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Emergency Caller- An On-bed Patient Health Care in Hospitals

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***Abstract*—** An important phase in the care and improvement of a patient's health is performed by a caretaker. Thus the proposed work provides the prototype of an algorithm named Emergency Caller comprising of both hardware and software components both at patient and nurse ends. Here is a system implementing a clinical scenario where this electronic system will reduce the possibility of nurse ignorance and improve safety of the patient. The work is an early attempt to introduce effective care in clinical scenarios. Nurses are the main caring faculty in hospitals. This care is very important for the patient who cannot walk or stand for long time and mostly for the critical condition patient who can't wait for a second. Care takers at hospitals are unable to take care of each and every patient simultaneously. To address this problem, given approach is used for patients. The patient will be provided with a remote having keys on it corresponding to particular tasks. This remote designed using AVR micro-controller and RF Module will transmit the instructions wirelessly to the PC of the ward incharge. The PC is connected with RF Receiver. Received information is streamed into a computer using software developed in MATLAB and the instructions get announced to the ward in charge automatically. The foremost objective of this project is to develop a system which reduces the cost of health care and ease the burden on the nurses thus providing better supervision of the patients as their call cannot be ignored thereafter. The prototype finds many applications in hospitals, nursing homes, rehabilitation centers and other health departments.

***Keywords*—**RF Module;MATLAB GUI;Speech Processing using MATLAB;AVR micro-controller

I. INTRODUCTION

There is an urgent need to provide more efficient and effective patient care. Many works have been done to monitor the health of a patient outside the hospitals [17] or nursing homes but very less works have been done to monitor the on-bed needs and requirement of a patient [1]. A number of algorithms have been proposed over the years that help in monitoring the health status of the patient and sending reports to the doctor through GSM technology or web technology. Previous researches have also been done to continuously monitor the heart rate or cardiac rate of a heart patient [2],[13],[11]. Zigbee based system was proposed that monitors Body Temperature and Heart Beat of patients [3],[12]. A coma patient can be monitored regularly and if there exist any physical change in body of the coma patient then it will alarm the signal and send an SMS through a CDMA mobile to the doctor at another place, so that the emergency state can be inhibited [4],[14],[16]. However this proposed approach is based on three popular technologies namely AVR micro-controller, RF and MATLAB technology. Embedded System is becoming an integral part of the engineering design process providing a good platform for efficient analysis and effective operation because of its reliability and time bound operation. The AVR micro-controller is a little command center awaiting your orders. Due to its versatility you can make your work done with a few lines of code [5]. RF is used for transmitting and receiving signals wirelessly as they can travel through larger distances making it suitable for long range applications. These signals can travel even when there is an obstruction between transmitter & receiver [6]. RF transmission is much more strong and reliable. Similarly MATLAB provides modeling, simulation, and prototyping of an application using Graphical User Interface (GUI) and many similar toolboxes. One of them is Signal processing Toolbox. We are surrounded by all kinds of signals in various forms. Many signals are natural, but most of the signals are man-made. Some signals are necessary (speech), some are pleasant (music), while many are unwanted (noise). Signals are carriers of information. Therefore extracting or enhancing the useful information from a mix of conflicting information is a simplest form of signal processing. More generally, signal processing is an operation designed for extracting, storing, enhancing and transmitting useful information [7]. This paper presents a low resource prototype which can accurately assist the nurses to provide proper care to the patient. The prototype includes a special feature of Medicine Alarm which will remind the nurse that '*Its time for medicine*'. This feature will help eliminate the work load on the nurses.

II. ARCHITECTURE

Architecture defines the structure, representation and description of the system. It illustrates the way in which the system is designed to implement a particular idea. This

prototype should be implemented as per the allocation shown in figure 1 for best results.

