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Design and Development of movable intelligent Trolley system for assistance of immobile patients

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Abstract

Recent technological advancements have resulted in development of new and advanced medical devices & systems, enabled with highly-sophisticated electronics and interactivity. In the year 1990, the safe patient handling and mobility (SPHM) practices has started gaining importance and now the science behind SPHM has become too strong to ignore. The safe patient handling considers manual movement and mobilizing bedridden patients as hazardous work and thus the purpose of this research is to bring solace in the life of bedridden patients and to convey the depth and breadth of the research conducted on electronically movable intelligent trolley system for assistance of immobile patients and control strategy thereof. The designed contrivance is electronically controlled movable intelligent trolley that can assist immobile bedridden patients by carrying the utility items to their bedside on slight movement of the wrist.

The trolley make use of 12 Volts, 7.3 Ampere rechargeable Lead Acid battery that can last up to 60 min. with continuous usage and the average speed of trolley is 5 m/sec.

Keyword: Accelerometer, Gesture controlled robot, microcontroller, and wireless unit.

Introduction

Nowadays, technical advancements in the field of medicine are turning into one of the most superior within side the area of generation. Gesture recognition is a good example of man-machine interface where computers can understand the human body movements. An electronic movable trolley responds to simple gesture recognition to control the locomotion of the trolley. The crucial part of the trolley is perception. Perception of the surroundings is indispensable for this system design. The trolley has to figure out minor variables around it, analyse them, and then adjudicate to operate correspondingly. This system aspires to direct the trolley necessarily.

In the proposed system, wireless technology is used to proclaim the direction with the course of slight wrist indication with the intention of the assistance of immobile patients. This electronic movable trolley can be ascribed to as a "Contactless Gesture Controlled carrier" since the trolley reveals its pathway effortlessly through the orientation of the transmitter circuit. A movable intelligent trolley is a form of robotics that is regulated through the wrist motions and not through vintage buttons. The bedridden patients need to put on a small available light weighted transmitting device, which incorporates an accelerometer, which transmits the ideal commands to the trolley and the trolley receives them and then proceeds appropriately. The foremost ambition of the system is to build a physical aid to provide locomotion to bedridden persons and facilitate their life. This electronically controlled movable intelligent trolley can assist immobile bedridden patients by carrying the routine items to their bedside on the petite movement of the wrist.

Literature Review

Gesture recognition control has become a popular research issue in the fields of motion, sign language, image processing, and other fields in recent years, and it is a versatile human-machine interface approach. Humans now prefer to use their hands directly as input devices in order to achieve more natural human-robot interactions (HRI). More briefly, the movements of the hands are recorded in a motion gesture control recognition system, and the machine is provided movement in response. These types of gesture control can be beneficial to the elderly, ill, and disabled. It can also be employed in severe environments where humans are unable to go. In this section, we'll go over some of the connected works:

The study report [1] attempted to provide an outline of the issues and solutions for recognizing gestures. The design realized in this work made use of Microcontroller Based Gesture Recognition system that does not need image processing. This allows a robot to move in a 360-degree circle. To measure the human hand gestures, a gyroscope sensor is used in this research work. The captured data is transmitted to the robot using RF communication which enables robot to move in various directions according to the human hand gesture.

A robot navigation interface is based on hand gestures is proposed in [2]. A user can operate a robot with his or her hand movements. A three-axis accelerometer is used to record hand movements of user and RF module is used for sending same data wirelessly to a computer. The received movements are divided into six different control commands for robot navigation. To categorize hand movements, the classifier uses a dynamic time warping method. Simulation findings suggest that the classifier could only reach a 92.2% accurate rate in the work.

Research presented in the reviewed literature [3][4] indicates development of a wireless robot systems that were controlled by arm positions and the systems recognize the gestures defined through temporal patterns. As claimed by authors, the challenges were aggravated by poor lighting at night and in unclear weather. This paper also discuss about motion technology. For man-machine interaction, accelerometers are employed for gesture recognition.

In the study reported[5], a simple robotic chassis is constructed that may be readily operated using an accelerometer rather than buttons. They have created a device using sensor and a signal regulating circuitary measure the acceleration. The accelerometer's output is analogue in nature and corresponds to acceleration. The hand gesture is detected, and the coordinates created are used as a parameter. If the appropriate conditions are met, microcontroller code statement gets executed which results in forward, backward, left turn, right turn movements and stop.

The study reported in [6] is a real-time monitoring system that uses gestures to allow humans to engage with robots. This is a huge help for people who have difficulty moving around. As claimed in this paper, the speech recognition has failed to dictate robots because to modulation and variable frequency, so a vision-based interface is urgently needed. The three stages of gesture recognition are capturing of an image, it's processing, and extraction of data. The implementation is accomplished through the use of various gestures to guide the robot. Physically challenged people's lives are made easier as a result of this project's impact.

Gestures are used to communicate between humans and robots, as well as between persons who use sign language, according to the research article[7]. A command is sent to the robot when the hand moves in a specified direction and the robot follows the direction command.

After reviewing published research articles and initiatives, it can be concluded that in terms of affordability, usability, and convergence with known and familiar technology, the research reveals that gesture-controlled systems are now becoming practical. Though there are numerous features and points to discuss from the research, the following themes have been extrapolated to summarize the evolution of the movable intelligent gesture controlled trolley systems 1) The users; 2) The type of gesture; 3) The application area; 4) The technology; and 5) The study approach. These themes will now briefly be discussed, with a view to justifying the design choices made for the movable intelligent trolley system.

