Automatic moving floor for smart rooms

B Ravi Subrahmanyam* and A Ambikapathy

Department of Electrical and Electronics Engineering, GCET (Dr. A.P.J. AKTU)
Greater Noida, Uttar Pradesh-201306 India
E-mail: ravisubbu97@gmail.com

Abstract. This paper presents Automatic moving floor of a room for smart homes; invention is provided to solve the problems like moving of heavy furniture in homes, cleaning of floor everyday and to help the old people to roam around the room. The complete invention consists of two disconnected parts namely, CoS (Control System) box and the Tiles. Tiles arranged in the form of an array, having high torque motors internally and set of gears. There will be a false floor just beneath the main designed purposely for several instructions (like cleaning of tiles, moving of tiles, etc.) to work upon. The CoS box is a control system that listen, record, analyze the data given by the user and finds the best suitable solution form the array with given conditions. The CoS box contains a microphone and a touch panel to give instructions, then it provides a suitable way or path for the tiles to move from starting point to desired locations within the room. The instructions to the CoS box can also be given through an android application to have more user-friendly interface.

1. Introduction

Smart homes and home automation are now quite common words in technological domain. There are a number of ways in which inventers are doing at their best to make homes future ready. Even smart Airports with moving floors are available. Home Automation Systems have been designed and developed for mobile phones having Android platform to automate an 8 bit Bluetooth interfaced micro-controller which controls a number of home appliances like lights, fans, bulbs and many more using on/off relays [1]. Even a Home Automation system that employs the integration of multi-touch mobile devices, cloud networking, wireless communication, and power-line communication to provide the user with remote control of various lights and appliances within their home has been developed [2]. IoT (Internet of Things) technology has been used in homes in order to achieve smartness. In order with the above technologies GSM based home automation, Phone based home automation, ZigBee based home automation, Wireless control systems are also been proposed for making homes more user friendly [3].

Some inventions in home automation have also been made in order to help the old and disabled people. ‘Voice Recognition Based Home Automation System for Paralyzed People’ was an invention by Mukesh Kumar, Shimi S.L in which the design of the low cost voice recognition based home automation system has been made, for the physically challenged people suffering from quadriplegia or paraplegia (who cannot move their limbs but can speak and listen) to control the various home appliances just by the voice commands according to their need and comfort with the help of voice recognition module, Arduino UNO microcontroller, and relay circuit [4]. ‘Automatic Fall Detection System using Sensing Floors’, paper describes the work of detecting falls of old and elderly people in independent living apartments using accelerometer concealed under tiles [5]. Also a huge research has been done on floor cleaning of smart homes. ‘Design and Development of Floor Cleaner Robot (Automatic and Manual)’ in this paper written by Manreet Kaur, Preeti Abrol; they used a microcontroller AT89S52 for all hardware and software operations, including a RF module, IR sensor, LCD display and a 12V battery and developed a robot to clean the floors [6].
This paper is suggesting an idea in the domain of home automation, smart airport and smart hospitals. Here the concept of automatic moving floor has been discussed with the help of two sets of tiles (with false and actual tiles) and CoS box specially designed. The every individual tiles of whole floor of the room consists of two tiles namely false tile and actual tile. These combination of tiles carries pressure sensor, a set of gears and motors along with transmitter and receiver pair for effective communication with the CoS box. The CoS box is designed as an intermediate between the tiles and the user, it is embedded with voice recognition system and a touch panel for the instructions from the user.

2. Description

The invention concentrates on the movement of floor in a room for smart homes and next generation houses. The floor is divided into an array of ‘tiles’ which are controlled by an automatic system called ‘CoS box’. There are two floors, the main floor and the false floor one below the other. There will be gap of one floor height between both the main floor and the false floor. Each floor consists of same number of tiles arranged with the precision.

Fig. 1 shows, the top view of the floor having the tiles arranged as shown. The black spots around each corner of the tile are the poles that are attached to the ground to have vertical movements of the tile.

2.1. Tiles

Tiles are designed with materials having strong strength that can withstand a pressure somewhat more than that of human and the furniture in the room. Also, each tile consists of pressure sensor, so to detect the presence of human or any object. Each tile consists of gears two big and four small gears (as shown in Fig. 2), that will help in the movement of tiles in any direction.

The two big gears that are held at the center of two adjacent faces are used for the movement along the same plane (i.e. Left, Right, Forward and Backward), whereas the four small gears are at the each of the four corners will be used for up and down movement (i.e. Along the z-axis), the other two adjacent sides of the tile are in the shape of teeth (extruded inwards).

