focuses on the adoption of mobile computing to allow intervention in reaction in efficient and economical way. In the context of this research, a key feature is to monitor the child's health condition and teachers in pre-schools would have an easy, accurate, efficient way of making the pupil's daily health status report.

3. ENARIO

In this section we present a hypothetical Scenario to illustrate the usefulness of our proposed system. The child is fictitious, but represents a common issue of a child who has an impending health problem and healthcare needs. We discuss the issues and describe how our system can be used to both address the problem and provide advantage over typical present day situation.

Song –woo Lee has a hereditary Atopic Dermatitis with Asthma and in its exacerbation period. Both parents are working and normally he is left in a pre-school when his parents are out t work. In most pre-schools in Korea average number of students in a class is 20-30 with a single teacher per class as shown in Table 2. Sadly, children in pres-schools cannot be attended individually at all times and such illness can be triggered by the following allergens low humid condition, dust, smoke, sand and some aeroallergens such as dust mites, pollens, molds and danger from animal hair or skin. When these allergens are present and the child is not properly monitored the exacerbation of Atopic dermatitis would possibly worsen as the child is continuously exposed to such allergens because inflammation-producing cells will permeate the skin from elsewhere in the body. These cells cause itching and redness and as the child scratches and rubs the skin response, further damage occurs.

Our health monitoring system offers a solution for Sang-Woo. Equipped with ADAC, tiny sensor provides constant observation of possible allergens in his surroundings and would monitor Sang-Woo's location within the school premises and check the vital statistics at a given time interval. The ADAC will alarm the child if he/she is at a high risk allergen environment, it would also send a distress signal when the child's body sensor is sending an abnormal body signal to the wrist computer or when the child is already out of the schools premises schools hours. And the monitored data will be forwarded to the Pre-School ADAC Medical Server which later can be retrieved by the teacher for health report to be given to the child's parents aside from the academic report which most teachers present to parents.

4. THE ADAC SYSTEM AND SERVICES ARCHITECTURE

The main objectives of ADAC are to provide means to prevent further exacerbation of Atopic Dermatitis with Asthma and an instant and efficient assistance to a child who is in a medical emergency situation thru an information feedback services that can be a notification in case of the child's distress or abnormal bio-signal levels. In this proposed system the child is the primary end user. The secondary user is the teacher. With the personal server running on the wrist computer, it provides a human-computer interface and communicates with the remote server.

4.1 Hardware Architecture

Key feature is to monitor the child's health condition and the teachers in pre-schools would have an easy, accurate, efficient way of making the pres-school pupil's daily health status report.

ADAC is a wireless sensor network for health monitoring integrated into a broader multi-tier ADAC telemedicine system. Fig. 1 illustrates the ADAC typical deployment configuration.

When an abnormal bio-signal is detected or when the child is in a distress situation the 2.4 GHz RFID tag transmits a unique ID number to a nearby Wi-Fi access point, which passes that information on to the child's teacher's mobile handheld device in a WLAN (Wireless local area network). Exciters are positioned at doorways, exits and other chokepoints, to detect when the child moves through them.

