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Balancing Shoe for Elderly People

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Abstract—*The main aim of this project is to reacquire the balance lost by moving either of the legs to the position where the subject is stable. So, we design a balancing shoe to rectify the problems for elderly people. Balancing shoe is nothing but back to balance. Balancing shoe should be worn on both the legs, so that, the unstable leg, depending on the fall condition, is brought back to the normal position. An accelerometer is used to detect the imbalance position, which is fed input to the controller. The controller is programmed in such a way that it runs the DC motor, which rotates the motion devices that are fixed to it, to retain the balance. Thus the motion devices finally move the leg to which the corresponding balancing shoe is worn providing stability to the subject, hence overcoming the fall.*

Keywords*: Accelerometer, DC motor*

1. INTRODUCTION

Balancing shoe is a conventional walking shoe that automatically performs a “backward step” accurately and only when needed. The shoe incorporates pressure sensors, an embedded integrated motion device, a microprocessor, smart algorithms and a rechargeable battery. When imbalance is detected, the motion devices roll the shoes slightly and gently backward until balance is regained. The smart algorithms assure detection of imbalance and that the shoe will only operate when needed. Balancing shoe is patent protected. Balancing shoe’s world class orthopedic surgeons, Neurologists, Scientist and engineers specialize in human biomechanics and balance disorder, to guarantee original, effective and practical solutions.

1.1 Stability

Stability of the balancing shoes are more flexible than the motion control shoe which providing good support. These shoes are for people who do not have proper balance. They tend to move which is not needed by walkers.

1.2 Old age

Falls are the leading cause of injury-related visits to emergency departments. One out of every three people aged 65 and older, takes a spill. Closer to age 80, the risk affects nearly everybody, and these falls often result in hospitalization. Related healthcare costs will be very high. The mortality rate for falls increases drastically with age in both sexes. Falls are accounting for 70 percent of accidental deaths in persons 75 years of age and older. More than 90 percent of hip fractures occur as a result of falls, with most of these fractures occurring in persons over 70 years of age. Risk factors for falls in the elderly include increasing age, medication use, cognitive impairment and sensory deficits. This falls also occur in people who are differently abled or partially paralyzed or who are mentally disadvantaged. Once they fall, the fear of falling again increases, which reduces their self-confidence. They always need to be assisted by someone either in person or by a supporting object. They can’t even go out alone and do their work by themselves due to this reason. The consequences of falling down can be very severe in few circumstances which lead to decrease in life expectancy.

1.3 Existing solution

There are many low cost products that provide walking assistance to the elderly.

- Rolling Walkers
- Standard Walkers
- Heavy Duty Walkers
- Crutches
- Walkers with Wheels

- Canes
- Knee Walkers
- Specialty Walkers
- Two-in-one Walker-Wheelchair

But all of the above mentioned things are very big in size, and are visible to others. They need to be carried with the subject all the time. These are more like a support Rather than acting only at the time of fall.

1.4 Problems

This problem of falls occurs mainly due to the inability to balance themselves. Factors that may affect balance are:

- Loss of muscle strength
- Reduced joint movement and stability
- The side-effects of some medicines
- Ear problems (including wax build up)
- Sudden movements, especially rising quickly from a sitting or kneeling position
- The effect of a hip or knee replacement in the short term.

Thus there is a serious need for some device to provide balance in such conditions. This project aims at reducing the rate of falls and injurious falls in people over 65.

