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A Novel System to Tackle Hospital Acquired Pressure Ulcer Patients

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Abstract: ***Health related problems are tremendously increasing in our day to day life. Hospital acquired pressure ulcers (HAPUs) is a major problem that affects the patients who are admitted in hospital with sudden illness for a long duration. Earlier the occurrence of HAPUs has been minimized by turning the patient for every 2 hours to alternating lateral positions, and by using pressure redistributing mattresses. Difficulty in monitoring patient position continuously, lack of turn reminders or alerts and insufficient caregiver facility increases the occurrence of HAPUs. A novel method is proposed to reduce the risk of HAPUs. The proposed method consists of checker board mattresses which automatically change its position according to the mobility and activity of the patient by using the Braden scale assessment tool which requires the appropriate sensors to monitor the mobility and activity of the patient. The patient's position is continuously monitored and the turning procedure is automatically carried out and updated regularly to the doctor's and the hospital's system, thereby enabling centralized monitoring. Using this proposed system, the risk of pressure ulcer is greatly reduced to a great extent and the work of caregiver is also greatly reduced.***

Keywords: ***Hospital acquired pressure ulcers, pressure redistributing mattresses, Braden scale assessment tool, USB endoscope.***

I. INTRODUCTION

Pressure ulcers (PUs) usually develop over a bony prominence as a result of pressure, or pressure in combination with shear stress and/or friction. Additional contributing factors include immobilization and malnourishment. Groups known to have a high risk of developing PUs include bedridden patients, wheelchair-bound individuals, frail elderly persons with no or limited mobility, as well as individuals with diabetes, poor nutrition, and chronic blood-flow diseases. Pressure ulcers represent an enormous burden on our health care system and an enormous problem for health care providers. Pressure ulcers result in both an increased length of hospital stay and increased hospital costs. Once developed, PUs represents an acute health condition that results in increased costs and suffering over many months and even years. Effective ulcer prevention and early detection will greatly reduce patient suffering/discomfort. The current approach used to identify PUs relies on health care workers, primarily nurses. Diagnosis is made through a combination of actions. At the time of hospital admission, a physical examination is conducted and a medical history is taken, with a focus on physical and mental problems such as incontinence or confusion. The Braden Scale which has been identified as the most reliable and valid tool for predicting ulcer risk, is used by nurses to assess the patient's risk of bed sores. Clinicians observe the patient's skin on a regular schedule to identify any discolorations or warmth indicating potential skin breakdown. Unfortunately, underlying tissue can be compromised by the time the skin actually opens.

II. LITERATURE SURVEY

A. Body Pressure Sensing Mattress for Bedsore Prevention

Body pressure dispersion mattresses are useful tools for preventing pressure ulcers. There are currently two types of body pressure dispersion mattress: reactive support surface mattresses, which are composed of materials such as urethane foam and active support surface mattresses, which use a combination of various air cells. In particular, the active support surface mattresses are often used for patients with a high risk of developing pressure ulcers. In order to constantly relieve the body pressure, these conventional active support surface mattresses use a system with air cells which split into several sets, thus continuously move in a wave-like motion, giving various discomfort like a seasick-feeling. Other downsides are that these mattresses make it difficult to perform rehabilitation practice on the mattress due to their softness. Delayed mobilization and rehabilitation may increase a risk of further developing disuse syndrome or new pressure ulcers. The basic function of a mattress is to keep comfortable condition for the patient in the bed, as well as to provide an adequate environment in performing appropriate rehabilitation and nursing. This not only prevents pressure

ulcers, but also helps the physical and mental stability of the patient, leading to an early rehabilitation and improvement in their QOL. In addition, we have to give a sense of relief to caregivers by reducing their physical and mental burden.