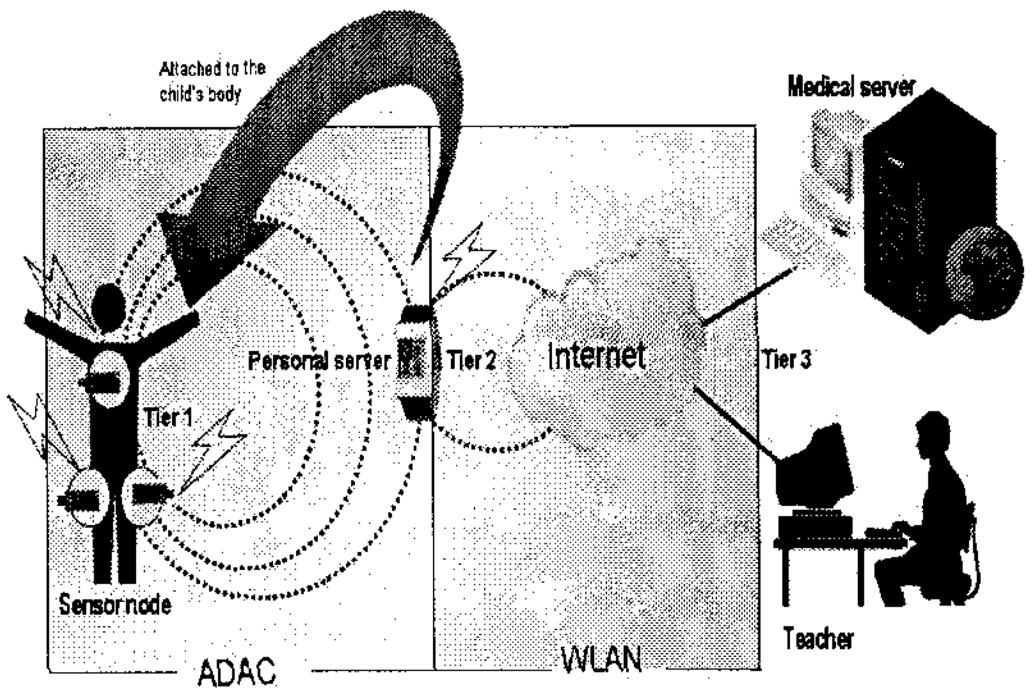

Fig. 1. ADAC typical deployment configuration

The system can locate the room in which a tag is located, and includes a set of configurable rules designed to trigger alerts when broken. For example, if the system fails to detect a tag's movement for a specified amount of time, or detect that a child has wandered into an off-limits or dangerous area, an alert can be issued.

TIP7xx mote as shown in Fig. 2 are the sensors used in this research a wireless module for sensor network, monitoring and application testing. It supports Low power, Multi-hop network with IEEE 802.15.4. It can utilize various sensors and communicate with each other by 2.4GHz band. This acts as the primary embedded platform for all sensors in our system. Each Tmote sky board utilizes Texas Instrument's MSP430F1661 microcontroller and Chipcon's CC2420 radio interface. The microcontroller is based around a 16-bit RISC core integrated with 10 KB of RAM and 48 KB flash memory, analog and digital peripheral, and a flexible clock subsystem. It supports several low-power operating modes consumes as low as 1μA in standby mode; It also has very fast wake up time of 6μs. The CC2420 is controlled by the MSP430 microcontroller through the Serial Peripheral Interface (SPI) port and a series of digital

I/O lines with interrupt capabilities. The TIP7xx series platform features a 10-pin expansion connector with one Universal Asynchronous Receiver Transmitter (UART) with two general-purpose I/O lines, and three analog input lines.

To show the feasibility of the research TIP700CM was programmed with Oscilloscope application that periodically takes sensor readings and sends a group of reading over the radio since this sensor suite includes integrated light, temperature and Humidity sensor. The TIP710GM-A is used as an interface, programmed with TOSBase application that acts as a simple bridge between the serial and radio links. TOSBase will copy its compiled-in group ID to message moving from the serial link to the radio, and will filter out incoming radio messages that do not contain that group ID. Using a Serial forwarder the application will instantiates a server which provides a bi-directional packet stream between a motes connected to the host PC and clients anywhere on the network. With the Oscilloscope application, it displays the reading coming from oscilloscope mote application. Fig. 3 and 4 show the mote used in this research with the X axis as the packet counter and axis Y as the sensor reading.

