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# LOW POWER IMPLEMENTATION OF AN IOT APPROCH FOR AN AAL WI-FI-BASED MONITORING SYSTEM

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**Abstract**-- A lot of research has been going on continuous home and personal monitoring applications. There are many solutions were adapted by these technologies to make better remote monitoring applications. The traditional continuous home and personal monitoring systems which are implemented with traditional client-server architecture which may fails in factors like low power consumption, un-deterministic data delivery time, more sensitive to external connectivity issues (temporary failures of servers), adhoc networks (using zigbee) and also increases the cost of implementation. However, when dealing with the home environment, and especially with older adults, obtrusiveness, usability, and cost concerns are of the utmost relevance for active and assisted Living (AAL) joint program. With advent of cloud services, the continuous remote monitoring based applications became truly "plug-and-play" approach implementation and also reduce the problems of temporary failures. One of the biggest challenges in this area is to make such application devices to work with low power (battery based applications). Power consumption is main concerns in implementing Wi-Fi sensors. In this project, a solution is proposed to improve the low power consumption in Wi-Fi sensors by making use of advanced RF based Microprocessor from Texas instruments (CC3200). A Bed Occupancy sensor automation have been designed and implemented to test the feasibility of the approach. The TI CC3200 comes with ARM-Cortex-M4 as a core and inbuilt Wi-Fi subsystem. The CC3200 provides different power modes to make the device enter into sleep or hibernate mode. This device will only enter only in work phase when the sensor is active state. During this phase, the processor sample and processes the sensor data and uploads to the cloud using REST API. ThingSpeak is an IoT cloud service used to present the sensory data as graphs, bar charts, and dashboards on the cloud Remaining time it will enter into sleep phase to save the power of the device, so that it will extend the battery life time of the device.

**Keywords:** SoC, WBAN, IoT, REST, AAL

## I. INTRODUCTION

The average population age [1] has been increment in a progressive manner, which has a deep social and economic impact. Most importantly, the affects of social and health care policies between younger and older class-ages creating a progressive imbalance, questioning sustainability of long-established welfare models. The requirement of age-friendly home environments implementation is necessary for older class ages, in order to improve the quality of life of aging population in an affordable way. The current popular Communication and Information technologies may contribute to the development of active aging scenarios [2], and are at the core of many worldwide research initiatives and programs. Among them, the "active and assisted Living joint program" (AAL-JP) [3] is exploring opportunities fostered by Communication and Information technologies to improve conditions of life for the older adults. The age-friendly home environments implementation is a relevant goal: concepts such as smart homes [4]–[6], ambient intelligence [7], telemedicine [8], [9], and telemonitoring [10]–[12] converge in such a perspective. Key enabling technologies include sensing, reasoning, communicating, and interacting components. In order to be effective, deployment of Communication and Information solutions within the home environment should not be perceived as intrusive, should not require bothersome changes in lifestyles and habits and needs to be accessible and trustworthy to (possibly unskilled) older adults.. A promising AAL objective consists of the exploitation of data coming from the home environment (through nonintrusive sensors) for the inference of "behavioral" data patterns, possibly meaningful in evaluating risk conditions or needs related to health and well being. For instance, behavioral remote monitoring is expected to be most relevant in early assessment and identification of dementia and in related safety provision [15]. In order to implement a low cost and low power AAL based age-friendly home environments, the requirement of making use of low power SoC technology. With the advent of miniaturization of SOC chip technology, chip manufacturing companies have been developing high performance digital microcontroller along with inbuilt wifi technology for the development of IoT. The Texas Instruments (TI) company, developed a low cost ,high speed and low power microcontrollers (named simple link wireless MCUs – CC3200) as SoC with a size 9mmx9mm. In this project, CC3200 is used as independent wireless sensor nodes for developing the application as per requirement. This CC3200 SoC come as an integration of wifi-module along with ARM-Cortex M4 digital processor. This chip also have analog sub modules like, programmable comparator, and Analog to Digital converters. A cloud based application is developed to monitor and display the information coming from CC3200 sensor node [5].