B. A Smart Bed Platform for Monitoring & Ulcer Prevention

The focus of this paper is to develop a software hardware platform that addresses one of the most costly, acute health conditions, pressure ulcers - or bed sores. Caring for pressure ulcers is extremely costly, increases the length of hospital stays and is very labor intensive. The proposed platform collects information from various sensors incorporated into the bed, analyzes the data to create a time-stamped, whole-body pressure distribution map, and commands the bed's actuators to periodically adjust its surface profile to redistribute pressure over the entire body. For proof of concept, we have implemented algorithms and architectures that cover four key aspects of this platform: 1) data collection, 2) modeling & profiling, 3) machine learning, and 4) acting.

C. Reducing Hospital-Acquired Pressure Ulcers

A quality improvement initiative across 21 hospitals incorporated a multidisciplinary approach, breakthrough collaborative methods, evidence-based improvement methods and care guidelines, front-line rapid improvement cycles, consistent process-of-care documentation, and real-time incidence data. Statistically significant decreases in both all-stage and stages III, IV, and unsaleable hospital-acquired pressure ulcers rates have been sustained for 5 years. HOSPITAL-ACQUIRED PRESSURE ULCERS (HAPUs) are a costly and largely preventable condition. All-stage HAPU prevalence among hospitalized patients in the United States is approximately 5%, and estimated prevalence of full-thickness. Patient-level risk factors associated with HAPUs are documented, as are evidence based practice guidelines for their prevention. Preventing HAPUs improves quality and reduces costs. Evidence-based care resulted in cost savings in more than 99.99% of Markov simulations, in which statistical modeling of the probabilities of different health statuses related to HAPUs (e.g., HAPUs of various stages with related impacts on outcomes and costs) captured the effects that society incurs when inpatient nursing care does not include a specific investment in their prevention.

III. PROPOSED SYSTEM

A novel method is presented in this paper to address the need for improved pressure ulcer prevention with appropriate sensors of lower cost and more accuracy. The aim of this method is to assist the caregiver in implementing an effective pressure ulcer prevention procedure. In many healthcare facilities, such a patient repositioning schedule is not always maintained owing to low caregiver compliance to turning protocols. Difficulty in monitoring patient position continuously, lack of turn reminders/alerts and suboptimal caregiver staffing ratio increases the occurrence of HAPUs. This new design consists of checker board mattresses which automatically change its position according to the mobility and activity of the patient by using the Braden scale assessment tool which requires the appropriate sensors to monitor the mobility and activity of the patient. The patient's position is continuously monitored and the turning procedure is automatically carried out and updated regularly to the doctor's and the hospital's system, thereby enabling centralized monitoring.