1.5 Statistics of aging population falling

From 2000 to 2014, around 14 million injury-related visits were made to emergency departments in India. Falls were the leading cause of external injury, accounting for 24 percent of these visits. Emergency department visits related to falls are more common in children less than five years of age and adults 65 years of age and older. Compared with children, elderly persons who fall are 10 times more likely to be hospitalized and eight times more likely to die as the result of a fall. Trauma is the fifth leading cause of death in persons more than 65 years of age, and falls are responsible for 70 percent of accidental deaths in persons 75 years of age and older. The elderly, who represent 12 percent of the population, account for 75 percent of deaths from falls. The number of falls increases progressively with age in both the genders. The injury rate for falls is highest among persons 85 years of age and older. Annually, 1,800 falls directly result in death. Approximately 9,500 deaths in elders are associated with falls each year. Elderly persons who survive a fall experience significant misery. Hospital stays are almost twice as long in elderly patients who are hospitalized after a fall than in elderly patients who are admitted for any other reason. Compared with elderly persons who do not fall, those who fall experience greater functional decline in activities of daily living and in physical and social activities and they are at greater risk for subsequent institutionalization. In older patients, a fall may be a non-specific presenting sign of many acute illnesses, such as pneumonia, urinary tract infection or myocardial infarction, or it may be the sign of acute exacerbation of a chronic disease. Up to 60 percent of nursing home residents fall each year; one half of these fallers have multiple episodes. Major injuries, including head trauma, soft tissue injuries, fractures and dislocations, occur in 5 to 15 percent of falls in any given year. Fractures account for 75 percent of serious injuries, with hip fractures occurring in 1 to 2 percent of falls.

In 2013, more than 250,000 elder Indians suffered fractured hips, at a cost in excess of 10 million. More than 90 percent of hip fractures are associated with falls, and most of these fractures occur in persons more than 70 years of age. Hip fracture is the leading fall-related injury that results in hospitalization, with these hospital stays being significantly prolonged and costly. It is projected that more than 340,000 hip fractures will occur in the year 2013.

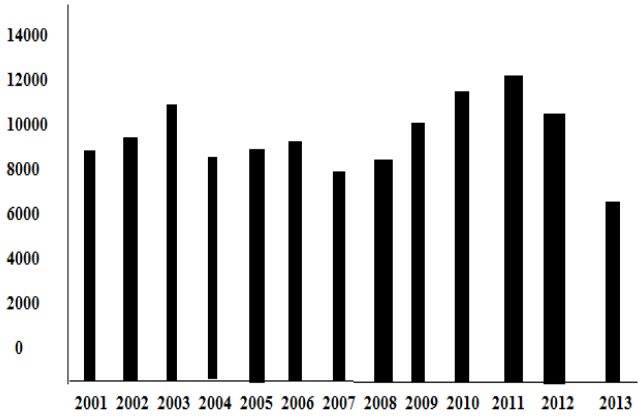

Fig. 1: Statistics of aging population falling

2. BLOCK DIAGRAM

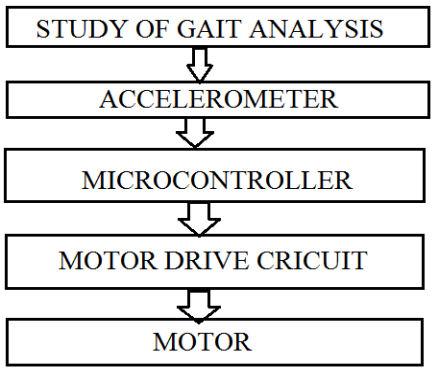

Fig. 2: Block diagram of balancing shoe

There are mainly five components involved in the balancing shoe. They are Accelerometer, Microcontroller unit, Motor Drive circuit and motor.

