International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-11, September 2019

Design of Automated Bed for Prevention of Pressure Ulcer for Patient with Moving Disability

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Abstract— In this paper, a design of mattress for patients suffering from pressure ulcer has been proposed. When patients are lying in the bed due to their disability or disorder, the body cells do not function properly and leads to decaying because the body is pressurized and there is no circulation of air. This design helps in lifting the patient body in a periodic manner in order to prevent decay and hence the formation of ulcers is prevented. The most important is that patient does not feel any discomfort in the body when the movement is made. The proposed system helps the patient with moving disability by preventing them from becoming victims of bed sores.

Keyword: Bed sore, Prevention, Pressure Ulcer, Pressure points, Disability.

I. INTRODUCTION

Bed sores are one of the most unnoticed medical problems in most of the patients with moving disability. The healing of Bed sore or pressure ulcer [3] depends on the age of the individual. It is inferred from that the existing methodologies moving the patient from left to right and right to left by manipulation of the human body gives relief to a particular extent [9]. Sometimes the wound is analysed by a multimodal sensor and a three-dimensional image of the wound is taken for assessing the treatment [6][7]. In some cases, an inductive sensor is used for measuring normal and shear force and according to the pressure caused the movement is made [10]. The problem with bed sore is that it cannot be healed once it occurs [8][12]. Timely change in the posture of the patient may have great effect in preventing the bedsore [5]. This paper discusses about the design of an automated bed with pressurized tubes which inflates with very low displacement. Moving or turning the patient is the vital key in preventing bed sores but, patient may feel uncomfortable while the patient is turned from left to right or right to left [11]. This automated bed eliminates the discomfort by providing very less movement of the flexible tubes.

II.PRESSURE ULCER & ITS STAGES

Pressure Ulcers occurs on skin that covers the bony area of the body such as heels, ankles, hips and tail bone [1].

Manuscript published on 30 September 2019.
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People suffering from pressure ulcers are those with medical condition that limits their mobility and unable to change their posture or those who spend more time in bed or chair [2]. Figure 1 shows the various stages of pressure ulcer.

A.Stage 1

Skin retains the red colour for few minutes after the pressure is removed and develops an abrasion on the outer layer of the skin.

B.Stage 2

Breakage of skin occurs and causes discolouration. Sore penetrates to the subcutaneous fat layer, pain and swelling occurs [4]. When pressure is removed the sore may heal in 2 weeks time.

C.Stage 3

A hole is formed which secretes a foul-smelling fluid. No pain in the sore and the nerves surrounding the sore are dead and very severe infection occurs.

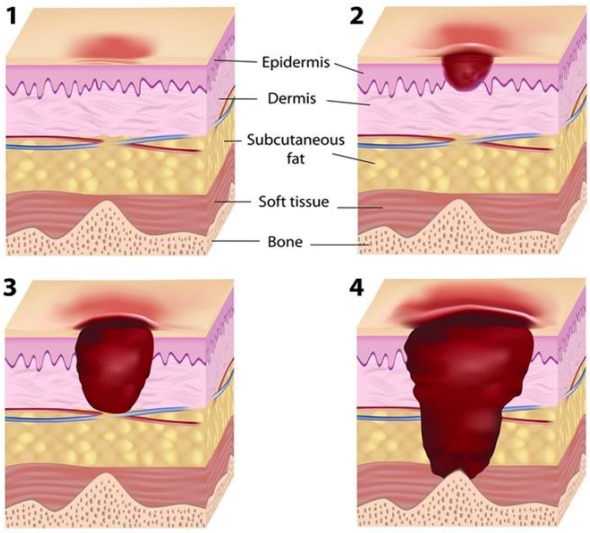

Figure 1 Stages of Pressure Ulcer

D.Stage 4

The sore destroys the tissue from the skin to bone and becomes necrotic. It takes months or years for the sore to be healed.

III. SYSTEM OVERVIEW

The system consists of two sets of air-filled tubes whose pressure is changed periodically so there is a small change in the height/displacement of the tubes. The air pressure given to the flexible tubes are controlled by Arduino controller. A compressor is used to pump the air inside the tubes by connecting it to two different solenoid valves.

The time period of the pressure inside the tubes is controlled by relay circuit which operated according to the delay programmed in the Arduino controller. The solenoid valves are opened and closed alternatively depending on the input given by the relay circuit from the Arduino controller. When the solenoid valves open alternatively the flexible tubes are filled with air from the compressor. The programming is done in the Arduino controller to open the solenoid valve alternatively for a specific time period. Figure 2 depicts the overall block diagram of the process.

A. Solenoid Valve

A solenoid valve uses a solenoid and it is also an electromechanical device in which an electric current is supplied to generate a magnetic field and thereby operate a mechanism which regulates the opening of fluid or air flow in a valve.

B. Relay

Relays play a major role in controlling a circuit by a separate low-power signal. It helps in opening or closing a contact in another circuit and switching from one input to another. Solid-state relays are used to control power circuits instead of a semiconductor device to perform switching.