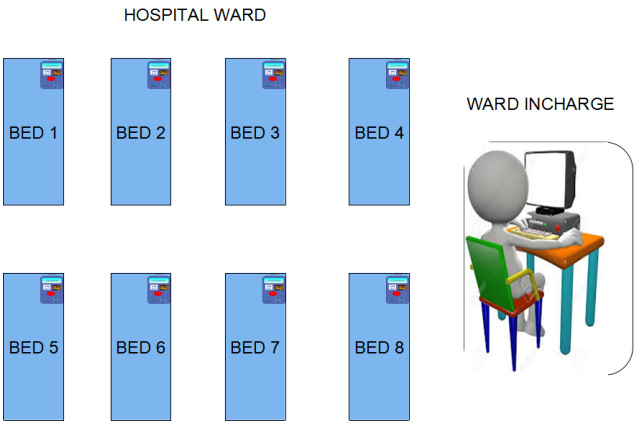

Figure1. Patient Allocation in ward

A. Block diagram

The Block Diagram represents the graphical representation of the prototype. The prototype of the remote to be provided to the patient designed using AVR micro-controller and RF Module. The sequence of transmission of instructions when received by the RF Receiver is represented in Figure 3.

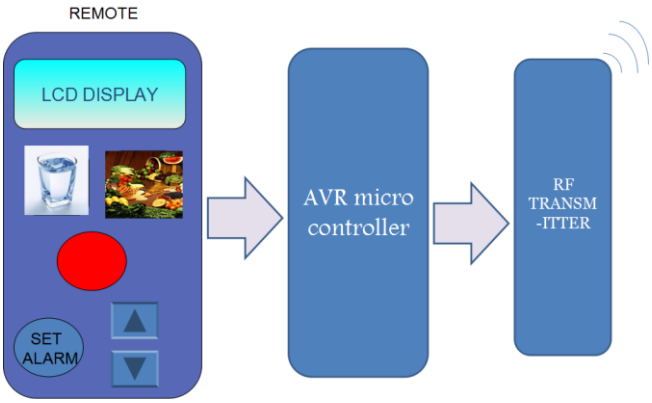

Figure2. Block Diagram representing the Transmission of signal in a patient's remote

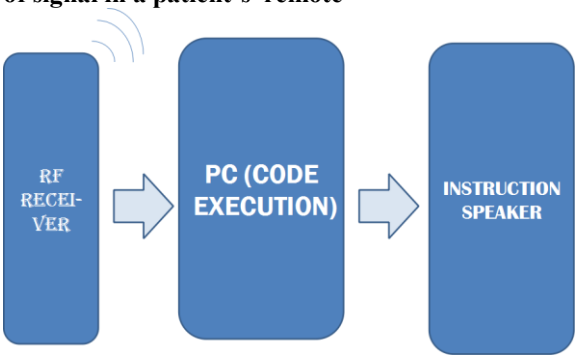

Figure3. Block Diagram representing the Reception of the signal at PC

III. HARDWARE DESIGN

The Hardware Design describes the different hardware components used in the designing of the prototype i.e. RF modules and AVR micro-controller .

3.1 REMOTE

The remote is provided with four keys as per the patient's need. First key is assigned the situation in which the patient needs water. Another key calls for food. An emergency button is allotted the case when there is a call for the nurse to checkup. An additional option of setting of alarm for next medicine time is introduced. The remote is designed using AVR controller and RF transmitter.

Figure4. Remote Prototype

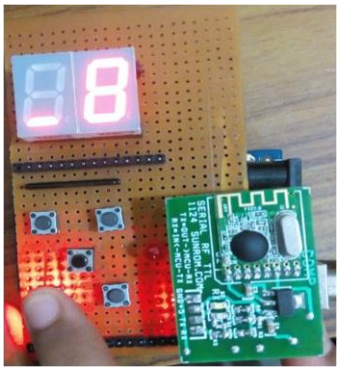

Figure5. Remote Hardware

3.1.1 AVR micro-controller

Embedded Systems is a widely used technology[15].The most popular of the micro controllers used today is AVR as its software is open source and is fast. These execute most of the instructions in single execution cycle. AVRs are about 4 times faster than PICs. They consume less power. The AVR controller is low cost, flexible and suitable for a wide variety of applications. Here the micro controller used is Atmel's ATmega- 328P. The Atmega 328P is a 8-bit AVR with maximum operating frequency of 20 MHz with a ISP flash memory of 32 Kilobytes. It has an SRAM of 2KB and 1 KB

EEPROM [8]. The first step in burning the code into AVR is boot-loading. The hex code is boot-loaded into the AVR micro-controller. Then the code for the prototype written in Arduino environment is burnt into AVR for execution. Thus the AVR acts as a memory for the remote. The Buttons are connected with the digital pins of AVR using a pull-up resistor. When the button is pressed the corresponding signal is sent to the RF for transmission. The RF Transmitter is connected to the RX-TX pin of the AVR controller to transmit the signal wirelessly.

