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Elevator for blind people using voice recognition

Farouk Salah, Mohamed Saod
Electronics & Communication Department
MSA University
Cairo, Egypt
Farouksalah1@live.com
Mohamed.saod@msa.edu.eg

Dr. Maher M. Abdel-Aziz
Communication,Electronics& Computers Department
Helwan University
Cairo, Egypt
mmabdelaziz@msa.eun.eg
manmaher24@yahoo.com

***Abstract*—**Blind people have many daily challenges. One of these challenges is the use of elevators in multi-floor buildings. Blind people deserve a more satisfying way to facilitate the use of elevator. To overcome this challenge for blind people we must interest by the following issues: Insure that the blind in front of the elevator's door - Confirm recording the required floor for the blind – Inform the blind arriving the elevator to his standing/required floor - Insure closing the elevator's door after making sure the blind enters or exits the elevator - Inform the blind the number of the passing floors.

Most of the current elevators targeted the handicapped and visually impaired people. The elevators targeted the blind people didn't have voice conformation to inform the blind the elevator status. Our proposed system satisfied all the issues stated above. The proposed system consists of two main parts: The first one is a remote unit with the blind and the second one is an elevator unit. The two units have wireless communication between each other through a transceiver module in each unit. The remote unite is responsible for handling the voice orders, voice confirmations and sending them through the transceiver to the elevator unit to control the elevator movement.

***Keywords*—**Microcontroller, Voice recognition, Ultrasonic sensor, communication module, Embedded System.

I. INTRODUCTION

The blind people cannot use the elevator easily. It is difficult to use the keypad if they cannot see it. Sometimes the keypad has Braille technique, but they will have hard time for locating its place. Even though they actually found the keypad, how can they know the number if they don't know Braille? The struggle of the blind people using elevators is real. They always need help in elevators from someone to press the button for them and to tell them when the elevator cabin arrives. Also, it's hard for them to know the elevator door is opening or closing. Not that only, but in case of emergency how they will act if there is no one with them to help.

Different systems had been introduced to overcome the challenge for blind and visually impaired people in using elevator. The first system introduced in 2014 and constructed a voice operated intelligent lift/elevator act as a human machine communication system to recognize the spoken words and takes an action [1]. The system was helpful for paralysis and disabled people, high circuit complexity and medium speech recognition efficiency. The second system introduced a Smart Lift - Voice Controlled Elevator in 2015 for blind or physically impaired people [2]. The system used a Braille keypad in the elevator cabin for recording the required blind floor which is so difficult to him. Also, the system has limited voice commands (10 only), low voice recognition accuracy, and high cost. The third system is voice initialized elevator introduced in 2016 [3]. The system has very high speech recognition efficiency, low power consumption, and cheap but no voice confirmation. The fourth system is an attentive elevator using speech recognition introduced in 2017 [4]. The system used elevator by voice commands to help the handicap and disabled people, and also dwarf people, but not for blind people.

As a genuine idea the proposed system would overcome the current expensive systems and targets category of blind people. The use of speech recognition and text to speech systems make using the elevator would be very easy and enjoyable. There will be a remote unit with the blind user. The remote starts the speech recognition unit when the blind near the elevator. Then the blind should call the elevator using the remote microphone and then a confirmation message would be replied through the loudspeaker in the remote. When the elevator arrives an arrival message "elevator is arrived" would be received by loudspeaker for the blind. Then the blind enters the elevator cabin. Inside the elevator cabin the blind will call the desired floor and a confirmation message would be replied by his remote, and when it arrives to the required floor an arrival voice message saying "elevator is arrived" would be received. When the door is opening there will be a voice message saying "door is opening". When it is closing a voice message saying "door is closing".

II. PROPOSED SYSTEM

Our proposed system makes an easy way to use the elevator especially for the blind people. Provided by the remote in which will give the blind person a fully control over the elevator. The remote have an auto power-off feature to turn off the remote after a certain time to conserve battery. A voice message to inform the user the battery is on low level to charge it. Also, there will be a voice confirmation for the selected floor and when the elevator arrives to it, and when the elevator`s door is opening or closing. In the elevator a relay is used to switch to some emergency rechargeable batteries when the power shuts down. The proposed system is not expensive since the remote contains the microphone and the loud speaker together instead of putting them in two different levels. Also, the whole system works offline (i.e. no internet needed).