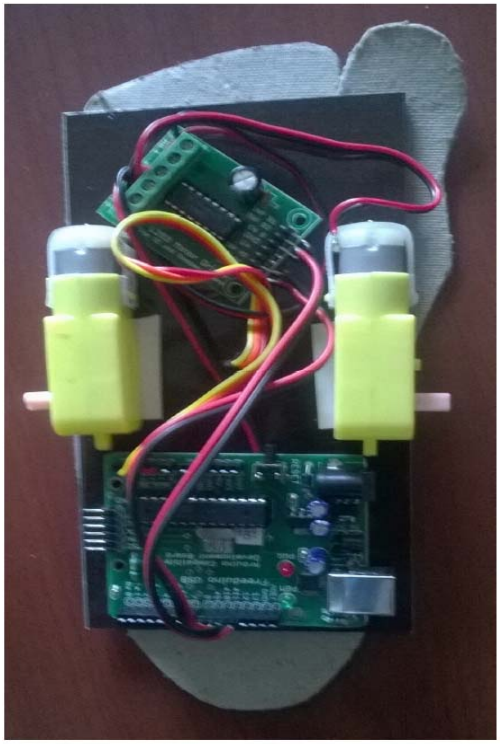

Fig. 3: Prototype of the design

3. METHODOLOGY

In this design analyzed gait parameters. Gait analysis method, to estimate the spatiotemporal measures based on two, three, four gyroscopes attached to the lower limb. The collected data from this method and then analyzed the problems.

3.1 Accelerometer

This is used as the main sensor in our project. An accelerometer is defined as an electromechanical device that measures the acceleration forces. These acceleration forces may be static and dynamic. Static is like a constant force of gravity pulling at our feet. Dynamic force is caused by moving or vibrating the accelerometer. Why are using accelerometer means force occurs when under a fall condition? It can help us understanding the surrounding of the balancing shoe.

3.2 Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. They have program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications and are also used in Personal computer design; Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. In this project, at mega 328 microcontrollers are used and it was programmed using Fredonia. Fredonia is an open-source Arduino-compatible production file. These are 100% functionally, electrically and physically compatible with Arduino hardware. Arduino is a single-board microcontroller, intended to make it easier to build interactive objects or environments. The hardware consists of an open-source hardware board designed around an 8- bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Current models feature a USB interface, 6 analog input pins, as well as 14 digital I/O pins that accommodate various extension boards.

3.3 At mega 328

Atmel 8-bit is a High performance, RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

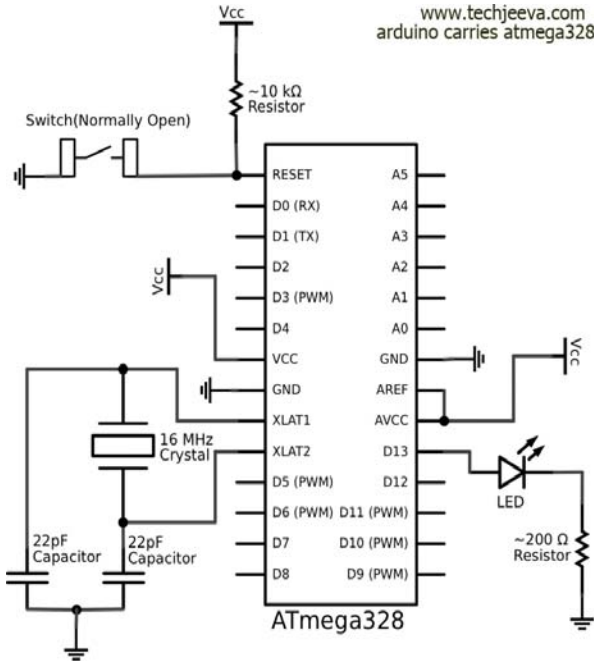

Fig. 4: Atmega328

4. WORKING

The accelerometer is calibrated to measure the tilt experienced by the accelerometer to make necessary modification and do the balancing according to this. When the tile is more in the forward direction the device of the motor is made to rotate in the backward direction to maintain the balance and when the tilt is more in the backward direction the motor device is made to rotate in the reverse direction to maintain the balance. The balancing is done to maintain the center of gravity at constant position. That is the accelerometer with the motor arrangement tried to maintain the Centre of Gravity at a stable position.