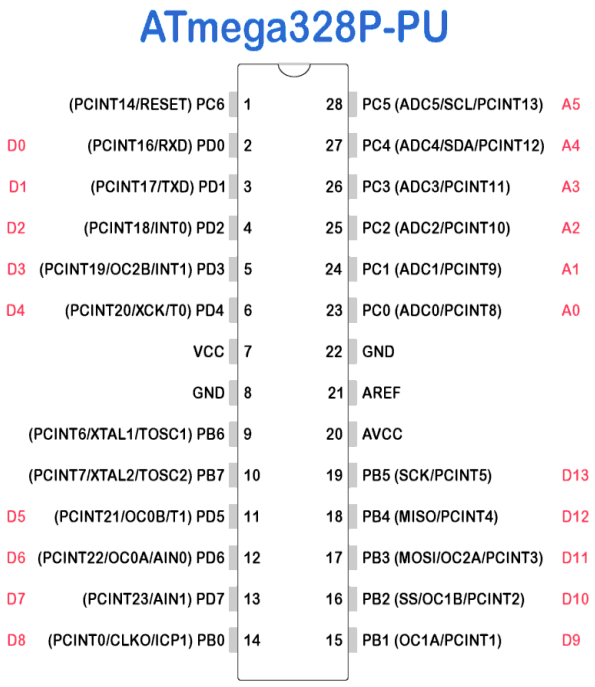

Figure6. ATmega 328P Pin Diagram

3.1.2 RF MODULE

The RF (Radio Frequency) is responsible for transmitting and receiving instructions wirelessly. This module covers electromagnetic fields and waves in two-dimensional and three-dimensional spaces along with traditional circuit-based modeling of passive and active devices [9]. RF Communication works on the principle of Serial Communication. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The RF Transmitter connected to the RX-TX of the AVR micro-controller transmits the signal wirelessly and the RF Receiver connected to the PC of the ward receives this signal and correspondingly performs the actions as per MATLAB GUI.

Figure7. RF Transmitter

Figure8. RF Receiver

4. SOFTWARE DESIGN

This section describes the designing of the software using MATLAB GUI. This section illustrates how the Ward boy uses Hospital GUI developed in MATLAB to keep a check on the patient's needs.

4.1 Flow Chart

The flowchart in figure 9 diagrammatically represents an algorithm of the work flow. This diagrammatic representation illustrates a solution model to the execution of commands in MATLAB GUI. These help in designing and managing a program.