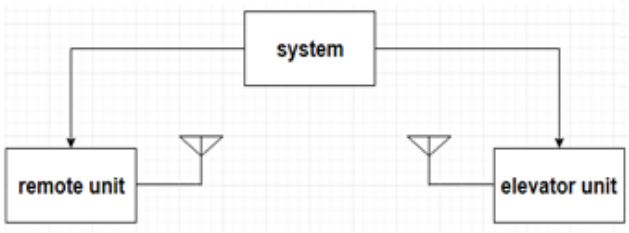

Fig.(1): Proposed System Methodology.

The proposed system consists of two main parts as shown in Fig.(1). The first part is a remote unit which will be with the blind user. The remote system ,as shown in Fig.(2), includes a microcontroller(Atmega328) to control and execute the voice orders of the speech recognition module (Speak2click) and send it to the

transceiver (CC2530) and the text to speech module (EMIC2) to make voice confirmations. The second part is the elevator unit in which includes, as shown in Fig.(3), a transceiver (CC2530) to receive the orders and deliver it to the second microcontroller (Atmega324) to control the elevator movement. The three ultrasonic sensors (HC-SR04) are used in each floor to guide the blind to be in front of the elevator`s door.

III. SYSTEM BLOCK DIAGRAM

The proposed system block diagram, as shown in figures (2) & (3), is divided into two main block diagrams: a remote unit block diagram and an elevator unit block diagram.

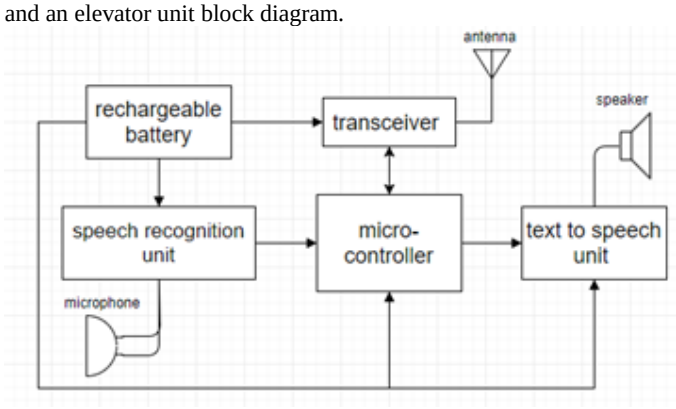

Fig.(2): Remote Unit Block Diagram.

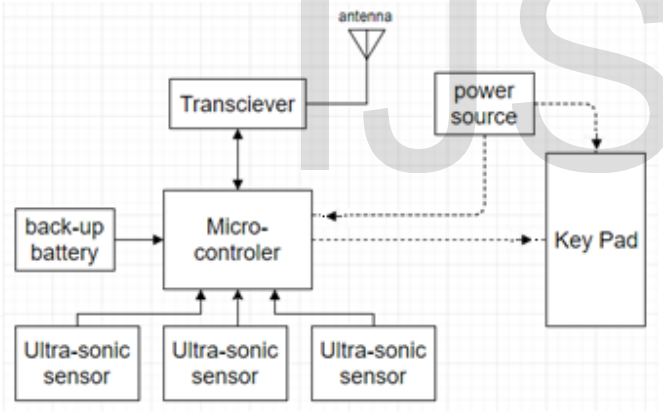

Fig.(3): Elevator Unit Block Diagram.