All the gears are divided into two categories; one those are used to move in the same plane will be referred as Horizontal Gears hereafter; other those are used for up-down movement will be referred to as Vertical Gears hereafter.

There are small poles on each corner of the tile, these poles are attached to the ground, and height of each pole will be about three and a half times of height of each tile. These poles act as a support to the tiles at the time of up-down movement. The poles and the tiles are designed in a way that there will not be any missing of the gears (as shown in Fig. 3).

The tiles contains a programmed chip which is used to have communication with the CoS box, and to perform the specified tasks.
2.2. CoS box

CoS box is a specially designed control system box that accepts, analyze and commands information as and when needed.

CoS box consists of a microphone, and a touch panel embedded for input from the user. Then it will process the information and come to a conclusion on the basis of input, and the respective instructions are then transmitted from the CoS box to each of the respected tile which is to be moved. The CoS box is connected to each and every tile of the room and have complete access to move those tiles as per the requirement.

The CoS box is also connected to an android application to have ease on assess with the commands. The data will be transmitted to the respective tiles, and the tiles move with proper and calculated time to avoid confusion within the tiles.

Fig. 4 shows a pictorial representation of CoS box, having a touch screen, along with microphone for input signals. Some buttons are also provided at the bottom for manual operation as and when needed.

2.3. Movement of tiles

Each tile consists of two big gears at the center of two adjacent sides i.e. horizontal gears; these gears are allowed to rotate in both the directions on a fixed axis with the help of high torque and low rpm motor, this will allow the tile to move on all the four directions on the same plane.

The four small gears on the corners of the tile i.e. the vertical gears are held to move the tile up and down.

When the tile has to move in the same plane except the two main responsible horizontal gears; the vertical gears shift a little inwards, so to have a free movement without any inconvenience. Similarly, when the tiles have to move in up-down direction except the vertical corner gears; the remaining two horizontal gears shift a little inwards.

When gears of one category move the other set has been shifted a step back (inwards). When this happens, the gears are programmed to come to a reset position so next time overlapping will not cause a problem.

When the tile has to move in the forward direction (say north) then the gear on the on the east face will rotate in clockwise direction, and the gear on the east face of adjacent tile (left to the concerned tile) will rotate in anticlockwise direction, now with the effect of Newton’s third law of motion the concerned tile will move forward (as shown in Fig. 5).

Fig. 6 shows an instant of up-down movement of the tile. Here all the vertical gears will move in the direction so as to achieve the desired task efficiently.
Let us consider a room with the arrangement of furniture as shown in Fig. 7. When a command from the user inputs as “Take me to the door” and the user stands on the tile with a star mark. As the CoS box takes the input and possess it with a conclusion that all the tiles with a dot mark have to move in the up and down direction only whereas tile with star mark and tiles beneath the floor will have to move in the same plane. So the CoS box will make the gear arrangement of all the necessary tiles as per their movement, hence to have an uninterrupted and smooth movement from bed to the door.

For an example as shown in Fig. 8; let a command says a tile 1 to move from position 1 to position 3 as shown in adjacent Fig.. Now tile1 will move forward to take the position of tile 2, tile 2 starts moving down to the place of tile 5, tile 5 shifts left to position 6 i.e. at the place of tile 6 and finally tile 6 move upwards to position 1, now tile 1 is at position 2. In the similar manner tile 1 move’s one more block to left and all the adjacent tiles change their positions for tile 1 to reach its destination. The tiles 2 and 6 in first movement (i.e. when tile one move from position 1 to position 2) will move first and take their position in the gap between the two floors, so to have a smooth movement for tiles 1 and 5, then tiles 1 and 5 move in their respective directions to complete the path. The movement and timing of tiles will been calculated by the CoS box beforehand so to have no time lag or any confusion among the tiles and a continuous flow is achieved. The speed for the movement of the tiles is set calculated so that the person using should not experience any effect of moment of inertia and/or momentum.
2.4. Charging of tiles Circuitry

Charging of tiles will take place through the concept of real time charging. All the tiles on both the floors will be connected to the supply. A battery is used to store the energy and will be utilized during the movement of tiles. And in steady state the energy used for the functions will be directly consumed from the supply.

The design of the tile will be such that when the two tiles will be in complete contact the circuit for charging of tiles will get complete and the charging of battery takes place. And when the tile is in moving state the contact breaks, the circuit will not be complete and the energy from the battery is used to feed the whole circuit.

2.5. Cleaning of tiles

The cleaning of tiles can be divided into two categories; temporary cleaning and complete cleaning.