Figure9. Hospital GUI

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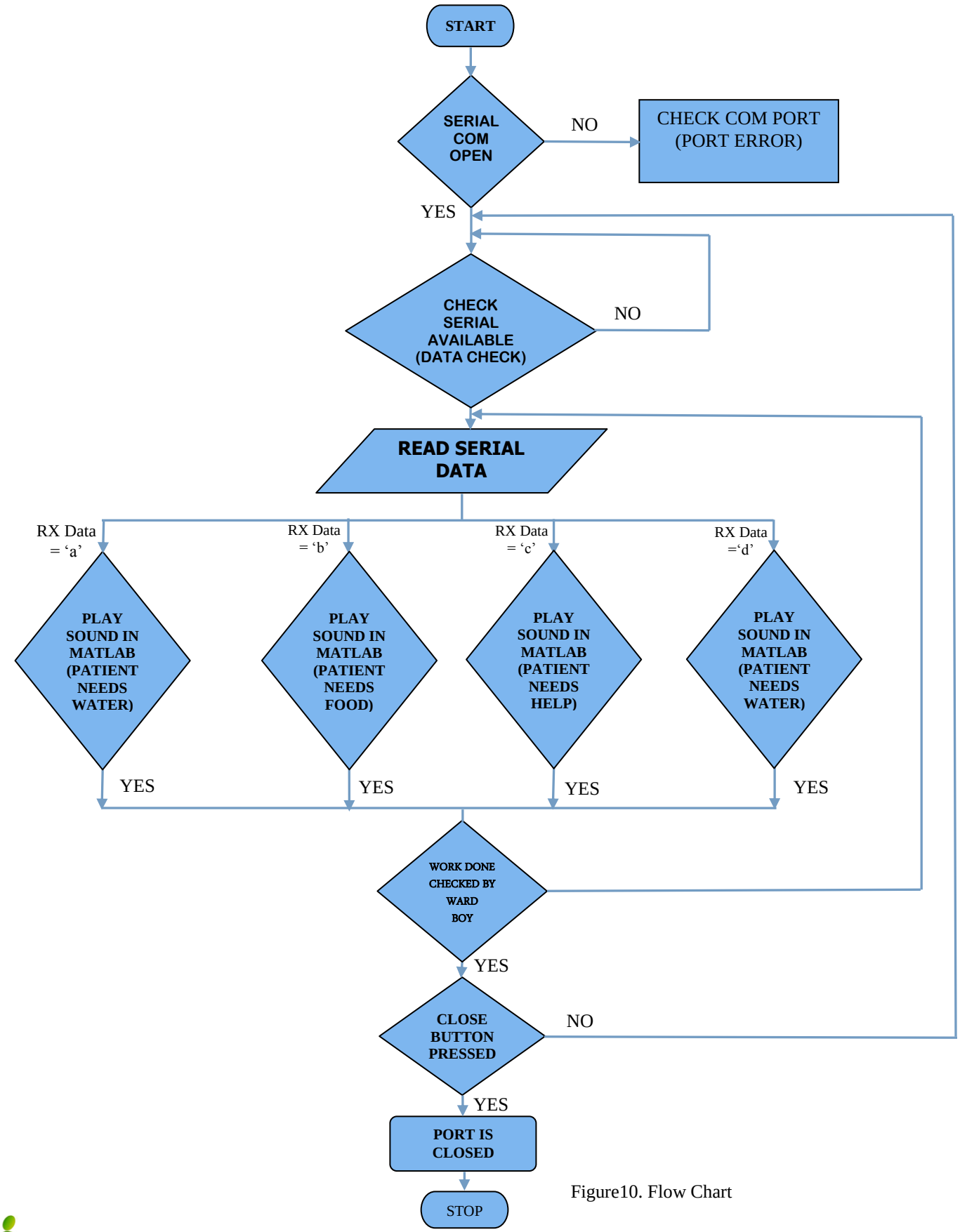

Figure10. Flow Chart

4.2 MATLAB

MATLAB is universally accepted as one of the most powerful data processing platform. Its connectivity with many advanced programming languages (like C, Java, VB) and availability of a wide range of toolboxes make it popular among the scientific and research community. MATLAB is one of several tools for working with mathematics. MATLAB-based GUI application is widely used.

4.2.1 *SPEECH PROCESSING USING* MATLAB

Speech has become the primary form of communication between humans. Speech is a non-stationary energy signal used to convey information. Many signal process MATLAB technical computing language to develop its algorithm. In this prototype MATLAB will follow the instructions of the signal received through RF Receiver and Speak correspondingly. For example, if the emergency button is pressed the MATLAB GUI will speak "The patient needs help....." until the ward boy presses work done on the MATLAB GUI.

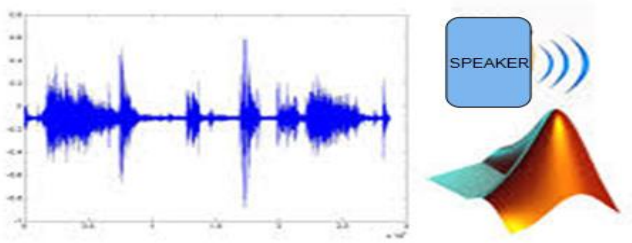

Figure11. Instruction Speaker

5. RESULTS

The above prototype will result in the following sequence of command execution.

a) The Hospital GUI opened in the PC needs to be activated beforehand for the execution of the system.

