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SHB



UOPEDUJO



DR.MATAR



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SMART HOSPITAL BED



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SMART HOSPITAL BED

PREPARED BY:

Alaa Arab 201411211
Ghada aljibouri 201210913
Fahed Shtawi 201411234
Hamzeh Mahmoud 201420334

SUPERVISED BY:

Dr.Mattar

DATE:

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1.PROJECT INITIATION

1.1 PROBLEM DEFINITION

Hospital beds are where most patients spend the majority of their time, after all, and new smart beds, help patients stay safe, while smart capabilities help nurses to handle patients case in more efficient way.

Injuries can be various and some could be critical like backbones injury, which requires professional treatment specially when it comes to movement, where one of the most dangerous threats to an injured person is unnecessary movement. Moving an injured person can cause additional injury and pain, and may complicate the victim's recovery.

Such patients need to be switched between different beds multiple times in order to be transferred between different locations such as an ambulance car, the Intensive Care Unit, and operation theater. The switching of patients with severe head traumas should be performed extremely smoothly and skillfully, therefore, they require up to four specially trained nurses for one patient. Furthermore, although manual pushing/steering is the simplest approach to control the movements of Hospital bed, it is not considered as the most efficient and reliable approach. The most convincing reason is that the performance of the pushing/steering tasks heavily relies on human reactions and decisions, which are subject to various unstable factors such as human concentration on the navigation task and proficiency in operating Hospital beds.

The surgery room is highly sterilized room and to keep it so we should prevent the access of uncleaned people, but this could be hard to achieve with the missing of Certain mechanics to drag the bed in autonomous way.

Another problem is that most of normal patient bed are highly expensive and they come with limited functions where to still need to attach extra devices to monitor patient's statistics such as heart pulses.



1.2 Current / Existing Systems

1.2.1 The Smart Hospital Bed (Existing System)

This system is developed by Hadramoot team, it's an Raspberry pi and Windows 10 powered device that transmits patient data to caregivers wherever they are, instantaneously.

contain sensors as temperature sensor heartbeat and pressure sensors and the level of oxygen in the blood and etc. All the signals necessary for the supervisor of the patient, the system is located on the bed and tied Sensor. transfer all patient signals, especially cases that need intense care. Signals are sent to the central system at the hospital across the Web in the form of a detailed report the status of the patient during certain periods of time. And in the case of a sudden change of the status of the patient occurrence of the system to send alerts. To the hospital System and Dr. supervisor alerted through the application of Smart mobile bed and the patient's bed issued an audio alert. three alerts be action.

1.2.2 Flexbed (Existing System)

A novel design of an intelligent robotic hospital bed with autonomous navigation ability. The robotic bed is developed for fast and safe transportation of critical neurosurgery patients without changing beds. Flexbed is more efficient and safe during the transportation process comparing to the conventional hospital beds. Flexbed is able to avoid en-route obstacles with an efficient easy-to-implement collision avoidance strategy when an obstacle is nearby and to move towards its destination at maximum speed when there is no threat of collision. We present extensive simulation results of navigation of Flexbed in the crowded hospital corridor environments with moving obstacles.



1.2.3 A semi-autonomous motorized mobile hospital bed (Existing System)

mobile hospital bed guided by a human operator and a reactive navigation algorithm. The proposed reactive navigation algorithm is launched when the sensory device detects that the hospital bed is in the potential danger of collision. The semi-autonomous hospital bed is able to safely and quickly deliver critical neurosurgery (head trauma) patients to target locations in dynamic uncertain hospital environments such as crowded hospital corridors while avoiding en-route steady and moving obstacles. We do not restrict the nature or the motion of the obstacles, meaning that the shapes of the obstacles may be time-varying or deforming and they may undergo arbitrary motions. The only information available to the navigation system is the current distance to the nearest obstacle. Performance of the proposed navigation algorithm is verified via theoretical studies.

1.2.4 Normal hospital bed (Current System)

is a bed specially designed for hospitalized patients or others in need of some form of health care. These beds have special features both for the comfort and well-being of the patient and for the convenience of health care workers. Common features include adjustable height for the entire bed, the head, and the feet, adjustable side rails, and electronic buttons to operate both the bed and other nearby electronic devices.

