Smart Hospital Bed

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***Abstract*— This report offers a description of an Embedded system project called smart hospital bed system implemented mainly using a PIC16F887 microcontroller, temperature sensor and pressure sensor. The system will help to monitor the bed status (occupied, not occupied), measure the temperature of the patient, and communicate with the nurse for emergency situation using an alarm sound and lights.**

Keywords*— PIC16F887*, Sensors, Alarm, LCD, Keypad

I. INTRODUCTION

The health care system in Africa is still behind a big part of the world. Sub-Saharan Africa averages 1.15 health workers for every 1,000 of its citizens[reference]. A severe shortage of nurses and midwives means that over two-thirds of women in Africa have no contact with health personnel following childbirth [1]. This clearly shows a need to optimize healthcare services delivery in order to serve a big number of patients as possible.

Currently, the strategies that are being used to tackle this challenges are very manual in the way that the nurse will check on the patient in regular(and sometimes irregular intervals). In addition to this, when a patient seeks out a hospital, most of the time, the Hospital is not aware of which beds are available and a manual search is carried out to ascertain which bed the patient can be admitted to. This is a very inefficient system as it's subject to a lot of inefficiencies and time wastage.

Our project plans to tackle these challenges by using the PIC microcontroller to automate this process so that at any time, the nurse can remotely monitor the patients and he/she knows the general availability of the beds in the Hospital.

II. PROBLEM STATEMENT

Sub-Saharan Africa averages 1.15 health workers for every 1,000 of its citizens. Therefore there is a need to efficiently maximize efficiency of health workers through automation

III. OBJECTIVES

To overcome this challenge, we designed a system called The Smart hospital Bed system which consists of five main components: PIC microcontroller (16F887), sensors, keypad, alarm and display. The components interconnections are shown in figure 1. below.

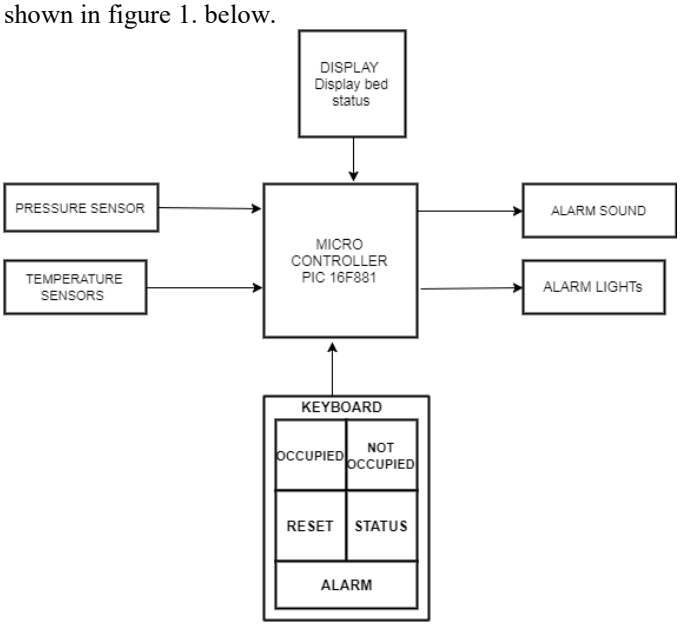

Figure 1: Overview of the system

This system is attached on the patient bed.The patient is allowed to only use the Alarm button on the keypad (which is for calling the nurse for emergency situation) and other buttons are for the nurses use. the Reset button resets the system, the occupied and not occupied button are used to set the status of the bed and finally the status button to check the status of the bed.

Figure 2 to shows in detail how the system works as it described below:

1. Password
The system need to be installed on hospital bed and then the nurse turn it ON.

A login component means that the nurse must set a password before using the system so that he/she will be only the one to change the bed status and status buttons of the keypad.