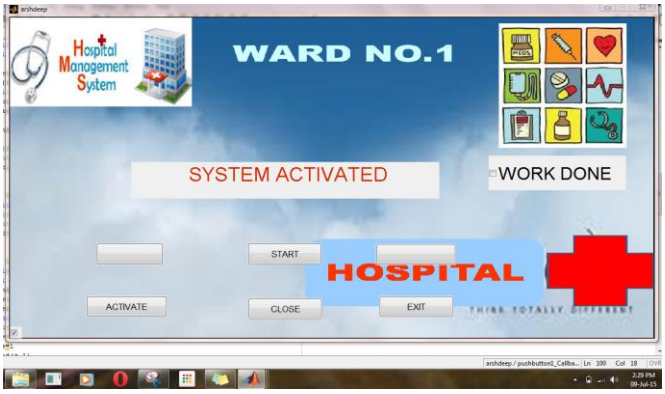

Figure12. MATLAB GUI showing system activated on pressing activate button

b) After activating the system the start button has to be pressed so that the processing of the received signal can be done.

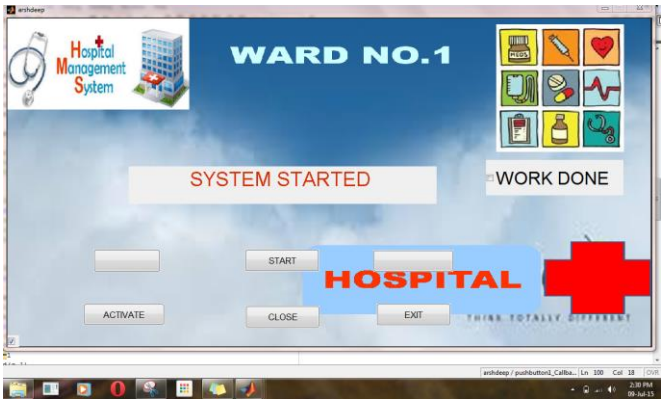

Figure13. MATLAB GUI showing system started on pressing start button

c) Whenever a button will be pressed on the remote, the corresponding signal will be transmitted by RF Transmitter.

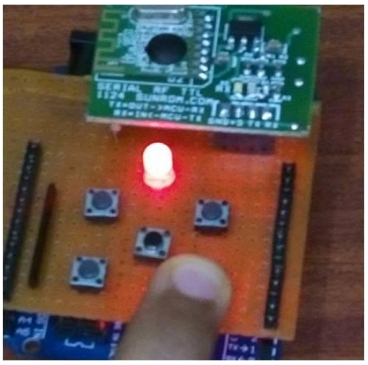

Figure14.Button pressed on remote

d) The transmitted signal will be received by the RF receiver attached to the PC of the ward.

Figure15. RF receiver attached to PC receiving the signal from RF Transmitter

e) After the reception of signal the MATLAB GUI will display as well as speak the corresponding command as shown.

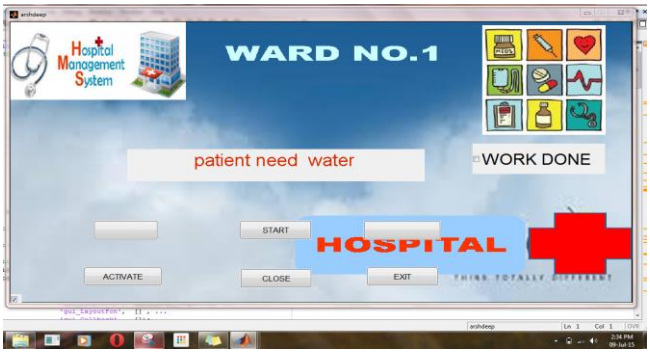

Figure16. MATLAB GUI showing patient need water when the RX data is received from RF Receiver

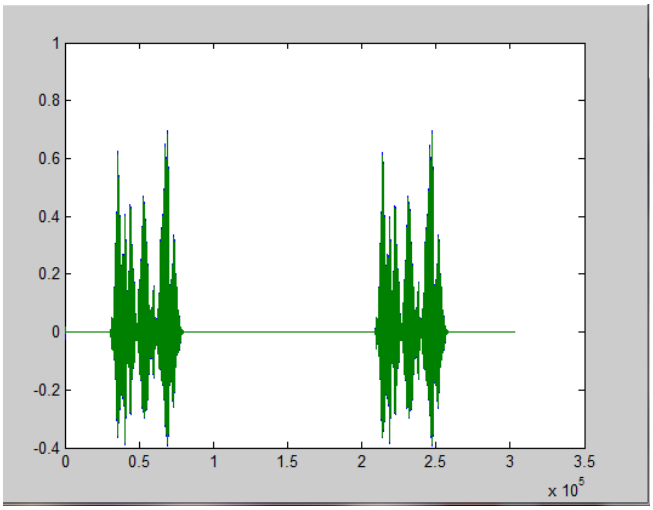

Figure17. MATLAB plot of spoken phrase 'patient needs water' when the RX data is received from RF Receiver.