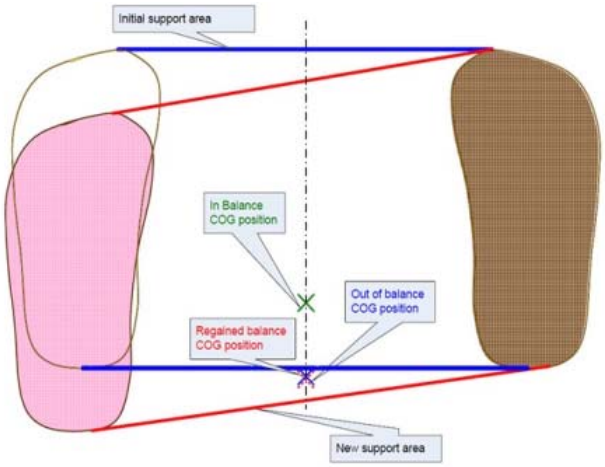

Fig. 5: Center of gravity

4.1 BO geared dc motor

A DC motor relies on the fact that like magnetic poles repels and unlike magnetic poles attracts each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°. A simple DC motor typically has a Stationary set of magnets in the stator and an armature with a series of two or more windings of wire wrapped in insulated stack slots around iron pole pieces with the ends of the wires terminating on a commutator. The armature includes the mounting bearings that keep it in the center of the motor and the power shaft of the motor and the commentator connections. The winding in the armature continues to loop all the way around the armature and uses either single or parallel conductors, and can circle several times around the stack teeth. The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets in the stationary part of the motor to create a force on the armature which causes it to rotate. The DC motor arrangement is kept in a gear like casing inside which the motor rotates, the casing is made up of Light duty plastic and gear is also made of the same material. The arrangement helps to get a constant and regulated torque to the motor arrangement.

4.2 Motor driving circuit

The most common method to drive DC motors in two directions under control of a computer is with an H-bridge motor driver. H-bridges can be built from scratch with bi-polar junction transistors (BJT) or with field effect transistors (FET), or can be purchased as an integrated unit in a single integrated circuit package such as the L293. The L293 is simplest and inexpensive for low current motors. The L293 is an integrated circuit motor driver that can be used for simultaneous, bi-directional control of two small motors. The L293 is limited to 600 mA, but in reality can only handle much small currents unless you have done some serious heat sinking to keep the case temperature down. Unsure about whether the L293 will work with your motor? Hook up the circuit and run your motor while keeping your Finger on the chip. If it gets too hot to touch, you can't use it with your motor. The L293 comes in a standard 16-pin, dual-in line integrated circuit package. In this design are drive more than one motor so that the stable position is obtained, for drive the motors simultaneously used L293.

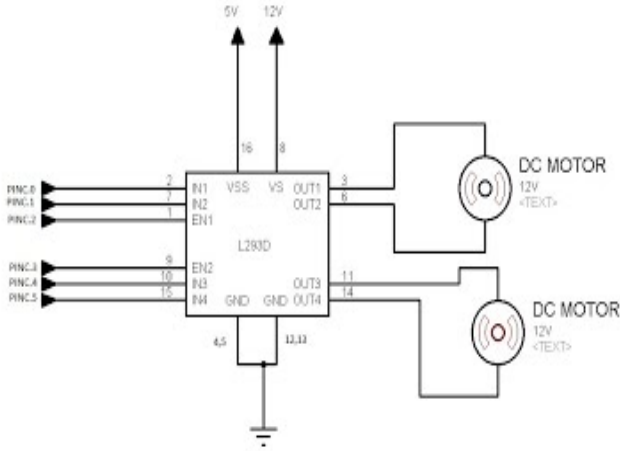

Fig. 6: L293 Circuit

5. CONCLUSION

The balancing shoe designed in this project is very helpful for elderly people and also much better than the present existing solutions. Elderly people can just put it on since it acts only during the fall conditions and in other conventional situations it is a normal shoe. Elderly people can overcome the various problems experienced by other supporting equipments available in the market.

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