AUTOMATED SMART ASSISTANT FOR A PARALYZED PERSON
(ASAP^2)

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Submitted to the Faculty of Electrical Engineering, Military College of Signals, National University of Sciences and Technology, Rawalpindi in partial fulfilment for the requirement of a B.E Degree in Electrical Telecommunication Engineering

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CERTIFICATE

It is hereby certified that the contents and form of the project entitled "Automated Smart Assistant for a Paralysed Person", submitted by the syndicate of

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has been found satisfactory as per the requirement of the B.E. Degree in Electrical (Telecom) Engineering.

Name (Supervisor): **Asst. Prof. Dr. Mir Yasir Umair**

Signature: _____

Date: _____

ABSTRACT

AUTOMATED SMART ASSISTANT FOR A PARALYZED PERSON

There are many people around the world who suffer from paralysis. Their physical limitations cause them to encounter severe hurdles in accomplishing day to day chores. Our project particularly addresses the problem of communication and focuses on assisting patients having completely paralyzed limbs (legs and arms) but can speak normally.

It is difficult for a paralyzed person to use typical communicating means (mobile phones etc) due to his/her physical restraints in the absence of another person. Relaying messages or calling via a phone is an almost impossible task for such patients. To counter this, a caretaker has to be present at all times for the patient to communicate effectively. Moreover, the patient is entirely dependent on others to fulfil his/her needs like switching appliances around him. Such problems can be addressed by a stand alone, effective & a reliable module that a paralyzed patient can use despite his/her physical restraints.

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DEDICATED TO

Allah Almighty

Faculty/Supervisor for their help & guidance

And last but not the least to our parents for their untiring support and prayers.

ACKNOWLEDGMENTS

We thank our FYP Syndicate Supervisor Asst. Prof Dr Mir Yasir Umair from the depth of our hearts. He has been extremely supportive to us from the very beginning. He has provided his technical expertise & experience on even the most minor problems regarding our project. He has been a great guide to take us through the whole process of FYP comprehensively.

None of this would've been possible without the support & encouragement of our parents. They've supported us in every possible way & we owe our success to their untiring efforts and countless prayers. May Allah bless all of them.

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LIST OF ABBREVIATIONS

ASAP or ASAP^2: Automated Smart Assistant for a Paralyzed Person

WHO: World Health Organization

GSM: Global System for Mobile

SMS: Short Message Service

SCI: Spinal Cord Injury

CHAPTER 1: Introduction

1.1 Overview

ASAP is basically a stand-alone hands-free that addresses the communication needs of a paralyzed person. There are many people around the world who suffer from paralysis. Our project particularly focuses on assisting patients having completely paralyzed limbs (legs and arms) but can speak normally.

1.2 Problem Statement

There has been a great increase in incorporating engineering to medical fields. This has resulted in great advances in health related technology (biomedical). We've addressed one particular problem where a paralyzed person can achieve some level of independence by being able to use communication technology despite the physical restraints.

It is quite difficult for a paralyzed person to use typical communicating means (mobile phones etc) due to his/her physical restraints in the absence of another person. A caretaker has to be present at all times for the patient to communicate effectively. The patient is entirely dependent on others to fulfill his/her needs like switching appliances around him.

Keeping in view the limitations a patient faces, we've implemented a solution in the form of ASAP that has the following primary benefits.

i. We have ensured that ASAP runs entirely on voice commands where at no point use of physical means (switching or dialling of buttons) is required.

ii. Apart from being a hands-free device, ASAP does not rely on internet connectivity for any of its features to work.

iii. The voice recognition module used can work in any language so that it is not a restraint.

1.3 Objectives

The primary objective of this project was to incorporate the use of GSM technology with a voice recognition system. Our purpose was to design a project where efficient communication between a paralyzed patient & any other person can take place just like a normal cell phone or any other gadget. The core objectives are listed as follows:

Objective 1

Assist the patient to communicate effectively in the absence of another person.

Objective 2

Allow the patient to switch and control appliances around him using his voice only.

Objective 3

Enable caretaker to stay updated of the patient's state using sensors and automated text messages based on the sensor readings.