According to figure (2) the remote block diagram consists of Speech recognition module that provides interfacing between user and elevator by taking orders from user and recognizes them and translates these words to format that the microcontroller can understand to execute them. Microcontroller Takes the orders from the speech recognition module and sends it to the transceiver to control the elevator and receive data from transceiver and send it to the text-to speech for confirmation. Transceiver module It works both transmitter and receiver and it transmits data wirelessly to the transceiver in the elevator to take action and receive the response of the elevator and send it to the microcontroller. Text to speech module It is used for voice confirmation to the user by taking the elevator response into spoken words, it mainly takes the text from the microcontroller and narrates it in audible words. Rechargeable battery it is a source of energy and provides the circuit with voltage and it can be charged. According to figure (3) the elevator block diagram consists of Transceiver It transmits and receives data wirelessly from the other transceiver in the remote control and send it to the microcontroller in the elevator to control the elevator and when the elevator response it sends the response to the other transceiver in the remote. Microcontroller that Takes data from the transceiver to control the elevator movement. Ultra-sonic sensors by using the sound echo to handle the alignment system and to guides the blind to enter the elevator, by sending the readings from the sensors to the text to speech unit. Back-up battery it is used also to provide the system with power when the power supply power cut off to keep the elevator online. Power source it is source of energy and provides the elevator with power.

IV. SYSTEM FLOWCHART

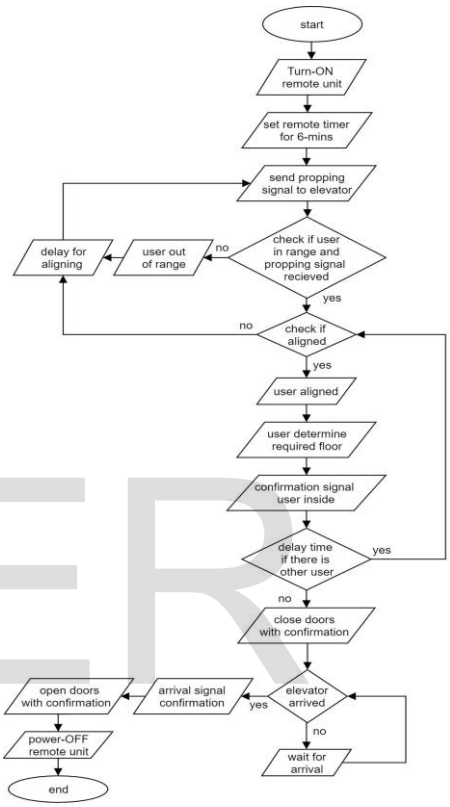

Fig.(4): Proposed system flowchart.

Flowchart description:

The blind user has the remote unit and standing in front of the elevator. As a start the remote will be turned on for duration of 6 minutes and will send a propping signal to the transceiver in the elevator to see if the elevator is available or not, if the signal was not received then the text to speech module will voice output user is not aligned and will retries to send the propping signal again for certain amount of times if retries times out then a delay of 5 sec will be made before returning to the sending propping signal block, if the retries didn't time out then the text to speech module will output "the elevator isn't available" and turn-off the remote and end it. If the propping signal was received, then the elevator will send a status signal to the transceiver and the text to speech module will output "the elevator on the way".

Next step is when the elevator arrives to the floor in which was called and the door has opened, the user normally will enter the elevator. The system will then wait for the user interrupts if the user interrupts means he choose the floor or the level he wants of course by his voice, then the door of the elevator will close and the elevator will go to the registered floor and when the elevator arrives the text to speech module will output "the elevator isarrived to the destination" and "the door will open", then the remote will turn off and end. Ifthe

user didn't make an interrupt, the remote will turn off by the auto power off circuit and end.

V. SYSTEM COMPONENTS

- Atmega 324P (micro-controller) [5]
- Atmega 328 (micro-controller) [5]
- Speakup2 Click (speech recognition module) [6]
- Emic 2 (text to speech module) [7]
- CC-2530 (RF transceiver) [8]
- HC-SR04 (ultrasonic sensor) [9]
- Nema 17 (stepper motor)
- Rechargeable battery
- Loudspeaker

VI. RESULTS AND DISCUSSION

By using the voice recognition module, which is the speakup2 click, we have been able to eliminate the use of the keypad. Since the voice recognition module transform the spoken words into orders that the microcontroller could comprehend. As for an example if the blind user said "three" the voice recognition module will transform that spoken word into "3" which is a trigger in the code of the proposed system, then the microcontroller will send the word "3" through the RF transceivers, which are two CC-2530, to the other microcontroller in the elevator unit which will send a signal to the stepper motor to 3x10,000 micro step, since each floor or level in the proposed system prototype is 10,000 micro step.

