

## DEVELOPMENT OF A POSITION MONITORING SYSTEM FOR PATIENTS

Md. Kamrul Hasan<sup>1</sup>, S. C. Banik<sup>2</sup> and M. S. Rabbi<sup>1</sup>

Department of Mechanical Engineering, CUET, Chittagong 4349, Bangladesh  
Email address: shimulcuet@gmail.com<sup>1</sup>, baniksajal@yahoo.com<sup>2</sup>, pavel\_rabbi@yahoo.com<sup>1</sup>

**Abstract-** Patient falls in the hospital are recognized as a serious health problem since they are common and may result in injuries and complications which prolongs hospitalization, decreases patients' functional capacities and leads to increased health care costs. This position monitoring system will ensure safety of patients by detecting position displacement after falling from toilet seat, chair or bed. So it will be possible to take instant measures to treat them which may save life. Moreover, it will ensure continuous supervision of the patients and to be informed immediately if any accident occurs without interfacing someone's privacy. For developing this system, IR sensors are used as position sensors which sense it and send signal to microcontroller and then the position of patients are displayed on LCD and make alarm if patient is in unusual position. A program has been developed for microcontroller circuit in MicroC. Here some simple equipments are used which make it a cost effective system. Hope, this system will do something beneficial for our patients as well as people, nation and country.

**Keywords:** Biomedical Engineering, Patient fall, Position displacement, Sensor, Microcontroller

### 1. INTRODUCTION

Patient safety is one of the nation's most pressing health care challenges. To ensure safety of patients from further unexpected accident is also a vital issue for medical science. Applying modern engineering knowledge in this regard, will definitely bring some hopeful outcome. It has been seen that due to some sort of physical constraints many patients fail to keep their normal body balance and fall from their normal position. As a result severe accidents take place which can lead them to serious injury and can cause even death. So position monitoring system of patients is necessary to detect their unusual position and take immediate measures which may save life.

Patient falls are defined as "an incident in which a patient suddenly and involuntary come to rest upon the ground or surface" [1]. Recently, the Prevention of Falls Network Europe recommended defining a fall as "an unexpected event in which the participant comes to rest on the ground, floor or lower level" [2].

Our hospitals suffer from lack of manpower. So it is very difficult for the medical staffs to ensure full time supervision for the admitted patients. On the other hand it will be inhumane if we just let the patients to die due to this reason which can be successfully eliminated by applying the knowledge of modern engineering. The most common victims of this situation are the heart patients and those who are admitted in ICU. These types of patients need continuous monitoring and supervision. Unless this, there their proper safety can't be ensured.

Out of this, some feedbacks may be required from their position to provide immediate medical support in case of any danger or emergency. This type of emergency can be raised at any time in any place. But statistics show that the majority are caused in toilet or washroom. Except it these types of accidents can also take place by falling from bed. Whatever may be the cause, the objective of this project is to ensure continuous supervision of the patients and to be informed immediately if any accident occurs without interfacing someone's privacy.

This project works in such a system which will continuously show the exact position of the patients in the LCD and also provide an alarming system when accident occurs. Here, IR sensors are used as position sensors.

### 2. LITERATURE REVIEW

A research program by René Schwendimann consisted of a series of retro- and prospective studies, using clinical and demographic patient data of more than 34,000 hospitalized patients from the years 1999 to 2003 of the "Stadtsipital Waid", an urban public hospital in Zurich, Switzerland [2]. In a 5 year population-based retrospective study they examined characteristics associated with hospital in-patient falls across clinical departments using incident reporting data and administrative patient data. In a population of 34,972 hospitalized patients (mean age: 67.3 years; female 53.6%, mean length of stay: 11.9 days), 7.2% of the in-patients experienced at least one fall during their

hospitalization (surgical department: 1.9%, medical department: 8.8% and geriatric department 24.8%) [2]. Comparison of fallers and non-fallers revealed that fallers were on average 13.5 years older, consisted of 3.8% more females and stayed on average 13.1 days longer in the hospital [2]. Two third (64.8%) of the patients who fell were not injured, 30.1% experienced minor injuries and 5.1% sustained major injuries [2]. Three out of four patients (75.7%) fell in their bed-rooms. Patients fell most often while ambulating (43%) and transferring (35%) [2]. Fall risk factors in patients who fell included: impaired mobility (83.1%), impaired cognition (55.3%), use of narcotics (38.6%), and use of psychotropic (25.4%) [2]. Half of the patients (50.1%) who fell while hospitalized had a pre-hospital history of falls [2]. These findings are in line with international findings indicating that in-patient falls in hospitals are common especially in departments of geriatrics and internal medicine. It appears that in-patient falls should be regarded as an important safety issue especially since one in three falls resulted in at least a minor injury. They recommend giving attention to identifying patients at risk for falling and implementing effective interventions to prevent patient falls and to minimize fall related injuries.