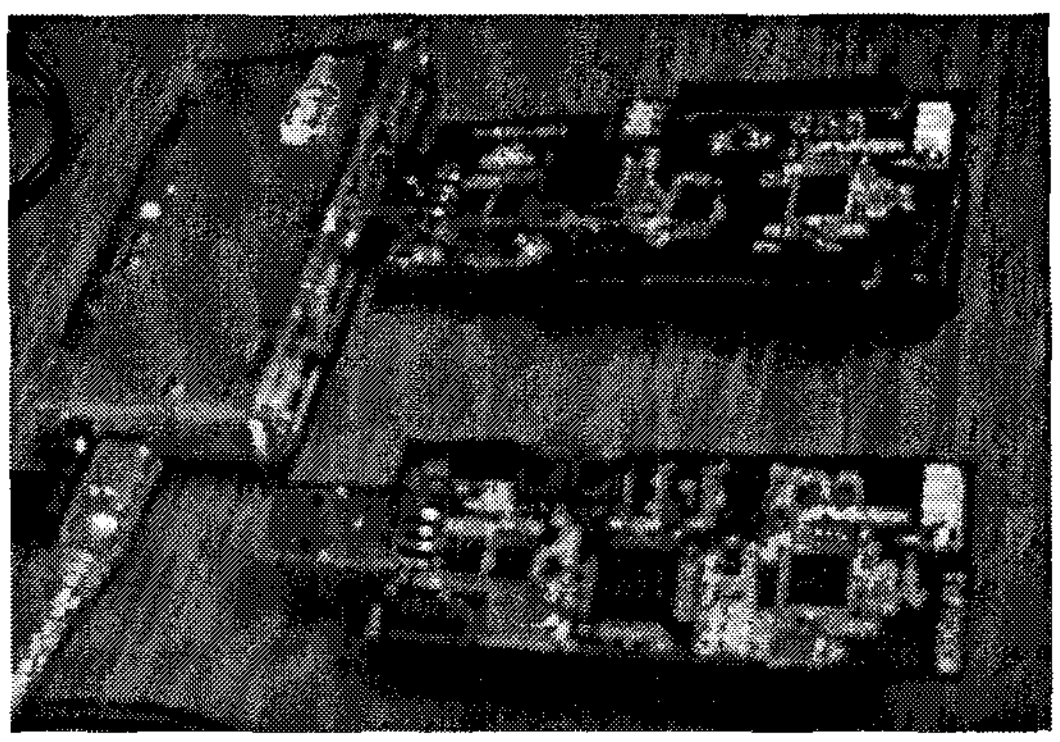

Fig. 2. TIP700CM and TIP710GM-a

Fig. 3. Oscilloscope readings (GREEN-temperature, BLUE-Active Radiation and PINK- internal Temperature)

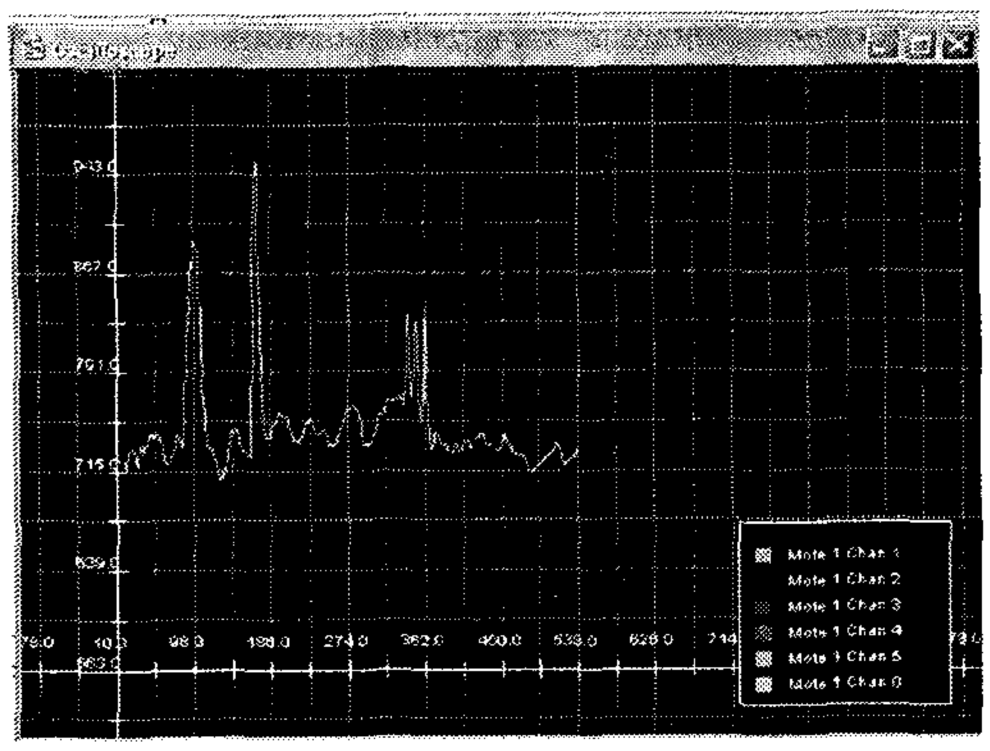

Fig. 4. Oscilloscope readings (YELLOW-humidity)

4. 2 Software Architecture

In this section we describe the software on the Tmote platform. Sensor node and network coordinator software that is to be implemented in the TinyOs environment.