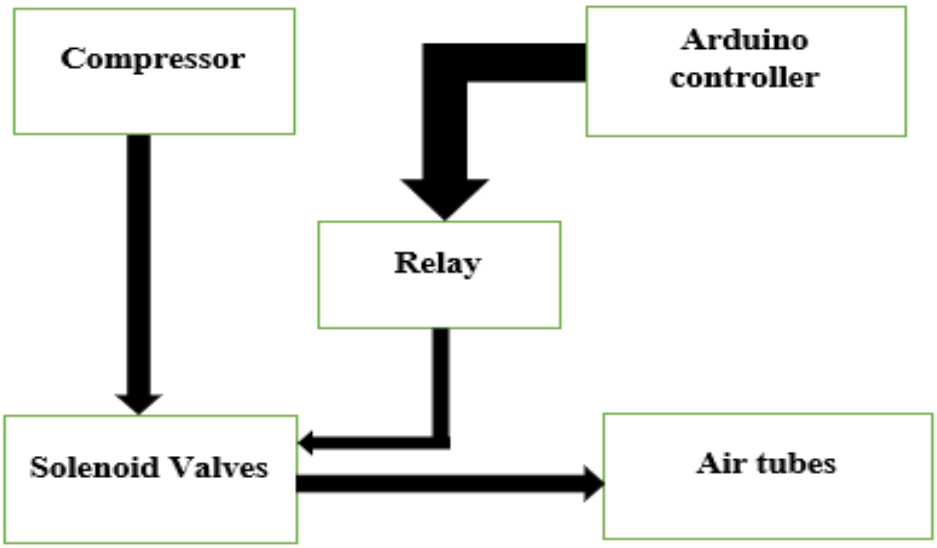

Figure 2 Block Digram of the Process

C. Compressor

Compressor is a device which is used for supplying air or gas depending on the application. The tubes are filled with air with the help of the air compressor for inflation of the mattress.

IV. DESIGN AND IMPLEMENTATION

The prototype is designed for the automated bed by using T-Joints connected using PVC pipes where one end fitted is not fixed and another end is closed with cap. Two sets were made and kept opposite to each other. The tubes should be filled by air through the compressor.

The flexible tubes inflate when the air is passed into the PVC pipes and they deflate periodically so that a movement is created on the body of the patient suffering from bedsore. From the observations, it is found that tubes can withstand the pressure of 10 psi while inflating. The tubes were maintained at a pressure of 6 psi inside it during the process. Pressure is given for alternate flexible tubes and thus when one set of tubes are inflated, the other set starts deflating. This set up gives a therapy and circulation of air for the body that suffers from immobility. Figure 3 shows the hardware setup of the design.

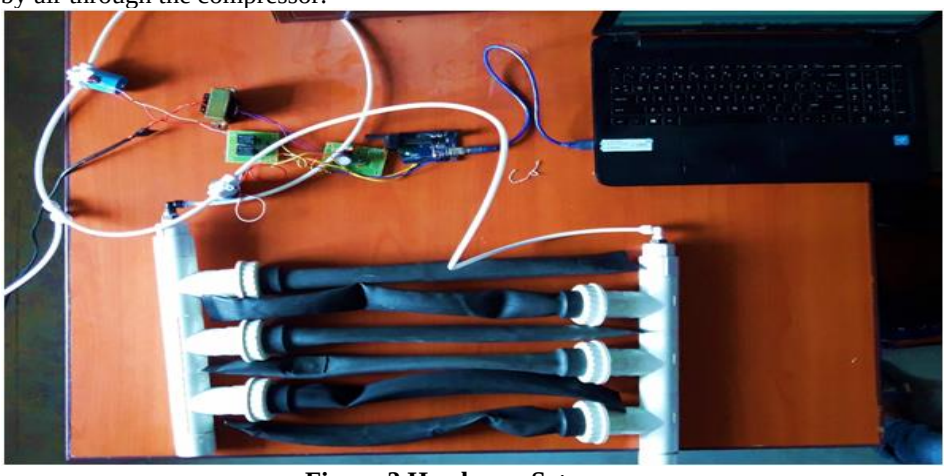

Figure 3 Hardware Setup

Retrieval Number: K20570981119/19©BEIESP
DOI: 10.35940/ijitee.K2057.0981119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

V. RESULTS & DISCUSSION

This prototype design is completely made for the people who are unable to move from the bed for a longer period of time. This design moves and relaxes the skin simultaneously so that the pressure points does not create pressure ulcers. When the air is given to the tubes, it bulges according to the relay system which creates an up and down movement so that the skin does not settle in a stable position. Arduino software is used for programming to provide time delay so that the relay switches give input to the solenoid valves in given time. The two sets of tubes were inflated with air at pressure of 10 Psi. When pressure increases in one set, the other should remain in its original position and vice versa. In this system, time delay is given for one minute.

Table 1 Pressure Readings for Inflation & Deflation of the tubes

	Pressure	Voltage
Inflation	10 psi	6 V
Deflation	6 psi	4 V

Table 1 shows the Pressure Readings for Inflation & Deflation of the tubes. The material of the bed must be chosen in a proper manner that suits the body of the patient. The programming is done in the microcontroller using Arduino to automatically switch the solenoid valves. The relay circuit switches and gives a delay of one minute. Inflation and deflation of the tubes were good. The modifications were done due to some leakages in the pipes and tubes. Therefore, implementation of prototype was successful.

VI. CONCLUSION

The proposed system for the anti-bedsore mattress was designed using materials such as flexible tubes. The continuous movement of the mattress was made and tested by giving air pressure. The prototype gave the required movement for every one minute and was able to withstand the pressure provided to the tubes. Inflation and deflation of the tubes were good.

In future this design can be developed into a product by selecting the proper material for the bed so that it can expand and contract depending on the air pressure given as input. This prototype design will be highly helpful for preventing the formation of bedsores for bedridden patients and patients with low-mobility.

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