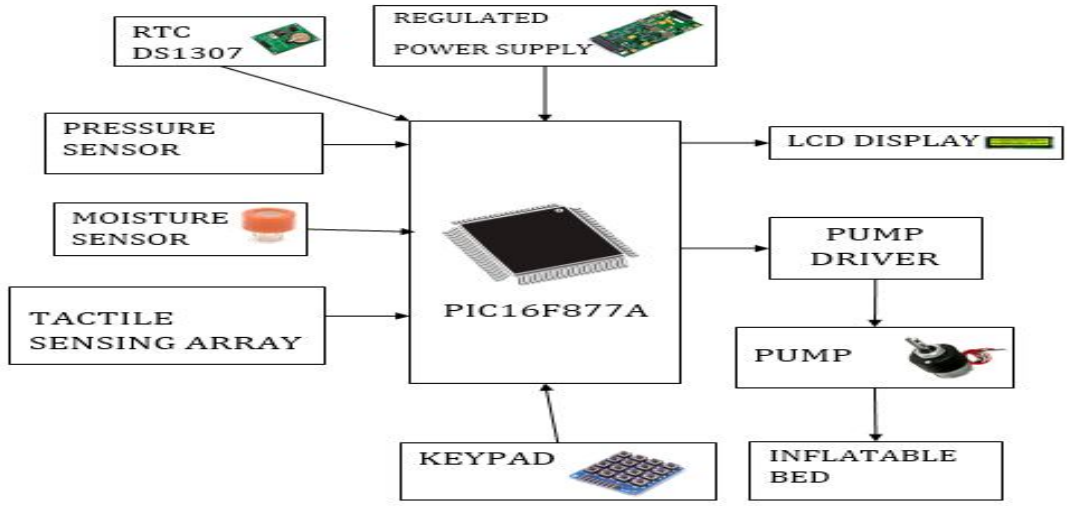

Fig 1: Block Diagram of the Proposed System

IV. HARDWARE DESCRIPTION

A. PIC Microcontroller

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. Here used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Qucik Programming and Erasing are few features of PIC 16F877.

B. LCD Display

Liquid crystal displays (LCDs) are the electronic devices which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

Pin No.	Name	Description
Pin no. 1	**VSS**	Power supply (GND)
Pin no. 2	**VCC**	Power supply (+5V)
Pin no. 3	**VEE**	Contrast adjust
Pin no. 4	**RS**	0 = Instruction input 1 = Data input
Pin no. 5	**R/W**	0 = Write to LCD module 1 = Read from LCD module
Pin no. 6	**EN**	Enable signal
Pin no. 7	**D0**	Data bus line 0 (LSB)
Pin no. 8	**D1**	Data bus line 1
Pin no. 9	**D2**	Data bus line 2
Pin no. 10	**D3**	Data bus line 3
Pin no. 11	**D4**	Data bus line 4
Pin no. 12	**D5**	Data bus line 5
Pin no. 13	**D6**	Data bus line 6
Pin no. 14	**D7**	Data bus line 7 (MSB)

Table 1: Character LCD pins with 1 Controller

Table 1 : LCD Pins to Interface With Controller

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarizers are pasted outside the two glass panels. These polarizers would rotate the light rays passing through them to a definite angle, in a particular direction.

C. Flex Sensors

This flex sensor is a variable resistor like no other. The resistance of the flex sensor increases as the body of the component bends. Sensors like these were used in the Nintendo Power Glove. They can also be used as door sensors, robot whisker sensors, or a primary component in creating sentient stuffed animals.

Fig 2: FLEX Sensor

Left flat, these sensors will look like a 30kΩ resistor. As it bends, the resistance between the two terminals will increase to as much as 70kΩ at a 90° angle.

D.Temperature Sensor

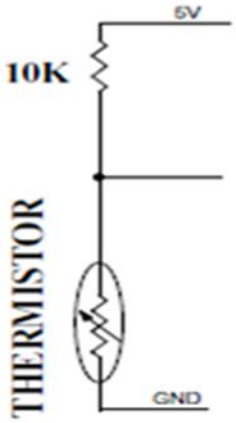

Fig 3: Schematic Diagram of Thermistor

In this circuit the thermistor is used to measure the temperature.

V. SOFTWARE DESCRIPTION

MP LAB is a freeware Integrated Development Environment (IDE) for the Embedded applications on PIC Microcontroller. It is developed by the Microchip Technology. MPLAB X is the recent edition of MPLAB, and is developed on the Net Beans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers.

Fig 4: MP LAB IDE for PIC Controller

The Proteus Design Suite is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It is developed by Lab Centre Electronics Ltd. The software runs on the windows operating system. This software is used for schematic capture, simulation and PCB layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

A. PCB Design

The PCB Layout module is automatically given connectivity information in the form of a net list from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. Design Rule Checking does not include high speed design constraints. PCB's of up to 16 copper layers can

be produced with design size limited by product configuration. The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the board's enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solid works or Autodesk for accurate mounting and positioning of the board.

VI. RESULTS AND DISCUSSION

The risk of Pressure Ulcers is prevented in this project by automatically measuring the Braden scale assessment tool using appropriate sensors. The final score of Braden scale is computed and compared with the threshold value and if the level is below the threshold value, then the patient is at risk. Then the air mattresses are automatically changes its position and distribute its pressure and the risk of pressure ulcer is rectified successfully.