4.2.1 Sensor Node Software: In the proposed system the sensor node software will collect physiological data, such as vital signs of the child – temperature, heart rate, pulse rate, etc. as well as the possible allergen present in the environment and the location data of the child within the school premise. The system will then analyze the signals in real-time and transmit the result wirelessly to the personal server. This software will run on the Tmote sky platform [11], [12] and custom application specific daughter cards. The software for three types of sensors: Vital sign sensor that will check the basic THP (Temperature, Heart rate and Pulse rate) of the primary user and the Allergen Sensor that will monitor for possible allergens in environment where the primary user at that instance is located and the location sensor that will locate and monitor the child's location at a particular time. The Sensor node and network coordinator software is implemented in the TinyOs environment.

4.2.2 TinyOS Components: In this research we use TinyOS, a lightweight open source operating system for wireless embedded sensor. It is designed to use minimal resources and its configuration is defined at compile time by combining components from the TinyOS library and custom-developed components. Well-defined interfaces are used to connect and define the data flow between components. A TinyOS application is implemented as a set of component modules written in NesC language extends the C language with new support for task synchronization and task management. This approach results in a natural modular design, minimal use of resources, and short development cycles.

TinyOS fully support the Tmote platform and includes library components for the Chipcon ad other on-chip peripherals. Fig. 5 shows the Vital sign, Allergen and location sensor Software architecture using TinyOs component model. The components gray are those reused from the TinyOs library. GenericComm provides generic packet handling and basic SendMsg, ReceivingMsg interfaces using TinyOs messages. A TinyOs message is a generic message structure with a reserved payload for application data[12] GenericComm would also interface to low-level platform specific TinyOS hardware drivers. The Vital Sign Sensor and Allergen Sensor application layer consist of custom components shown in blue.

4.2.3 Personal Server Software: Personal Server provides the surer interface, controls the ADAC, fuses data and events, and creates unique session archive files. The software will be implemented in Visual Basic using Visual Studio 2005. It will run on either Windows CE pocket or windows PC. User Archive files are created in real-time using a custom binary file format, and are then converted to a Microsoft Access database for off-line analysis. The ADAC research typically involves only two sensors: Vital sign Sensor and Allergen Sensor.