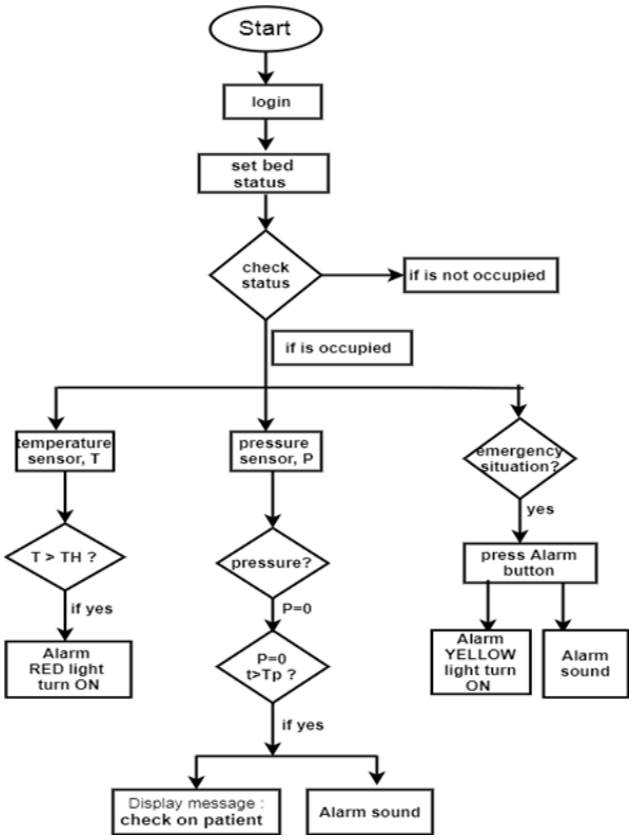

Figure 2: System functional flow chart

2. Status

The status component is the bed status that the nurse set. OCCUPIED means the bed has a patient occupying it. If the status is UNOCCUPIED the system will not do anything. but if the status is OCCUPIED, the system will be active and it will start to take measurements from its sensors (temperature and pressure sensor), and enable the Alarm button so that the patient can use for emergency situations.

3.Temperature Sensor

The system will measure the patient temperature in real time. when the patient temperature (T) exceed a threshold temperature (means the maximum temperature of the patient that the nurses thinks the patient can tolerate denoted as TH) , the system should automatically send alarm to the nurse room in form of RED lights and also indicating the bed number.

4.Pressure Sensor

A digital pressure sensor is used where if the patient is in the bed the pressure sensor value will equal to one, P=1 otherwise it will one , P=0.

If the patient is not on the bed for a time (t) which exceed the threshold time (the maximum time that the patient can spend out of his bed according to his medical conditions denoted as Tp) , the system will automatically send a message (“Check on patient “) to the nurse together with an alarm sound to attract the nurse attention.

The nurse would then check if the patient may not fallen down out of the bed , or if the patient ignored his instructions by taking more time out of the bed or finally the patient has left the hospital. this time if the patient has left the hospital the nurse can set the bed UNOCCUPIED.

5. Alarm Button

The system has an interface for the patient to notify the nurse in case of emergency situations. This interface is form of button on the keypad labelled Alarm. in case of emergency situation, the patient will press the Alarm to notify the nurse to call the nurse. when he/she presses the button the nurse will get the emergency alarm in form of Light (yellow light will turn ON) and a buzzer.

IV. METHODOLOGY

A. HARDWARE TOOLS USED

A PIC16F887 tool kit is used for the project. It comes with a set of hardware tools like a Keypad, LCD, LEDs.

Figure 3 : system implementation

1. LCD

An HD44780 character LCD display is used. Data and commands are sent to the LCD [2].To differentiate between data and commands, the Register Select bit is either cleared or set. When the Register Select is high, commands are being sent through PORTD to the LCD. When the Register Select is low, data is being sent through PORTD to the LCD

Commands are used to specify things like cursor on, cursor off, cursor blinking, to clear the screen [2].

Data is what is sent and shown on the LCD as characters like ‘1’, ‘2’, ‘A’.

The LCD is connected as shown in the Kit;

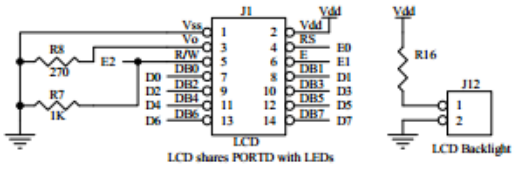

Figure 4: Liquid Crystal Display (LCD) circuit

For our project, the LCD was used in a number of ways;

- To show when the Temperature goes above the threshold
- To show the status of the bed; whether is occupied, not occupied, when temperature is higher than threshold.
- To show that a password can be implemented using a keypad and the LCD

Figure 5 : Liquid Crystal Display (LCD)

2. Keypad

A 4 by 4 push button keypad is connected on the kit. The keypad allows numeric or alphanumeric information to be entered. The technique usually used to read a keypad follows the figure below as connected on the Kit.