The rest of the paper is organized as follows. Section II describes the related work of this paper. Section III presents the overall architecture and complete block diagram of proposed system of this project. Section IV presents the software and hardware implementation of the proposed system. Section V presents the results of hardware and BED Occupancy sensor data on the Things Speak cloud service of this paper. Section VI provides the conclusion of the paper.

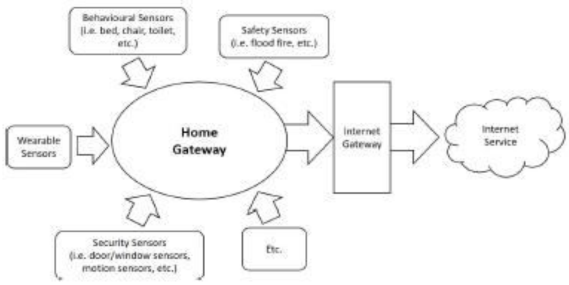


Figure 1: Generic architecture for home sensor network

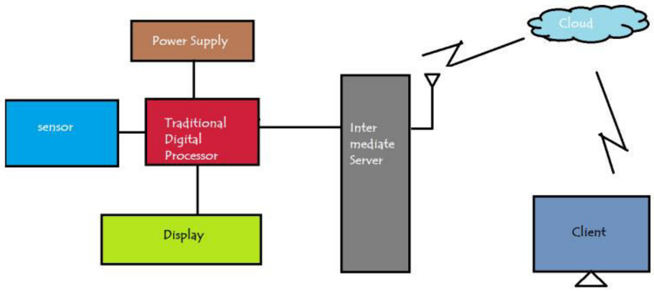


Figure 2: A simple model of Existing System architecture for active-assisted living.

## II. RELATED WORK

The present research on active and assisted living focusing on home-monitoring systems have been reported in [18]-[20] by. Such systems uses a large number of different sensors to track the daily activities. In figure 1, a generic architecture of the home-monitoring is shown figure 1. referring to different variety of classes of home sensors, a home gateway, which stores, aggregates, and processes sensor data, and an Internet gateway providing access to cloud-based services like thingspeak, exocite, etc. Deploying the sensor based network into a user's home is a highly demanding design task, due to the non-intrusiveness, usability, and acceptability concerns mentioned in the introduction above: initially, home sensor systems-based their connectivity

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over wired technologies, exploiting either proprietary protocols [21]–[23] (e.g., X10, KNX, and LON), or open standards such as Ethernet [24]. With the advent of Wireless communication the connectivity of home sensor network is providing much higher flexibility and installation ease, at the expense of some delicate design issues, dealing with propagation of radio signals within a built environment. Also, some maintenance tasks are introduced (checking and replacing/recharging batteries, for battery-operated devices). In this case too, a number of different varieties of technologies have been introduced: among the most diffused, bluetooth is mostly exploited for short-range communication (e.g., body area networks (BAN)) whereas Z-wave [25] and ZigBee [26]–[28], protocols (among many others) have emerged as most practical options for the implementation of a home sensor network.

## III. SYSTEM ARCHITECTURE

The proposed system active and assistive home monitoring is shown in figure 2.

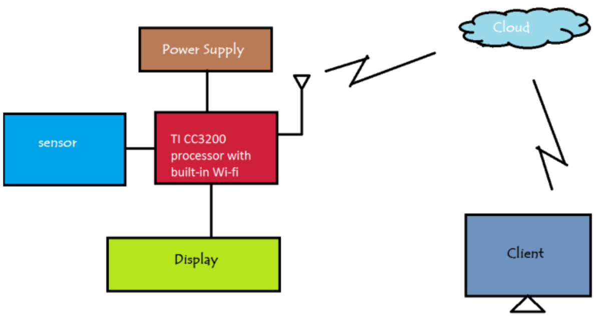


Figure 3: Implemented block diagram Proposed System for active-assisted living

The proposed system architecture is a single System on Chip (SoC) and Wi-Fi connectivity can be used to monitor all the normal human vitals and directly send such information to web services without using any personal servers. The recent advancements in Wi-Fi technology will allow the Wi-Fi devices to operate with low power. So by using this IP based multiple sensor node instead of multiple BIN's will reduce the cost and power requirement for remote heath monitoring systems. Because of the Internet of Things, the multiple sensor data from proposed device can be viewed from anywhere and anytime.

