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GSM COMMUNICATION AND CONTROL OF THE ROBOTIC ASSISTANT FOR THE ELDERLY

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Abstract: Designing a communication unit for an assistant robot designed for the elderly and ambulatory patients in need of assistance. The communication unit uses the GSM / GPRS network. This module will later be able to control the robot. The communication unit works with two ATmega328 processors that are interconnected and also with the main control microprocessor that provides control of the motors. The main task of the communication module can send warning messages in case of an accident or SOS signal when you press the emergence button. The next task is to process and learn about environmental safety of the patient through some sensors such as flammable gas sensor, recording the barriers warning of dangerous inclination. The last task is to create a communication tunnel between the patient, the senior and the family, or the operator who takes care of the patient by remote access. This communication is solved as well as through a mobile phone, but the robot calls only from phone numbers that are pre-programmed. This communication module will be some warning messages and automatically notified. After creating a database of sounds communication module can convert text messages to audio interpretation.
Keywords: GSM, DTMF control, microcomputer, CO sensor

INTRODUCTION

The robotic assistant is primarily intended for carers who care for patients who can´t walk or have a degree of dementia or disability that can´t work without the support and caregiver. Such patients do not require other robot features such as stability in the state or fixation of the patient during treatment. They have close contact with the caretaker who cares about them.

However, the robot is also intended for patients who do not need the caregiver and use it as a support for walking, rehabilitation, or robot serving in the elderly's home for help such as lifting things out of the country, providing a senior environment, or communicating with the patient / senior his family, or an operator who cares about a patient from a remote workplace. For these purposes, the robot has a communication module that is only one of several robot parts. This module is based on a GSM / GPRS microprocessor called sim800. Through it, it can connect to a standard GSM network as well as a mobile phone. It can receive calls, SMS messages, and it can also be connected to the Internet. The prototype of the assistant robot used the sim800 microprocessor built on a development module designed for prototype Arduino boards. This prototype, however, is not intended for serial production and serves only to debug the electronic, program and hardware parts. The prototype electronics are unnecessarily large, and a new integrated electronic unit is designed to be more compact and reliable.

The communication module consists of two ATmega328 and ATmega2560 microprocessors interconnected via a serial line. One ATmega328 microprocessor communicates via a serial line with a GSM module, which we can call the microprocessor as a GSM controller. The second ATmega2560 microprocessor is designed to play sounds, but also performs the function of processing various analogue and digital inputs.

It also connects a communication module with a master microprocessor. Below in the picture Figure 1 is a schematic diagram of a connection where a method of communication between microprocessors and connected peripheral devices is shown.

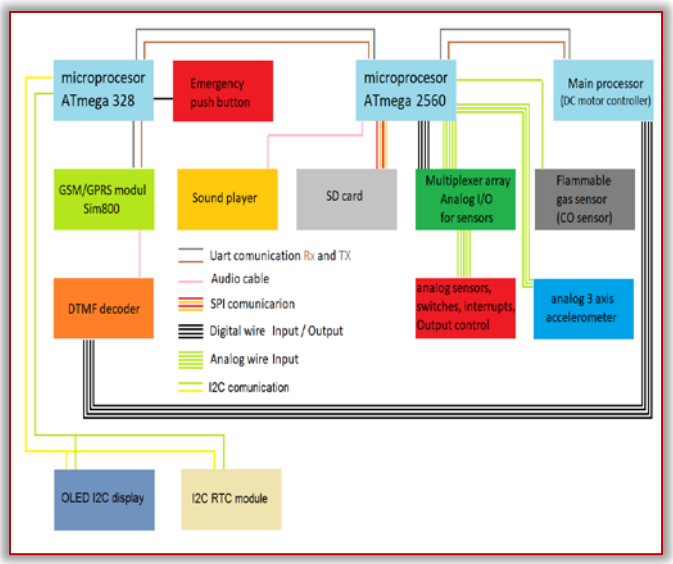

Figure 1. Block diagram of the communication module

In addition to the two microprocessors and the GSM processor, the sim800 also includes an RTC - Real Time Clock, an OLED display, an SD card slot, and five sixteen channel I / O switching multiplexers. The communication module also includes a 3-axis accelerometer and carbon monoxide sensor. Both the accelerometer and the gas sensor have an analogue output and are connected directly to the processor without switching the multiplexer.