Fig 5: Pressure ulcer design entire kit

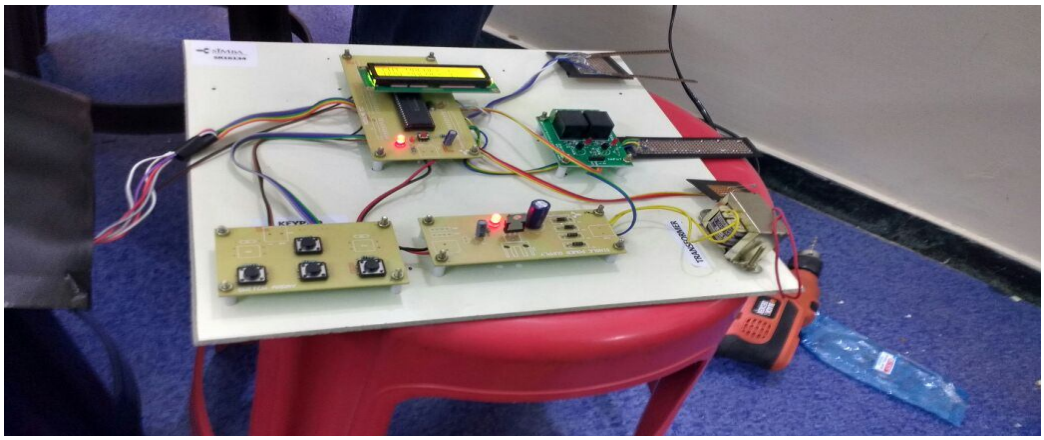

Fig 6: Pressure ulcer kit display unit

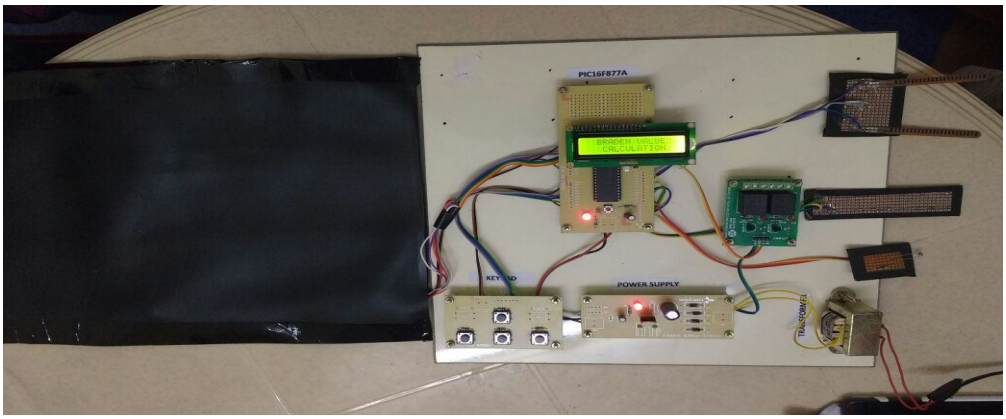

Fig 7: Braden scale measurement using our proposed method

VII. CONCLUSION

This project have been working on the development of a novel system to tackle the risk of pressure ulcers which fulfills diverse aspects of clinical and patient's demands; e.g. 1) equipped with an automatically- regulated body pressure relief function, 2) supporting a comfortable sleep, 3) providing a good-practice on-bed condition for rehabilitation, and 4) accelerating safe and smooth support in bed-to-ambulation movement. In ICUs and hospital wards such a turning procedure is not always followed strictly because of a low caregiver compliance to turning protocols. Difficulties in continuously monitoring patient position, lack of a system which can provide turn reminders/alerts and suboptimal caregiver staffing ratio increases the occurrence of HAPUs. The goal is still far, but the present mattress equipped with a self-feedback pressure dispersion system and specially developed double-layered compact air cells meets with the above demands, at least, in an acceptable level.