The proposed system consists of i) Bed-Occupancy Sensor, which converts the analog pressure into analog voltage. ii) Sampling and ADC section, which converts analog electrical signals to digital signals, which in turn processed by the high performance digital ARM microcontroller. iii) The ARM microcontroller processes the digital data and convert internet IPv6 data packets. iv) the wireless transceiver module allow the device to get connect to router.

## IV. SYSTEM IMPLEMENTATION

The working of the proposed system implementation is divided into three parts. Since the embedded processor used in this device run with Real Time Embedded Operating System. The following sections will be executed as an independent parallel task in the processor itself using real time operating system.

1) Bed-Occupancy Sensor
2) Display Section (LCD Booster pack)
3) Processing Section
4) IoT Connectiviy

**1) Bed-Occupancy Sensor:**

It is based on a pressure sensitive pad [49], suitable for placing at under-mattress, the figure 4 shows the physical appearance of the sensor. The pressure sensor behaves as a variable resistor, lowering its resistance value when pressed. It is therefore connected as a pull-down element in a voltage divider, the output of pressure sensor is connected to a analog input of the microcontroller hardware board. The long cable features a plug and play connector, to avoid tearing off the cable (for instance while making the bed). An additional digital input therefore comes from the cable connector, to signal a fault condition (disconnected pad). Furthermore, the battery voltage is transmitted, to allow for remote maintenance tasks. An identical setup, except for a smaller-size pad, is exploited for a chair occupancy sensor.

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Figure 4: Pressure sensor as Bed-Occupancy Sensor.

**2) The Display Section:**

The Sharp Memory LCD Booster Pack display module comprised of 96x96 pixels to render of smooth-moving graphics with 50% reflectance as shown in figure 5. This display is based on the LS013B4DN04 display and comes as a plug and play module, so CC3200 Launch Pad Evaluation Kit programmers can use this readymade Booster Pack to display analog sensor readings, time & other related information. This display will consume low power use of 10 µW. The booster pack LCD is visible in a 0.5-lux environment without requirement of external light source.

- Reflective panel of display comes as white and black with aspect ratio of 1:1
- 1.3-inch display screen has resolution of 96x96 pixels (9216 pixels stripe array)
- Display control can be controlled by serial peripheral interface protocol (SPI)
- Typical power consumption of the display module 6 µW - 10 µW (static mode, depends on update rate)

Figure 5: LCD booster pack

**3) Processing section:**

CC3200 launch pad comes with integrated ARM cortex-M4 processor, which process the bed-occupancy sensor and temperature samples and converts them into digital values using its internal 12-bit ADC. The ARM processor further process the ADC values and then convert them as TCP packets, which can be easy to send via internet. This CC3200 launch pad also comes with integrated temperature sensor TMP006, these temperature values taken as body temperature and send it to internet.

**4) IoT Connectivity:**

The CC3200 launch pad board comes with integrated on-chip Wi-Fi module. This Wi-Fi module consumes very low power during the transmission/reception of the wireless data. It's just to programmed as station mode to connect to home router, which in turn connects to internet. Thingspeak portal is a IoT cloud based services, where we can upload the sensor data and plot that data as graphs and bar charts. Through programming, it's possible to configure to different cloud based services.

## III. RESULTS

The proposed system implementation as shown figure 6. The right side of the figure shows the pressure sensor. Bottom red color board of the figure is CC3200 MCU launch pad board, which is itself consists of ARM cortex--M4 processor and on-chip wifi module. The display 96x96 LCD booster pack showing message about the IoT cloud (ThingSpeak) connectivity.


Figure 6: Hardware implementation of proposed system (CC3200, LCD Booster Pack, Pressure sensor).