I briefly want to mention the principle of communicating with the GSM module and the processor through AT commands. With the help of specific commands such as "AT + CMGF = 1 \ r" and "AT + CMGS = TELEPHON NUMBER", for example, an SMS message will be created. After entering this command, the GSM module does not wait for the AT command but all the received text from the microprocessor is inserted into the SMS message. Waiting for the

unanswered characters char 26 (ctrl + z) this symbol will terminate the writing action and then send the SMS.

The GSM module and the processor communicate over the serial UART line and use the RXD and TXD pins to connect them to the cross. Through these pins, the two microprocessors communicate with each other. Communication is bi-directional.

The GSM module sends the microprocessor the response. For example, on the basic AT command "AT", the GSM module responds with "OK" this command does not set anything. It serves to verify communication between processors. If the answer is not so there is a problem in communication. However, there may be several problems. Most often this may be a bad connection of the RXD and TXD pins but the wrong bit rate may be set, the module may be turned off or a microprocessor sending error (program error)

FUNCTION AND DETERMINATION OF THE COMMUNICATION MODULE

— The main role of the communication module

Thanks to the GSM module, a robot can communicate with the patient's family or a doctor and the family or physician can communicate with the patient. Of course, the best possible solution is to be with such a patient in person, but if it is for no reason, for example, the family members live and work abroad or are so busy that they can´t spend most of the floor with the patient. This is a convenient alternative. In addition to creating connections with other people, this module can receive and send SMS messages. A special feature is the ability to convert text to sound. However, the text-to-audio conversion is strictly defined and it is not possible to generate but play only the sound.

The recorded sounds are saved in the ".WMV" format and stored on the SD card. This text-to-audio conversion does not require any access to the external server or generates words "robotic" as some chips allow. However, this device is dependent on your own recorded sound database. However, this text-to-audio transfer has the advantage of being able to play special words that would not be able to play the different existing ones because they are not familiar with those words.

This option is suitable for older patients who can become accustomed to some words that can´t be read by conventional audio players. These words can be uploaded by the patient's own family. It is also possible to record recordings, for example, to recall medicines that will be more extensive, for example, "grandmother do not forget to give evening medication" and this soundtrack will be evoked by the text "EveningMedicine". This text can be generated by the robot itself as a result of a time alert set to remind drugs or through SMS messages sent by family members.

The robot is thus able to play messages sent by people, system recordings indicating dangers, reminders or later releases of this project, as well as social interactions and narratives such as "Hello good morning" or "Your lunch is ready, I wish good taste".

Another advantage of playing this text can be when the family uses the app to record their own sounds in their own language and their voice that may be more enjoyable to the patient or senior than the voice of a stranger or a "robotic" generated voice.

On the other hand, it may be more time-consuming to create your own word database. But the robot can be delivered with a certain database of words, and the family can supplement this database and possibly replace some words.

Of course, somebody in the family can send a SMS message to their buddy or somebody who helps them, and some of the SMS messages will not be able to play audio because they will not be recorded in the database. In this case, this communication module will generate a TXT file on the SD card and write the words used in the SMS message but can´t be played, the communication module can be programmed so that if the case occurs, it sends the SMS message by returning the sent number "These words could not be played".

Then, according to this list, someone in the family can upload the necessary recordings / missing recordings via the app. The text-to-audio conversion is based on the fact that the received message or the generated text by the robot is broken down into the individual words that must be separated in the text by the space bar. These words are then stored in a spreadsheet, and then the processor searches for and plays back the recordings.

Figure 2 is a listing of the microprocessor to the computer (this listing is only for demonstration and work on the development in the real application, the listing will not be, would be unnecessary). For SMS messages sent from a mobile to a robot communication module, it is necessary for the messages to begin and end with "#". This character better determines the beginning and end of the accepted string of characters.

Because the GSM module also sends the phone number from which the SMS message was sent, as well as the date and time, in addition to the SMS text message. However, if SMS messages do not start with "#", it can mean instruction for the microprocessor program, such as sending the battery status, or if everything with the patient is fine.