Proposed Design

The following components are used for processing, executing, and implementing the locomotion of movable trolley.

- ATmega-328P Microcontrollers (8-bit)
- Hybrid RF Transceiver Module (433-MHz)
- ADXL 335 Accelerometer
- 12 V, 7.3 A Lead Acid

The user controls the motion of the trolley with the help of hand gestures. The user wears a fingerless glove that has the transmitter circuitry attached to it and depending on how the user tilts the hand, the trolley moves. Suppose the user tilts the hand in front, the trolley moves in the forward direction until user gives the next command. When the user tilts hand slightly backward, the trolley moves in the backward direction and similarly for left and right direction.

The setup of this movable intelligent Trolley system for assistance of immobile patients is quite simple. ADXL-335 accelerometer sensor detects the hand motion and sends the data to ATmega-328P Microcontroller which identifies the hand gesture and with the help of radio frequency transmitter sends the data to the trolley. In the trolley RF Receiver captures the signal and sends it to the microcontroller which instructs the motor driver to move the motors according to the hand gestures provided by the user. Table 1.1 describes the motion of the carrier according to the Movement of the hand.

Movement of Hand	**Side**				**Direction**
	D3	**D2**	**D1**	**D0**	
Tilt Front	0	1	0	0	Forward
Tilt Back	1	0	0	0	Backward
Tilt Left	0	0	1	0	Left
Tilt Right	0	0	0	1	Right
Neutral	0	0	0	0	Stop

Table 3.1 The motion of the carrier according to the Movement of the hand

Block Diagram

Fig.1 indicates simplistic block diagram of working of proposed movable intelligent Trolley system. The proposed design make use of ADXL-335 accelerometer sensor, a 8 bit ATmega-328P microcontroller for identification of hand gestures and RF trans receiver. L298N is motor drivers used for driving the motors.

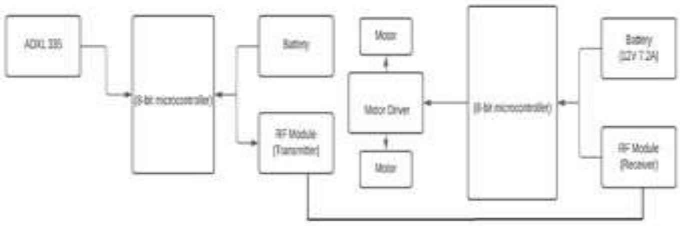

Fig.1 : Transmitter and Receiver Circuitry

A Mathematical Analysis is performed to estimate and analyse angle of Inclination in accelerometer sensor and moment of inertia of trolley, as follows:

- Angle of Inclination in ADXL-335

$$\theta(theta) = \text{atan}\left(\frac{Axout}{\sqrt{Ayout^2 + Azout^2}}\right)$$

Where,

Axout - Acceleration values in g unit for X

Ayout - Acceleration values in g unit for Y

Azout - Acceleration values in g unit for Z

- Centre of Mass of Carrier

The base of the carrier is rectangular so its centre of mass will lie at the intersection of its two diagonals. Since various components had to be added which would have changed the centre of mass, we added the components in such a manner that the centre of mass remains at the intersection of diagonals.

- Moment of Inertia of trolley (In X,Y and Z direction)

$$\text{Ix} = \frac{1}{12}\text{M}L^2, \text{Iy} = \frac{1}{12}\text{M}B^2 \ and \ \text{Iz} = \frac{1}{12}\text{M}(L^2 + B^2)$$

Where,

M – Mass

L – Length of carrier base

B – Breadth of carrier base

Result and Conclusion

The user can utilize various hand gestures to navigate the electronically movable intelligent trolley system. The goal of this technology is to create a more dependable and user-friendly method of navigating the intelligent trolley, which can assist bedridden patients through simple gesture commands. The intelligent trolley is based on an accelerometer-based direction control module that navigates by tracking even the tiniest hand movement. A visual indication is provided through a light system on all four corners of the electronically moving intelligent trolley as night vision guiding, which turns-on every time the trolley boots up. This light aids easy navigation when a bedridden patient handles the trolley in a dark. With the help of the RF Module and ADXL335 accelerometer, the trolley takes the patient's wrist gesture as input and establishes wireless communication.

The analysis of designed system with referred literature is provided in the table 4.1

	Our System	[8]	[9]	[10]	[11]
Accelerometer	Y	Y	N	Y	Y
RF Module	Y	Y	N	Y	Y
Motor Driver	L298N	L293D	L293D	NA	L293D
Motors	Johnson Motors (Geared)	DC Motors	DC Motors	DC Motors	DC Motors
LED lights	Y	N	Y	Y	N
Battery	12 V, 7.3 A Lead Acid	NA	NA	Lead Acid	12 V
Rechargeable	Y	NA	NA	N	N
Average Speed	5 m/sec	NA	3 m/sec	NA	1 m/sec
Limit for Communication	100 m	NA	100 m	NA	NA
Battery Duration	~ 60 min	NA	NA	NA	45 - 60 min

Table 4.1 Comparison with similar systems *(Y – Yes, N – No, NA – Not Available)*

From the above comparison and analysis, it can be concluded that the proposed carrier system establishes wireless communication between transmitter and receiver system, much more efficient in terms of performance, more user friendly, easy to control, having long lasting backup power and LEDs for night traversal, and a high payload capacity (~8 KG's). The proposed movable intelligent Trolley system may benefit the upcoming health care industry, particularly in providing assistance to the immobile patients and to the society, at large.

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