Hospital beds and other similar types of beds such as nursing care beds are used not only in hospitals, but in other health care facilities and settings, such as nursing homes, assisted living facilities, outpatient clinics, and in-home health care.

While the term "hospital bed" can refer to the actual bed, the term "bed" is also used to describe the amount of space in a health care facility, as the capacity for the number of patients at the facility is measured in available "beds."

Beds with adjustable side rails first appeared in England sometime between 1815 and 1825

In 1874 the mattress company Andrew Wuest and Son, Cincinnati, Ohio, registered a patent for a type of mattress frame with a hinged head that could be elevated, a predecessor of the modern-day hospital bed

The modern 3-segment adjustable hospital bed was invented by Willis Dew Gatch, chair of the Department of Surgery at the Indiana University School of Medicine, in the early 20th century. This type of bed is sometimes referred to as the Gatch Bed.

The modern push-button hospital bed was invented in 1945, and it originally included a built-in toilet in hopes of eliminating the bedpan.



1.3 Literature Review.

1.3.1 Introduction

One major focus of “smart bed” advances is improving patient safety and comfort throughout a potentially lengthy hospital stay. Technology companies are joining in the smart bed trend, too, offering useful tools that can work in harmony with the beds to yield even more valuable data.

Those “smart beds” motorized semi-autonomous hospital beds and in order to accomplish this different type of sensor module should be attached to micro-computers, where reactive navigation algorithm is launched.

This document will handle different type of sensors modules and micro-computer that have been used in this project.

1.3.2 Autonomous Robots

All robots are machines, but not all machines are robots. (Hughes, 2016)

The Seven Criteria of Defining a Robot

Before we can embark on our mission to program robots, we need a good definition for what makes a robot a robot. So when does a self-operating, software-controlled device qualify as a robot? At ASC (Advanced Software Construction, where the authors build smart engines for robots and softbots), we require a machine to meet the following seven criteria:

1. It must be capable of sensing its external and internal environments in one or more ways through the use of its programming.
2. Its reprogrammable behavior, actions, and control are the result of executing a programmed set of instructions.
3. It must be capable of affecting, interacting with, or operating on its external environment in one or more ways through its programming.
4. It must have its own power source.
5. It must have a language suitable for the representation of discrete instructions and data as well as support for programming.
6. Once initiated it must be capable of executing its programming without the need for external intervention (controversial).
7. It must be a nonliving machine. (Hughes, 2016)



Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, without explicit human control. Examples range from autonomous helicopters to Roomba (Overview, 2014)

Autonomy is the ability to make your own decisions. In humans, autonomy allows us to do the most meaningful, not to mention meaningless, tasks. This includes things like walking, talking, waving, opening doors, pushing buttons and changing light bulbs. In robots, autonomy is really no different.

Autonomous robots, just like humans, also have the ability to make their own decisions and then perform an action accordingly. A truly autonomous robot is one that can perceive its environment, make decisions based on what it perceives and/or has been programmed to recognize and then actuate a movement or manipulation within that environment. With respect to mobility, for example, these decision-based actions include but are not limited to the following basics: starting, stopping, and maneuvering around obstacles that are in their way. (what-autonomous-robots, 2018)

Crucial Components of an Autonomous Robot

The key components to the autonomous action mentioned above include these three key concepts: perception, decision, and actuation.

Perception:

For people, this is mostly our five senses. Eyes, ears, skin, hair, and many other biological mechanisms are used to perceive the world. For a robot, perception means sensors. Laser scanners, stereo vision cameras (eyes), bump sensors (skin and hair), force-torque sensors (muscle strain), and even spectrometers (smell) are used as input devices for a robot. And with both people and robots alike, we can now think of other kinds of information inputs, like the endless supply of data from the internet; in fact one might think of the internet of things as an endless sea of sensors with very long wires reaching back to the robots that might use them.