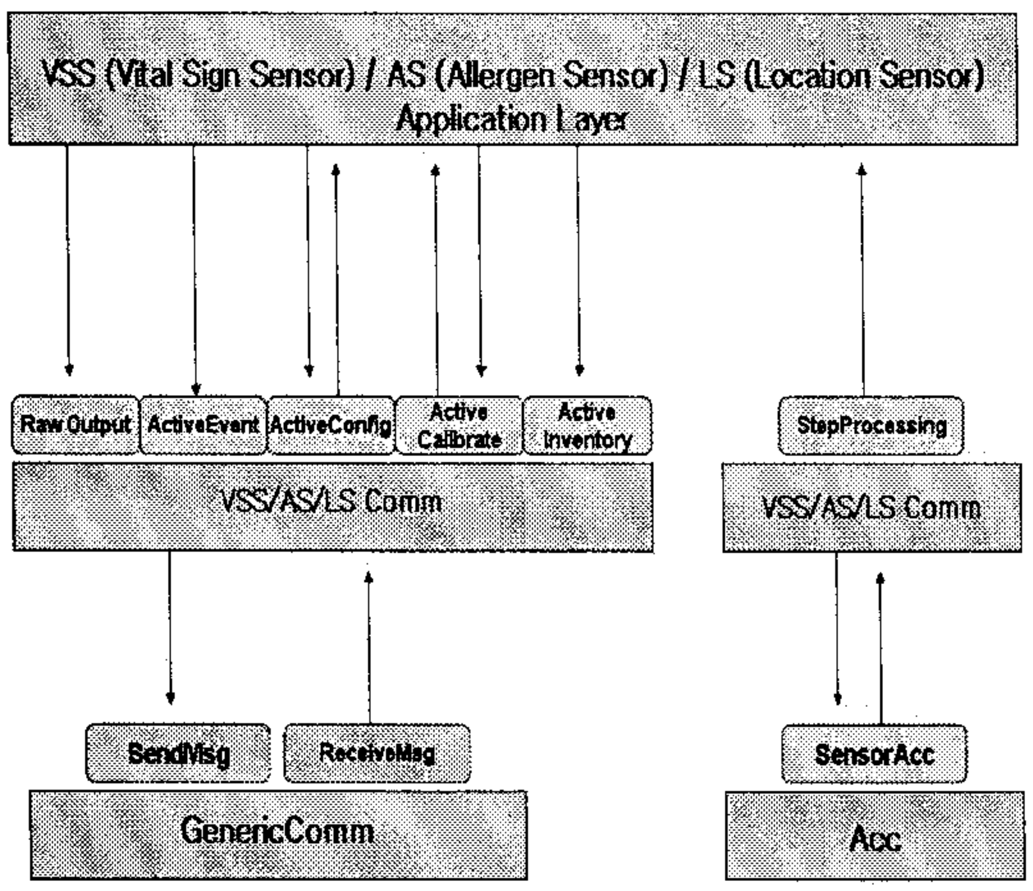

Fig. 5. Simplified sensor node interface connection

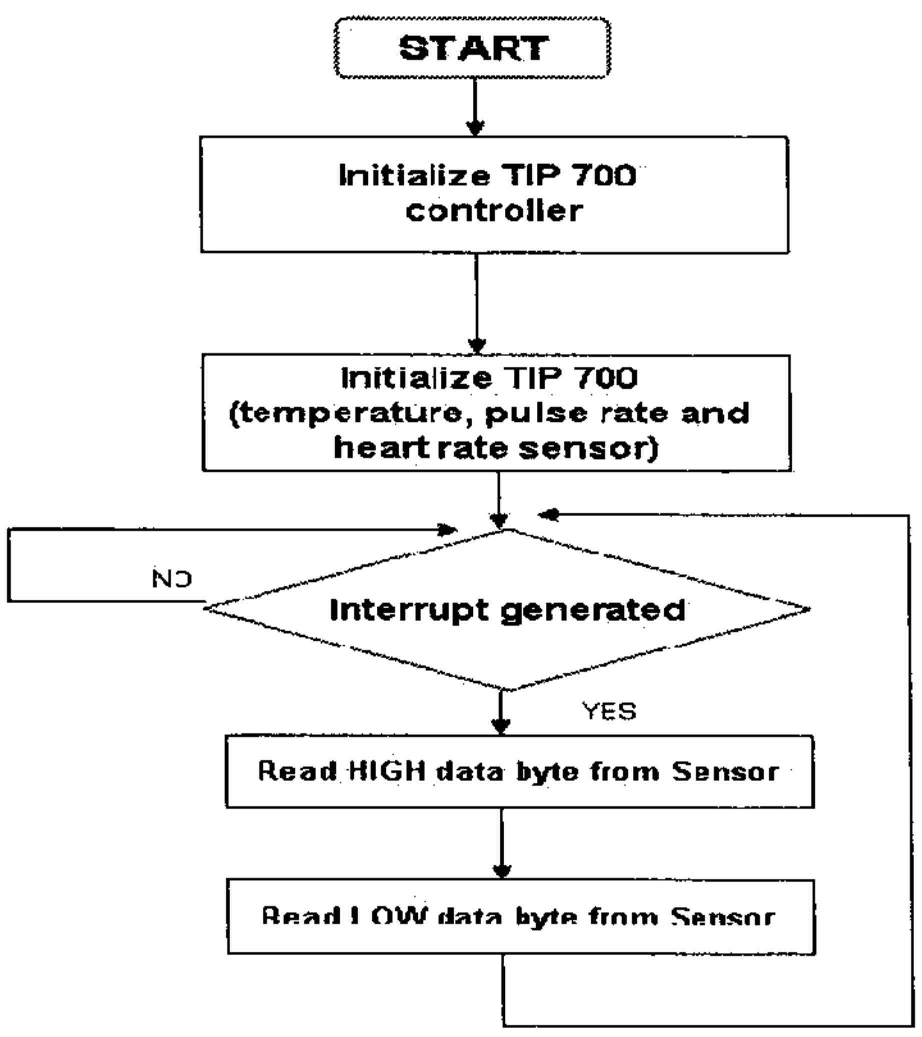

Fig. 6. Reading from vital signs (temperature, pulse and heart rate) Sensor

Fig.7 depicts the message flow during a typical ADAC health monitoring session and fig. 6, the flow chart of vital sign sensor. The Personal Server begins a health monitoring session by wirelessly configuring sensor parameters, such as sampling rate, selection of the type of physiological signal of interest, and specifying event of interest. The Personal server aggregates the multiple data streams create session files and archive the information in the primary users database. Real-time feedback is provided through the user interface. The user can monitor his/her vital signs and be notified of any detected warnings or alerts