Falls among hospitalized patients are common with rates varying from 2.4 falls per 1000 patient days in large tertiary university hospitals up to 9.1 falls per 1000 patient days in geriatric hospital departments [2]. Fall related injuries occur in up to 50% of the in-patients who fall, and up to 10% of these patients experience a major injury [2]. The type of activities that hospitalized patients were involved in when falls occurred included bed-related activities in 23% to 39% of falls [2]. Other fall related activities included: walking (e.g., going to the bathroom) in 10% to 42% or transferring (e.g., standing up, sitting down) in 7% to 24% of falls [2].

Of course, monitoring high-risk patients, as effective as that care strategy might appear to be in theory, suffers from the obvious practical disadvantage of requiring additional staff if the monitoring is to be in the form of direct observation. Thus, the trend in patient monitoring has been toward the use of electrical devices to signal changes in a patient's circumstance to a care-giver who might be located either nearby or remotely at a central monitoring facility, such as a nurse's station. The obvious advantage of an electronic monitoring arrangement is that it frees the care-giver to pursue other tasks away from the patient. Additionally, when the monitoring is done at a central facility a single nurse can monitor multiple patients which can result in decreased staffing requirements.

Thus, a device is needed that can detect a patient's presence or absence on a toilet seat and signal that condition to an electronic monitor. Additionally, this device should not interfere with the normal operation and use of the toilet. Moreover, the system should not hamper the personality of patient in the Toilet.

### 3. REQUIREMENTS BEHIND THE PROJECT

For developing the patient monitoring system, the

following items are required:-

- ☐ Sensor:
  - IR Emitter
  - IR Receiver
- ☐ Microcontroller- 16 F877A PIC MCU
- ☐ Op-amp (LM 324)
- ☐ LM 7805 Voltage regulator
- ☐ Capacitor (Electrolytic)
- ☐ Crystal (20 MHZ)
- ☐ Resistor
- ☐ Variable Resistor
- ☐ Diode (1 N 4007)
- ☐ Light Emitting Diode (LED)
- ☐ Vero board
- ☐ Bread board
- ☐ LCD (Liquid Crystal Display)
- ☐ Alarm Buzzer
- ☐ C programming using MicroC
- ☐ Power Supply
  - Microcontroller: +5V
  - Sensor: +5V
  - Regulator: constant 5V

## 4. LAYOUT AND CONSTRUCTION

### 4.1 Working Principle

When patient sit on the toilet seat the IR sensor senses it and sends signal that he or she is in the right position. But when the patient falls from the seat it can detect it and will be shown on display or makes alarm with the help of microcontroller. A block diagram of position monitoring system using IR sensor is shown in figure 1.

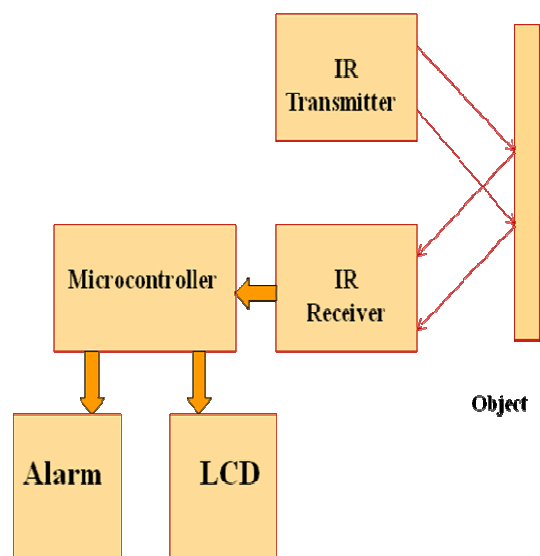


Fig. 1: Block diagram of position monitoring system using IR sensor.