Decision:

For humans, it's our brain that makes most of the decisions; or in some cases our "gut" or even our neural system. Our brains make higher level decisions, about where we want to walk for example. But sometimes our biology supersedes our brains and our bodies react to things before our brains even know what's happening. Those reflexive behaviors, like eyelids closing faster than a flying piece of debris, are operating faster and without the permission of our brains for the purpose of keeping us safe. Autonomous robots have a similar decision making structure. The "brain" of a robot is usually a computer, and it makes decisions based on what its mission is, and what information it receives along the way. But robots also have a capability that is similar to the neurological system in humans, where their safety systems operate faster and without the permission of the brain; in fact in robots, the brain operates with the permission of the safety system. In an autonomous robot, we call that "neurological" system an embedded system; it operates faster and with higher authority than the computer that is executing a mission plan and parsing data. This is how the robot can decide to stop if it notices an obstacle in its way, if it detects a problem with itself, or if its emergency-stop button is pressed.



Actuation:

People have actuators called muscles. They take all kinds of shapes and perform all kinds of functions, from grabbing a cup of coffee to beating our hearts and pumping blood. Robots can have all kinds of actuators too, and a motor of some kind is usually at the heart of the actuator. Whether it's a wheel, linear actuator, or hydraulic ram, there's always a motor converting energy into movement. The endless permutations of actuators provide a lifetime of joy and fascination for the people who create and work with them.

1.3.3 An Intelligent Robotic Hospital Bed for Safe Transportation of Critical Neurosurgery Patients Along Crowded Hospital Corridors(FLEXBED)

Chao Wang, Andrey V. Savkin, Ray Clout, and Hung T. Nguyen, Senior Member, IEEE

Flexbed is a motorized electric-powered HB, which allows semi-autonomous and autonomous control of the movements of the HB to be applicable. This is the major distinction to the conventional HBs whose movements rely on human labor. The appearance of Flexbed and its key components.

The key components of Flexbed are described as follows.

- 1) **Driving wheels:** Flexbed features two driving wheels with a diameter of 320 mm located at the sides of the base sections.
- 2) **Encoders:** The incremental quadrature encoders (model 775, see [26] for the specifications) have been attached to both driving wheels. Each of These encoders generates two square waves in incremental quadrature mode which provide the position, direction or velocity information of the wheels.
- 3) **Support lifts:** The bed is supported by three support lifts in Flexbed. There is one dc actuator inside each of the support lifts for independent extension or contraction movement of each lift. These movements allow the personnel to adjust the bed to the Trendelenburg position, anti-Trendelengurg position, tilt to right or to left position from motor controllers implemented in ipad. The available connection between ipad and Flexbed is RS232 serial cable or Wifi connection.
- 4) **Power supply:** The motors for driving Flexbed and the actuators in the support lifts are powered from two 12-volt batteries in series. The power for the other electronics is supplied from a separate 12-volt battery. The power switch is located on one side of Flexbed together with the emergency stop bottom.
- 5) **Range Sensors:** Flexbed allows various range sensors to be connected, such as Hokuyo URG-04LX laser range finder and Microsoft Kinect. In this paper, we use a Hokuyo URG-04LX laser range finder as the range sensor. It is mounted in the front of Flexbed and provides the distance data from Flexbed to the obstacles. It has a maximum range of 240 scan angle with maximum scan radius of 4 m. The pitch angle is 0.36 and the accuracy of 1% of the measurement.



- 6) Motor controller: We use RoboteQ HDC2450 as the motor controller of Flexbed. The motor controller is responsible for receiving information from the encoders and sending control signals to the motor system via serial interface or USB interface. Furthermore, this motor controller can also be manually controlled the utility provided by RoboteQ.
- 7) Embedded control board: The embedded control board used in Flexbed is Keil MCB2300 Micro-controller board. For implementation and error correction purposes, we utilize a Labview Embedded Module for ARM micro-controllers to interact with the relevant devices. The Virtual Instrument (vi) program generated by Labview can be easily converted into C/C++ language by build-in program of Labview and downloaded to MCB2300. The Labview is running in a notebook (Windows 7 operating system with dual core CPU running at 2.66 GHz and it has 4 GB RAM).