In temporary cleaning the two of four vertical gears will move a little downwards so to form a little slope of the tile, and due to the effect of gravity the heavy dust particles will fall down from the tile, resulting to a temporary clean tile.

In complete cleaning of tile the tile will move to the location assigned for cleaning. In the false floor a corner, which is not as useful, will be made as cleaning centre for tiles.

2.6. Replacement of tiles

When there is any problem in any of the tile it will be diagnosed by the CoS box and will be informed to the user about the problem. If after troubleshooting still the problem persists and requires a replacement, then on the command of user all the four standing gears set will move in a direction such that the tile will come out from the array of main floor. In the similar manner a new tile will be kept back in its position.

3. Overview of the entire operation(Flowchart)

Fig. 9. Flow Chart
Fig. 9 shows a flow chart representing the entire process briefly. Here the block control unit refers to the CoS box of the system, the input to which is high pressure location identification data (as it has been connected to all the tiles), along with the voice command through the audio sensor (embedded within the CoS box to have audio input from the user), and as the output it activates the moving mechanism between false and the main floor (i.e. the gears between the tiles depending upon the instructions, will get activated).

4. Result and Conclusion

Fig. 10 shows a pictorial representation of the desired output. The various steps in the flow are shown through pictures represented in increasing number format from (a) to (h). Where,

a) Represents that there is a man in the room who is sleeping at any instant.

b) Represents that after some time interval the man wants to go to the door, and he gives a voice input saying “Take me to the door”

c) CoS box listens to the instruction through the microphone embedded in it. And analyze it to come to the best optimum solution.

d) At first the tile placed in the forward direction of the path will move down. As well as the tile just beneath the target moving tile will move upwards. There is a space of one tile height between the two floors. So both the tiles will travel half way down at first.

e) As soon as both the tiles reach their half way, the remaining two tiles (i.e. the target tile on which the man is standing and the tile beneath the forward placed tile moving downwards.) will move in the horizontal direction as per the instructions given by the CoS box.

f) In this ways all the tiles move as of completing a vertical quadrilateral path.

g) Each tile is embedded with a transmitter-receiver pair to have a communication with the CoS box. In the similar manner the man reaches his destination.

h) Finally the man reaches the desired destination location.
Fig. 11 shows the schematic representation of the selection of the optimum path by the CoS box as soon as it receives the instruction. The various steps in the process flow are represented by the increasing number format from (a)-(e). Where,

(a) Represents the basic layout of the room an array of tiles.

(b) Pressure sensors are embedded in each tile, so as to know if there is any object on any particular tile. Hence all the tiles encountering certain pressure are obtained.

(c) As the position of all the furniture (i.e. bed and dressing table in this particular case) in the room is already defined in the CoS box at the time of installation.

(d) So it will be easy for it to find out the starting and ending tiles for the movement.

(e) CoS box finds the optimum path for the tiles to move.

References

[1] Shirisha Tadoju and Mahesh J; August-2015 Int. J. of Adv. Technol. and Innovative Research, ISSN 2348-2370 Vol.07,Issue.10; ‘Bluetooth Remote Home Automation System using Android Application’; Pages:1815-18

[2] Dipti P Wale, Prof Patil S S and Dr. Anekar S V; May-2015 Int. J. of Innovative Technol., ISSN 2321-8665 Vol.03,Issue.01; ‘Home Automation using Cloud Network and Mobile Devices’; Pages:0054-58

[3] Satish Palaniappan, Naveen Hariharan, Naren T Kesh, Vidhyalakshimi S and Angel Deborah S; April 2015 Int. J. of Comp. App. (0975 – 8887) Vol.116 – No. 11 ‘Home Automation Systems - A Study’; Pages:11-18

[4] Mukesh Kumar and Shimi S L; October 2015 Int. J. of Adv. Research in Electronics and Communication Engg. ISSN: 2278 – 909X, Vol.4, Issue 10, ‘Voice Recognition Based Home
Automation System for Paralyzed People’; Pages:2508-15

[5] Mohamad Daher, Ahmad Diab, Maan El Badaoui El Najjar, François Charpillet and Mohamad Khalil; December 2016 Int. J. of Computing & Information Sciences Vol. 12, No. 1 ‘Automatic Fall Detection System using Sensing Floors’ Pages 75 – 82 DOI: http://dx.doi.org/10.21700/ijcis.2016.110

[6] Manreet Kaur and Preeti Abrol; July 2014 Int. J. of Comp. App. (0975 – 8887) Volume 97–No.19 ‘Design and Development of Floor Cleaner Robot (Automatic and Manual)’; pages:32-38