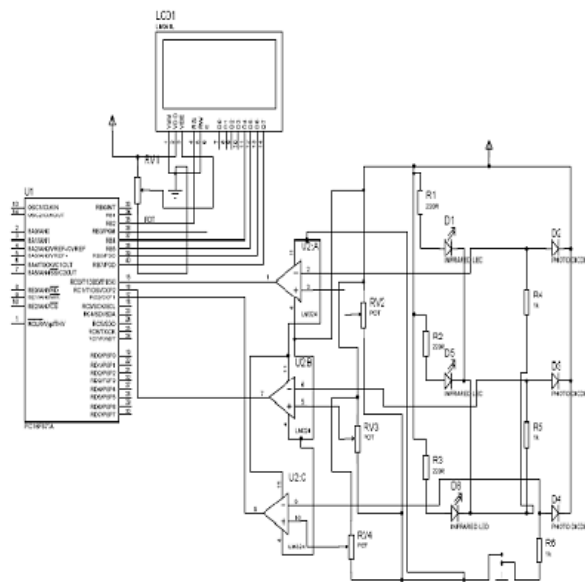


Fig. 2: Circuit Diagram of the Project

#### 4.2 Construction

Figure 3 shows the project setup.



Fig. 3: Project setup

Figure 4 shows the breadboard connection of the project.

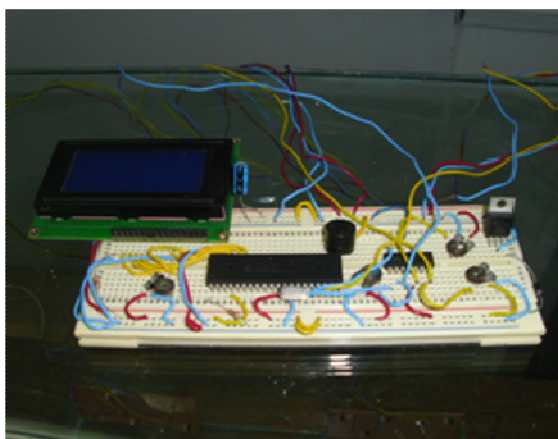


Fig. 4: Breadboard connection of the project

Figure 5 shows the block diagram of position of sensor in toilet.

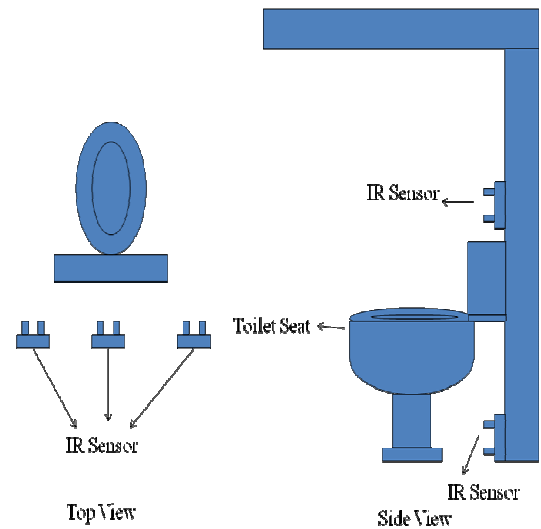


Fig. 5: Block diagram of position of sensor in toilet

In the project three IR sensors are used-

- Just behind the patient, sitting on toilet seat which detects that patient is in his normal position on toilet seat, is shown in LCD with the help of microcontroller.
- Right side of the patient, just above the floor which detects if patient falls on right side, shown on LCD and make alarm so that nurse or someone can rescue and give him or her proper treatment.
- Left side of the patient, just above the floor which detects if patient falls on left side, shown on LCD and make alarm so that nurse or someone can rescue and give him or her proper treatment.

In Figure 6 the three positions of sensors are shown.

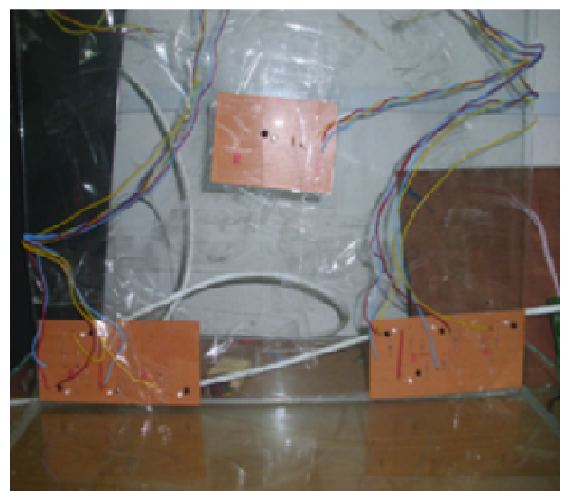


Fig. 6: Position of sensor in the project

#### 5. POSITION ON DISPLAY

Figure 7, 8, 9 shows the LCD on which three positions of patient are shown.