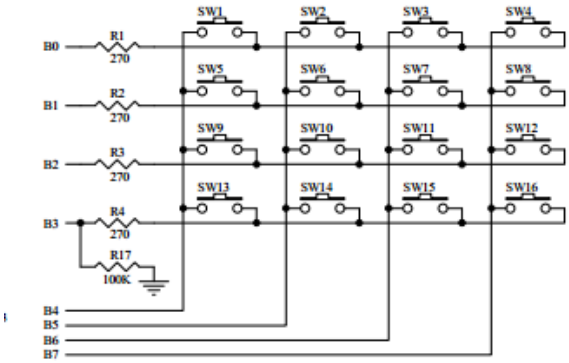

Figure 6: Keyboard Circuit

First the column bits are set to output, with the row bits as input. The output column bits are set to 0. If no button is pressed all row line inputs will read 1, due to the action of the pull-up resistors.

When a button is pressed then its corresponding switch will connect column and row lines, and the corresponding row line will be pulled low[2]

For our project, the Keypad was used to implement a number of things;

- Sensor simulation; Since we were not able to access the digital sensors; temperature and pressure, then keypad buttons were used to simulate the on/off of temperature over threshold and the on/off of pressure.
- To change the status of the bed (Occupied or Not Occupied)
- To enter a pass-key for password (though this had a challenge of the debounce form the keys which means one press would translate to about 7 presses)
- For an alarm button. When the alarm button is pressed, a yellow LED goes off and a buzzer sounds

3. LEDs

Standard 3mm LEDs were used for emergency. When the temperature was beyond a certain temperature, a red LED would light. When the alarm button was pressed, the yellow one would light..

B. SOFTWARE TOOLS

1. Branching and subroutines

The subroutine is a program section structured in such a way that it can be called from anywhere in the program [3].

Subroutines are used in so many ways especially when processing an if else situation. Where something is done in case a bit is HIGH or LOW. The code snippet in the Interrupts section shows a BTFSC which checks whether the ‘pressure’ bit of sensors is HIGH. If is HIGH, then it branches to the subroutine PAT_TIMER, else it jumps that particular instruction and returns.

2. Arithmetic instructions

Arithmetic instructions are particularly important for counting. The instruction DECFSC was used to subtract one from the file patient_timer from 256 till zero which was useful to get the timing needed to implement the delay on patient falling off the bed.

3. Macro

A macro is a grouping of instructions, defined by the programmer and given a name. Once defined, the macro can be used in the program at any time [3].

A macro was used to reduce the code that is used to display something on the LCD as shown;

Code snippet:

```
display     macro const
            MOVLW const
            MOVWF   PORTD
            CALL    DISPLAY_DATA_ON_LCD
            endm
```

Use:
display ‘A’

4. Lookup table

A look-up table is used to implement the password key functions. It returns a particular character ‘1’, 2’ or ‘3; that is displayed on the LCD

5. Interrupts: Timer and counter

The function of an interrupt is to alert the CPU in no uncertain terms that some significant external event has happened, to stop it from what it is doing and force it (at greatest speed possible) to respond to what has happened [3].

The Timer Overflow interrupt was used in the implementation to count down the time before an alert can be sent to the nurse’s station for the patient to be checked on once the pressure sensor is off.

Code snippet:

```
Int_Routine         MOVLW 0
                    MOVWF       TMR0
                    BCF INTCON, 2
                    BTFSC  sensors,pressure
                    CALL PAT_TIMER
                    RETFIE

PAT_TIMER           DECFSZ      patient_timer
                    RETURN
                    CALL PRINT_PAT
                    BCF INTCON, 5
                    MOVLW       D'256'
                    MOVWF       patient_timer
                    RETURN
```

This code shows that once the interrupt is set off, it decrements the patient timer file. This was done so that a bigger delay would be obtained before the alert could be sent and yet a Timer Overflow interrupt can go to a maximum of about 0.3 sec.

V. CONCLUSION

A smart Hospital Bed project can easily be implemented using a PIC microcontroller. Depending on the status of the patient, the doctor or nurse can monitor real time their temperature, whether they are in bed, when there is an emergency. Other patient vitals can be added to the system for monitoring. With an Analog to Digital Converter (ADC), thresholds can easily be set for readings from analog sensors also.

VI. DIVISION OF LABOR

This project was done by two people; Agatha Niwomugizi and Aime Musangamfura. The work was done simultaneously in that all the work was discussed and developed by mutual discussion at every stage.

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