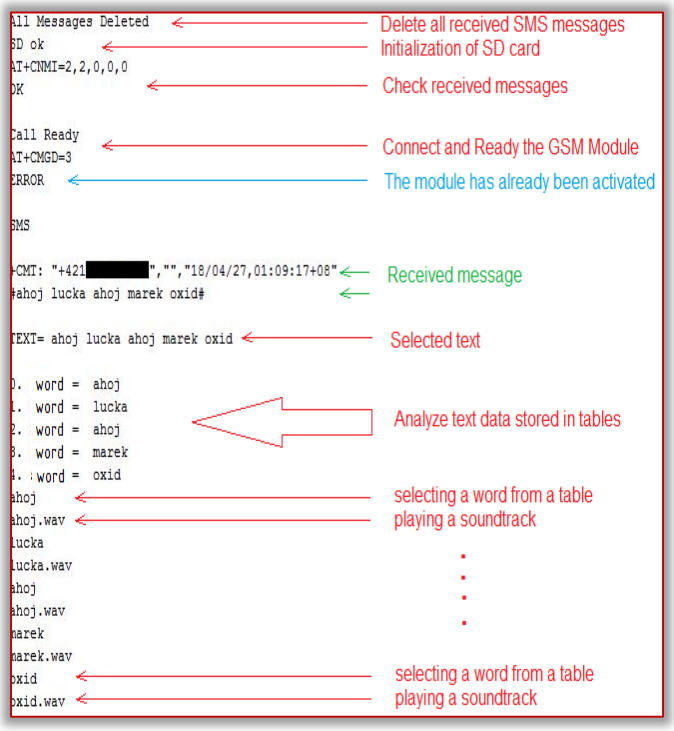

Figure 2. Module initialization, SMS reception, text analysis and wordplay

— Patient protection and warning messages

The second important role of this robot is to ensure safety for the patient or senior. Although a robot is not fully capable of protecting a patient from various dangers, he can at least provide him with protection in certain cases. Currently, this communication module only has a carbon monoxide sensor, which also detects the presence of flammable gases such as natural gas, BUTANE.

So, in addition to poisonous carbon monoxide, the module can also detect the presence of flammable gases. However, it is difficult to identify the difference between flammable gases and carbon monoxide. It is mainly because the combustible gases contain a large percentage of carbon monoxide. The need to distinguish whether space is filled with flammable gas or poisonous carbon monoxide is not necessary. The essential thing is the ability to record dangers. This MQ-9 gas sensor module is equipped with analogue output as well as digital. The digital output is set by the potentiometer directly on the sensor. Of course, analogue input is better to determine the concentration. However, the digital output may indicate a sharp change in the concentration and activate the external interrupt whose function will be to instantly send the SMS message.

The robot can then switch to safe mode and assume that there is a flammable or explosive gas in the room. Under this assumption, all components that could scrape off (electric motors) can be shut off to cause an explosion or fire. In operation, however, there may still be different sensors and sensors and, of course, a communication module. He or she can send the message immediately to the family members or directly to the fire brigade or other security component. If the household is transformed to partially intelligent and there are ventilation fans in the room, of course the engine should be built-in somewhere out of space or free of scratches, so the robot can activate it remotely and thus partially or completely ventilate the rooms to save the elderly or the patient. This situation can occur mainly in seniors who suffer from a high stage of sclerosis and may forget to ignite a stove or an open gas cook without burning and thus escaping natural gas.

The position safety feature currently available for this communication module is a 3-axis accelerometer. It has separate analogue inputs that do not go through the multiplexers, so the processor can measure the rotation speeds relatively quickly. In addition to the impacts, the accelerometer can also record rotation and the ground due to gravity acceleration. In case the robot and the patient are just flown to the ground even if it is not to be done because the robot is dimensioned for it, the processor can record this status and send a warning message.

All of these sensors affect the safety of the patient. However, in the later stages, a large number of other sensors will be added. One of these may be a thermal sensor or a small thermo-camera that could identify a fire and call firefighters. Alternatively, if the robot was equipped with a built-in powder or fire extinguisher, he could fire himself.

The robot may also have sensors of a different type such as a blood pressure sensor, a pulse or infrared thermometer, and through these sensors, the physician can see health data from the patient. Of course, it is always better when a doctor looks directly at the patient, but sometimes it can be time consuming or affordable, and then such a remote examination would have to be enough.

The last security element is the emergency button that the patient can call for help, after pressing the SOS alert message sends to the pre-programmed telephone numbers.

— Robot control with a DTMF decoder

Thanks to the GSM module, the robot is also able to connect to the Internet, specifically to a server. Using a page or mobile app, such a robot could also be remotely controlled. A small camera on the robot or camera system in the apartment is possible and it is possible to manipulate the robot and go home, measure the pulse, blood pressure, and so on.

However, the Internet connection has one disadvantage that should first be overcome, the disadvantage is that such a robot could begin to control the overwhelmed security element by another unauthorized person. This could lead to a patient or a senior being endangered and lead to health hazards, or could open the front door and rob the apartment. There is, however, one alternative to remote control of the robot that would be safer. This option is tonal control. Once a call has been made between the operator and the robot, the operator can control the robot by using keypad tones on mobile or applications to generate these tones. These tones are converted into logical outputs by the demodulator in the robot. These tones are 16 together and can be written with 4 logical outputs. These outputs then go to the main processor, and by using a combination of tones or individual tones, the robot can remotely control the operator.