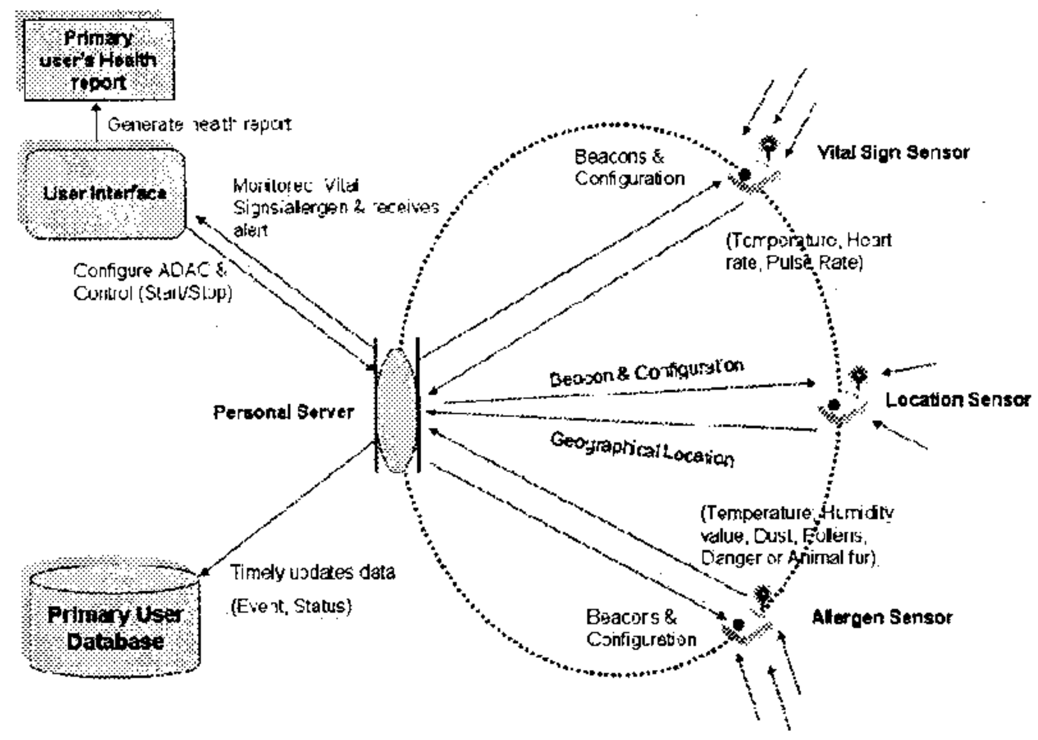

Fig. 7.Data flow of ADAC proposed system

5. CONCLUSION

Our focus was on developing an intelligent mobile platform so as to provide assistance to children in Pre Schools, to assist teachers in making health reports for their students and provide confidence to Pre schools and parents that the children's health conditions are religiously being monitored.

The project is currently making the first design step towards a sophisticated general-purpose software and device. This system will allow a dramatic shift the way Pre schools make education more efficient and effective in the same fashion the internet has changed the way people communicate to each other and search for information.

The shift towards a more proactive preventive will not only improve the quality of life, but will reduce healthcare cost.

The proliferation of wireless devices and recent advances in miniature sensors prove the technical feasibility of a ubiquitous health monitoring system. In this paper we describe both the Hardware and Software architecture of our proposed system. The hardware architecture leverages off-the-shelf commodity sensor platform. Similarly, our software architecture builds upon TinyOs, a widely used open-source operating system for embedded sensor networks.

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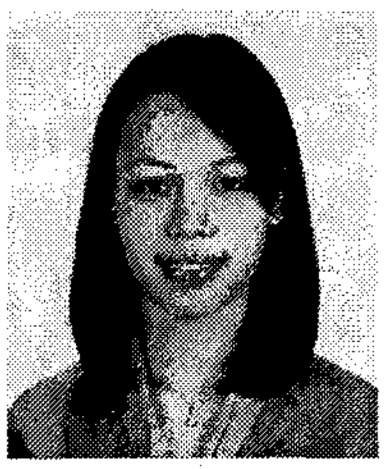

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