The figure 7 showing both temperature and bed occupancy sensor data on the display and at the same time on the ThinkSpeak IoT cloud based service as shown in figure 9. Here the field1 represents the temperature data and field2 represents Bed Occupancy data.

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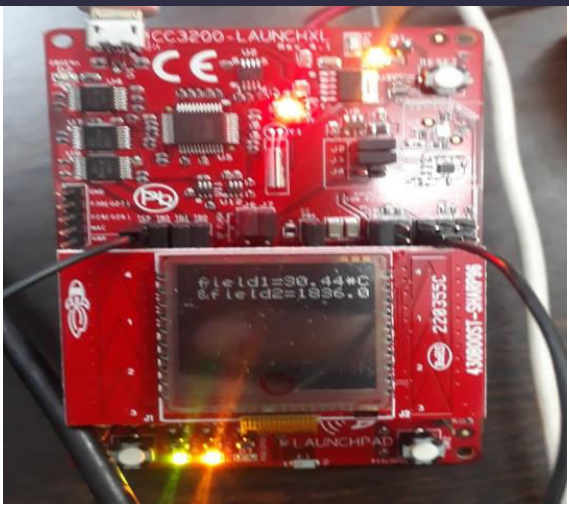


Figure 7: Temperature and Bed Occupancy data

The below figure 8 shows the amount of current in milli-amperes is shown, the system connecting with cloud based services. Therefore, the entire system will consumes a maximum of 2mA current while transmitting the data to cloud. Because of this, CC3200 is the most suitable processor module for developing Active and Assisted Living Home Automation.

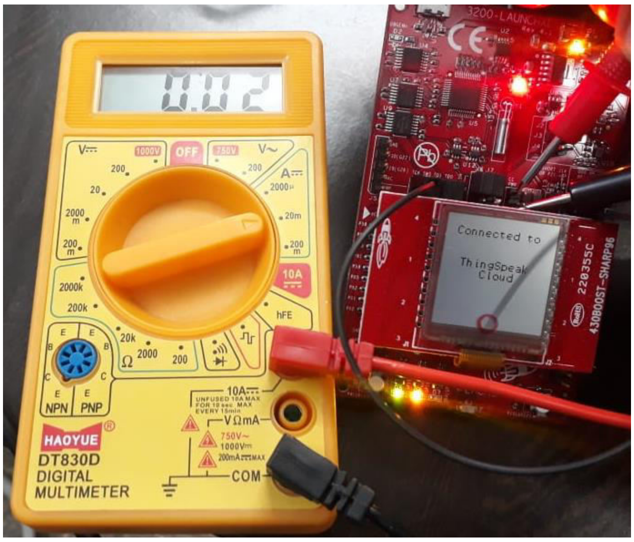


Figure 8: The amount current consuming by the system when connecting with cloud based services

The figure 9 shows, live data plotting on the ThingSpeak IoT cloud based services. The right side graph is for bed occupancy and left one is temperature data.

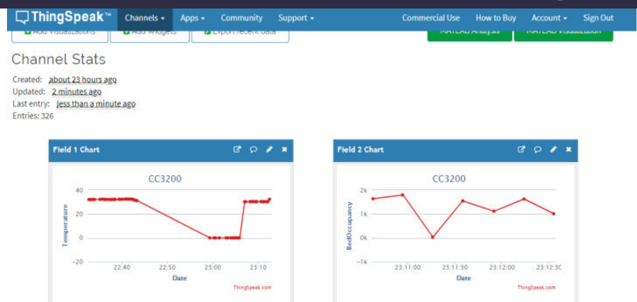


Figure 9: shows the both temperature and bed occupancy data wave forms on ThingSpeak cloud.

## IV. CONCLUSION

In this paper, CC3200 MCU launchpad is the one of the best suitable processor for development of active and assisted living for home automation. The Integration of ARM cortex M4 processor and on-chip wifi module will reduce the space and wiring connections. At the same time, everything will easing configured. As the results shows, it will take very less power and available in reasonable price which is main requirement for AAL.

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