Taking control over this way of control can be far more challenging and therefore safer. A telephone number is required to make a call, and it is pre-programmed in the communication module; in the case of a call from another number, the module will be considered as unauthorized access and terminates the call and sends the SMS message to the phone number to which it sends the alert messages. In order to further protect this method, the robot can wait for a password or PIN code to be entered by voice dialling after a call.

CONCLUSION

The robot communication module for care and assistance with walking or self-employed patients / seniors is a prototype in development that will be further expanded and improved. Emphasis will be placed on enhancing text-to-speech to make this system as user-friendly. In the final version, this communication module can be used as a separate programmable unit for other robots as well.

The next level of development will be the integration of the GPS system and the extension of the position sensor (accelerometer) to the gyroscope and magneto meter for accurate positioning in exterior and interior.

When used outdoors, in conjunction with ROBOTIC ASSISTANT FOR THE ELDERLY, it can send the patient's position while walking or if the patient is lost. Multiple sensors are planned to be inserted into the base assembly to monitor the surrounding area without the need for shooting.

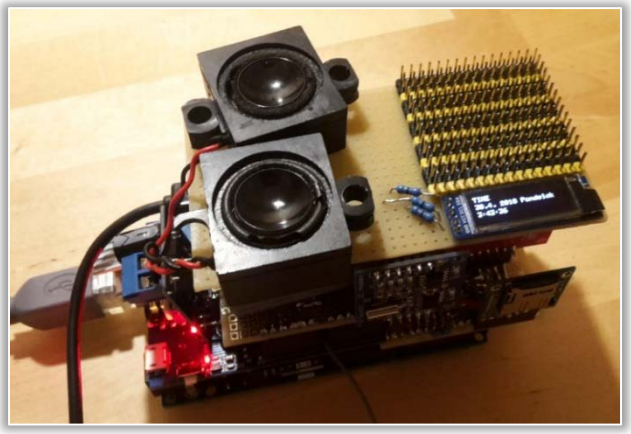

Figure 3. The prototype of the communication GSM module

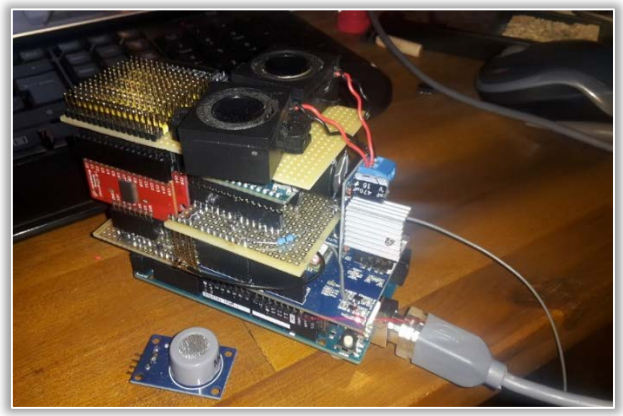

Figure 4. The prototype of the communication GSM module and gas sensor MQ-9

One option is to improve the CO2 sensor in conjunction with organic part detection, barometer, thermometer and hygrometer. Also, a casing is developed in which it will be completely stowed and will have attachment points to allow this communication module to be connected to any device. Figure 3 and Figure 4 shows the prototype of the communication GSM module.

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Note:

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References

[1] Gašparík M, Černý M, In Applied Mechanics and Materials, Design and production of a unit that enables the user to control a vehicle through the use of a smartphone. Vol. 816, (2015)

[2] Gašparík M, Šolek P: The 6th International Conference on Modelling of Mechanical and Mechatronic Systems MMaMS 2014 25-27 November, Design the robot as security system in the home. Vol. 96, (2014)

[3] Matthew S, Haoyong Y, Steven D: IEEE Transactions on Neural Systems and Rehabilitation Engineering, Robotic Personal Aids for Mobility and Monitor-ing for the Elderly. Vol. 14, (2006)

[4] Rongrong Zhang, Xiaoping Zou, Wenhui Huang, Qimu-Surong, Communications and Network, A Smart Home System Design Based on GSM. (2013)

[5] Anirban Sarkar, Sadia Sultana & Md. Habibur Rahman, Global Journal of Researches in Engineering: F Electrical and Electronics Engineering, A Smart Control System of Home Appliances Using SMS. Vol. 17, (2017)

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