The text to speech module, which is EMIC2, gives the proposed system an advantage over the current systems in making vocal confirmations to inform and guide the blind in using the elevator. The detailed move of the elevator will be heard by the blind through the text to speech module such as: "elevator arrived", "elevator is on the way", "elevator passed floor number 2", "door is closing" and etc.

Another upper hand for the proposed system is the alignment system which constructed from three ultrasonic sensors. The alignment system will guide the user to enter the elevator and to make sure he enter safely without harming himself.

The three ultrasonic sensors are fixed in each floor in positions (left-center-right) with critical angles to make sure they don't interfere with each other.When the left sensor detects the blind user, the text to speech module will inform the user to move right. If the right sensor detects the user, the text to speech module will inform the user to move left. If the center sensor detects the user, the text to speech module will inform the user to move forward.When the three sensors aren't detecting any other blind user, the door of the elevator will close after a small amount of time and a voice message"door is closed" will be confirmed. Table (1) shows a comparison between the current systems and the proposed system.

Table (1): Comparison table between current systems and the proposed system.

systems / Parameters	An Attentive Elevator using Speech Recognition (2017)	Voice operated intelligent Lift/Elevator (2013)	Smart Lift - Voice Controlled Elevator (2015)	Voice Initialized Elevator (2016)	Proposed system (2018)
Blind-enabled	No	No	Yes	Yes	Yes
Speech recognition Efficiency	High	Medium	Low	High	High
Voice confirmation for the blind	No	No	Yes	No	Yes
Display	Yes	Yes	Yes	Yes	Yes
Power consumption	Medium	Low	Medium	Low	Low
keypad	No	No	Yes	No	Yes
System complexity	Simple	Complex	medium	Medium	simple
Cost	120 $	80 $	190 $	172.5 $	153.53 $

VII. SYSTEM PROTOTYPE

The proposed system PCB and prototype are shown in figures (5) to (8). Figure (5) shows the remote unit PCB. Figure (6) shows the elevator unit PCB. Figure (7) shows the remote unit prototype. Figure (8) shows the elevator prototype structure which consists of three floors, elevator cabin, elevator unit PCB, and three ultrasonic sensors in the ground floor which should be repeated in each floor.

Fig.(5): Remote unit PCB.

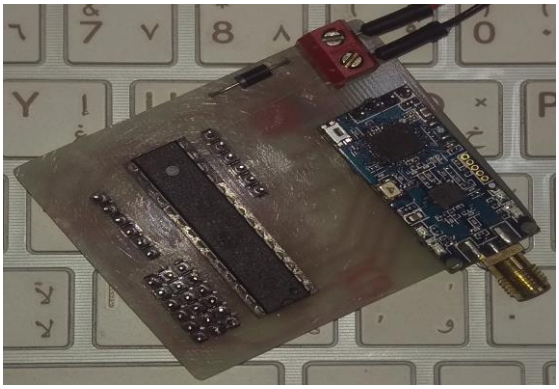

Fig.(6): Elevator unit PCB.

Fig.(7): remote unit prototype

Fig. (8): Elevator prototype.

VIII. CONCLUSION

Blind and visually impaired people encounter serious problems in leading an independent life due to their reduced perception of the environment.One of these problems is the use of elevators in multi-floor buildings. Blind and visually impaired people couldn't see and read the elevator keypad or know which floor they are on? Braille markings have helped blind people to use elevators, but not everyone with vision loss knows how to read braille. A few small adjustments can make elevators easier to use for blind and visually impaired people. Many developments of the accessible elevator interfaces are currently witnessing.Most of the current elevators targeted the handicapped and visually impaired people. The elevators targeted the blind people didn't have voice conformation to inform the blind the elevator status.

With the help of ourproposed system, the blind people can use the elevator easily and prevent any awkward situation in front of the normal people. The proposed system has two main units:a remote unit with the blind and an elevator unit to control the movement of the elevator cabin. The remote unit contains voice recognition moduleto eliminate the use of keypad and text to speech moduleto make voice confirmations for the blind.Also, three ultrasonic sensors mounted in front of the elevator location at each floor for guiding the blind to be in front of the elevator door. The proposed system is accurate,friendly using, and save money.

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