a novel design of an intelligent robotic HB Flexbed with autonomous navigation ability, which safely delivers patients from one location to another inside of a hospital. The designed intelligent HB is motorized and guided by a completely autonomous navigation algorithm. It is quite likely that such robotic intelligent HBs will eventually replace existing conventional HBs which are not guided automatically but pushed manually by hospital employees. Despite significant improvements on various parts of the HBs, systems for autonomous navigation of mobile HBs have not yet been investigated. (flexbed, 2018)

1.3.4 Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Mega2560's digital pins. The ATmega2560 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation on the Wiring website for details. For SPI communication, use the SPI library.
(mega , 2018)



1.3.5 Lm393 Motor Speed Measuring Sensor Module

Widely used in motor speed detection, pulse count, the position limit, etc. The DO output interface can be directly connected to a micro-controller IO port, if there is a block detection sensor, such as the speed of the motor encoder can detect. DO modules can be connected to the relay, limit switch, and other functions, it can also with the active buzzer module, compose alarm.

Features

- Using imported trough type optical coupling sensor, groove width 5 mm.
- The output state light, lamp output level, the output low level light.
- Covered : output high level; Without sunscreen : the output low level.
- The comparator output, signal clean, good waveform, driving ability is strong, for more than 15 ma.
- The working voltage of 3.3 V to 5 V
(lm393 datasheets, 2018)
- Output form: digital switch output (0 and 1)
- A fixed bolt hole, convenient installation
- Small board PCB size: 3.2 cm x 1.4 cm
- Use the LM393 wide voltage comparator Module

This IR speed module sensor with the comparator LM393, we can calculate the speed of rotation of the wheels of our robot. If we place a ring gear that rotates attached to our wheel. It could also be used as an optical switch. The basic operation of this sensor is as follows; If anything is passed between the sensor slot, it creates a digital pulse on the DO pin. This pulse goes from 0V to 5V and is a digital TTL signal. Then with Arduino we can read this pulse.

1.3.6 Conclusion

As a conclusion our Project will consist of several sensors module sending dynamic reading to mega Arduino board, where the mega board will compute the reading in order to provide series of reactions including adjusting the motors speed and the robot direction.



1.4 Project Objectives

Objective 1: to provide comfort to the hospitalized patients and convenience to the hospital employees.

Objective 2: reduce the switching process of patient from bed to bed.

Objective 3: fast and safe transportation of critical neurosurgery patients without changing beds.

1.5 Stakeholder List

People who affect the project and get affected by it, represent in the table below:

Stakeholders	Interest	Importance
Patients	spend most of their time laying down on the bed.	High
Nurses	Use the Bed	High
Hospitals	Primary Sponsor	High
Supervisor	Supervise the project	High
Project manager	Ensure the progress of the project	High
System Analyst	Gather requirement	High
Development Team	Develop the project from design to code	High
SHBs companies	Competitor	Medium

1.6 Proposed scope and Process model

The work plan of our project includes the following:

- Create a four-wheels semi-autonomies bed with 4 DC Motors.
- Develop a mechanism to control the Speed using two Speed Sensors.
- Stop in case of obstacles using ultrasonic Sensors.
- Start off alarm when the patient heart pulses stop.
- Scissor jack to adjust the height.
- Gesture control using glove (only for directions).
- Smart solar-panel the tracks the sun light.
- Mechanism to switch the patient from his bed to our SHB.



- IR sensors to detect Safety lines.
- Gyroscope to ensure straight movement and 90 degree turns.
- Indicator turn lights.
- Website that declare the functionality of the SHB and it also provide some support and it also include a tab where the doctors can store and retrieve the nightshift reads of the patient sing SHB.

The project will be managed using scrum framework to ensure the best result.

The fact that our process includes too much uncertainty and the use of new technology. Therefore, we are using spiral process model, where a table of potential risks and its solutions will be developed.

1.7 Scope excluded and project constraints.

the following will be excluded from the project:

- SHB won't avoid obstacles (it will only STOP in case of obstacles).
- The process of switching patient from its bed to the SHB won't be automated (it is mechanical with human help).

Constraints to the project:

- The limitation of resources (programmers, hardware and budget).
- The limitation of Time (3 Months).
- Lack of experience.

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