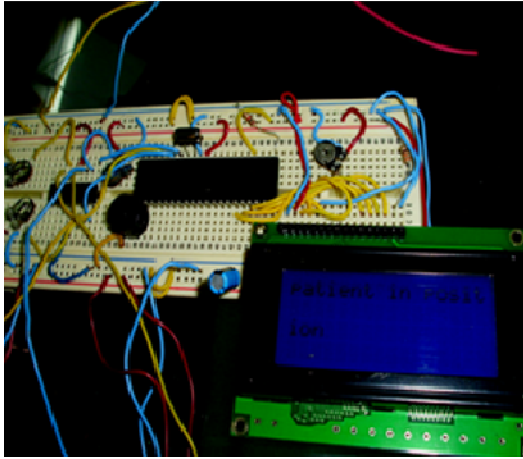


Fig. 7: LCD shows that patient in his right position

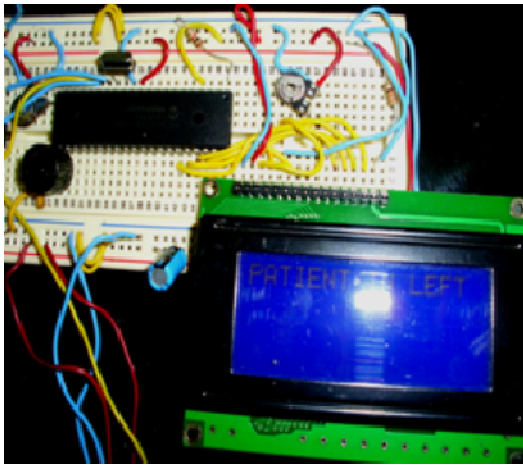


Fig. 8: LCD shows that patient falls in left side

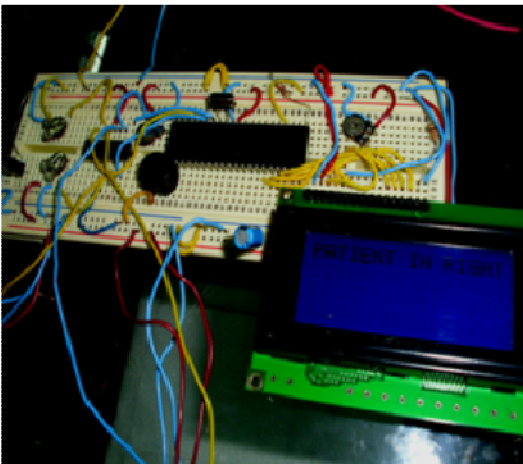


Fig. 9: LCD shows that patient falls in right side

## 6. CONCLUSIONS

This project has combined the design and problem solving skills of engineering with medical and biological sciences to improve healthcare diagnosis and treatment. Such a system is developed which will ensure safety of patients by monitoring position of them continuously. It can detect position displacement instantaneously. It can't prevent the falling of patients in toilet, bed or chair but

can detect it and show on display. So it would be possible to take instant steps to treat them which may save life. Engineering knowledge should be applied for the welfare of human being. So from humanistic point of view the project is so much important. It will help to reduce sudden death. It can be effectively used for safety of patients who are in critical condition in hospitals. Patient safety is such an important part of our health care system and it helps define quality health care.

## 7. REFERENCES

- [1] <http://www.freepatentsonline.com/5945914.html>.
- [2] R. Schwendimann, *Patient falls : a key issue in patient safety in hospitals*, PhD Thesis, University of Basel, Faculty of Science, 2006.
- [3] Tack KA, Ulrich B, Kehr C, "Patient falls: profile for prevention", *Journal of Neuroscience Nursing*, pp. 83-89, 1987.
- [4] Fred H. Holmes and Sanford, "Toilet seat occupancy monitoring apparatus", Patent-5945914, Bed-Check Corporation, Tulsa, Okla, 1999.
- [5] <http://www.microchip.com>