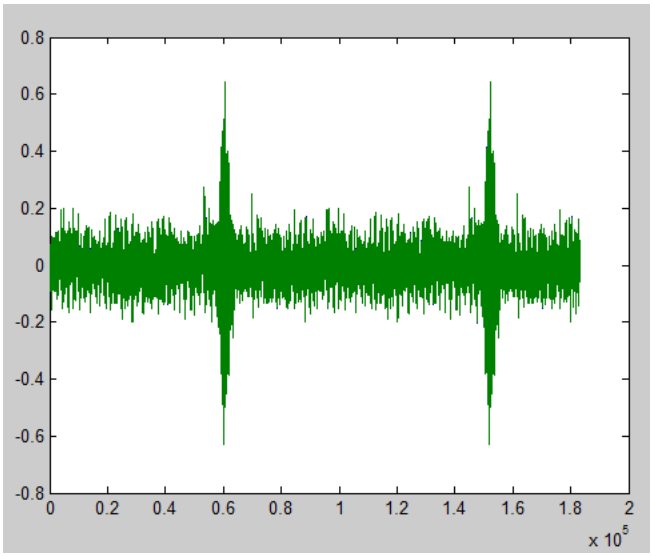

Figure18. MATLAB plot of spoken phrase 'patient needs help'.

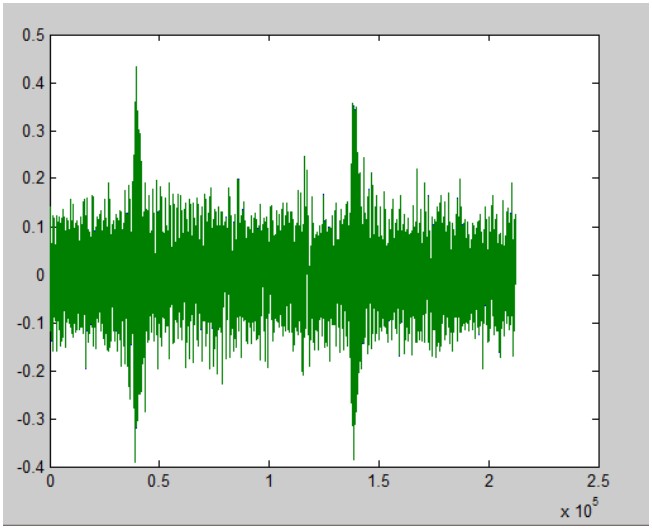

Figure19. MATLAB plot of spoken phrase 'medicine time'.

f) The GUI will keep on speaking until the work done is pressed on MATLAB GUI.

Figure20. MATLAB GUI showing Work done pressed

6. FUTURE SCOPE

As with any other RF device, the performance of an RF module will depend on a number of factors. Often there can be obstacles such as walls, floors, dense construction which can absorb the radio wave signals, so the effective operational distance will be less. The transmitter power can be increased by which a larger communication distance can be achieved. Correspondingly, the receiver sensitivity can also be increased to produce the effective communication range. Increasing the operating life of the device can be increased somehow. Also, the RF may be prone to interference with other RF devices in other wards which can be improved further so that it can be used at a massive scale. The performance of the overall system may be improved by using matched antennas at each end of the communication link. Future work can be done on increasing its speed.

7. CONCLUSION

This technical note is based on monitoring the on-bed needs of the patients which will help ease the burden on the health-care organizations. This is expected to be a remarkable innovation for the quality of care provided to the patients on bed. The low income patient community may be most accessible. The biggest advantage of this system is that it can be used without requiring any prior training. It will cost a little to manufacture and operate. Further improvement in this prototype can be done on its speed and accuracy. New features can be added in this system like routine check-up time once a day for every patient and many more. The services provided by this prototype can range from primary health care to highly specialized care found in leading medical centers.

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