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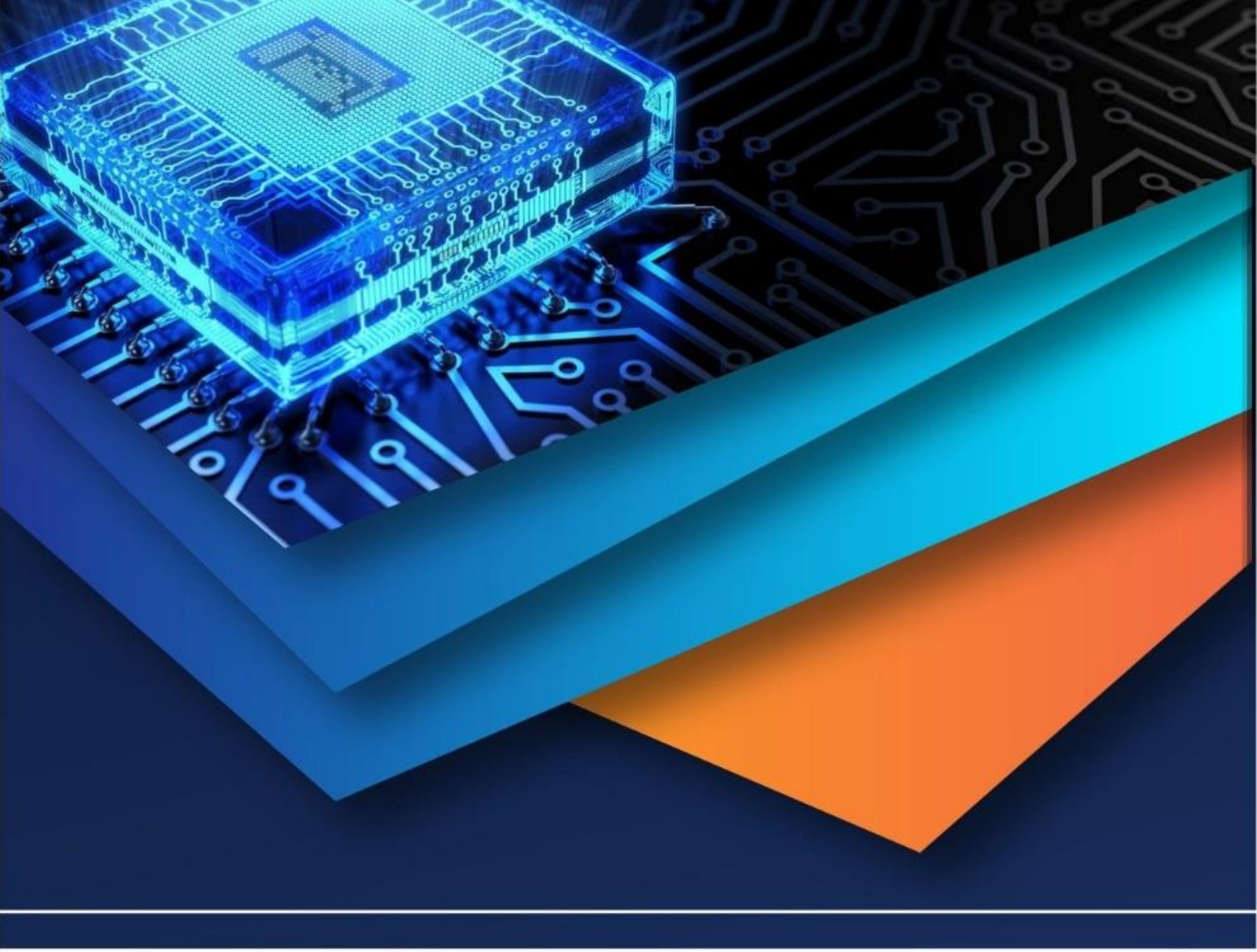

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