Objective 4

Implementation on hardware kit to develop a stand-alone system

1.4 Approach

Our project uses a voice recognition module to carry out commands from the paralyzed person. A GSM module is interfaced for voice calling and SMS services. A voice recognition module is kept activated around the clock. This module recognizes the commands spoken by the patients and relays the controller to act accordingly. The patient can command ASAP to establish a call or perform other such functions. This enables the patient to communicate effectively despite his/her physical limitations. In case an incoming call isn't received, a pulse sensor will monitor patient's heartbeat to determine if the person is sleeping. Automated SMS will be sent back to inform caller if the person is sleeping. Pulse sensor further monitors the heart beat in case of any abnormal readings where automated text messages are sent to the caretaker notifying him/her.
Patient can also use voice commands for automation purposes. A relay module is interfaced with the controller giving patient an option to control appliances around him using voice commands only. A temperature sensor is also interfaced which gives ASAP automatic control for maintaining the room temperature by automating appliances like fans, air conditioner etc.

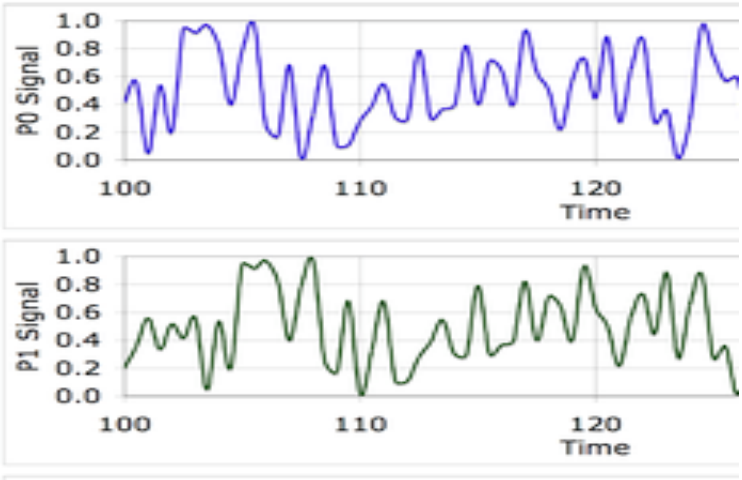
CHAPTER 2: Literature Review

2.1 Existing literature

In 1952, Bell Labs were the first to conduct a research on speech recognition.[2]

a. Nowadays, Speech recognition modules generally work by converting analog voice signals to sampled digital signals. These signals form a database where new signals are correlated under pre-defined thresholds and hence matched for recognition.[1]

Figure 2-01 The figure below shows two signal that can be matched using correlation



2.2 Problem Formulation

The module used for voice recognition in ASAP works on the same principle.

a. Voice recognition has been employed for health purposes in various forms. Though it is most widely used for documentation purposes in this sector. Research is being conducted to employ it on other medical processes as well.[2]
b. Quadriplegia is a form of paralysis where all the limbs of a body lose motor control & sensation. [3] According to researchers, an estimated 12500 SCI happen per year in USA alone, as of 2015. 47% of those injuries result in quadriplegia. As of 2015, there were roughly 250000-330000 people living in USA with SCI. [4]
c. There are many factors that influence heart rates of a person. Factors like a person's activity level, fat level, medication body position etc. Generally when at rest, a person's heart tends to relax as well. The BPM is usually between 60 &100. However while sleeping, BPM fall below 60 and a BPM between 40 to50 is considered normal.
d. There are many applications using speech recognition employed and developed by leading smart phone companies in their mobile sets. Apple iphone uses Siri & android phones use Google for voice recognition. However there are two major drawbacks while using such apps. The first major drawback is while these applications are strong in recognizing speech, there functioning is not entirely hands-free. To activate the app, pressing of buttons or other touch functions are required. This takes the paralyzed person out of the equation. The second drawback is some applications like OK Google though entirely hands-free, require 24/7 internet connectivity to be able to assist a patient. This solution is inapplicable in areas where internet connectivity is not reliable. Thus we needed

to develop ASAP in such a way that it counters both these problems comprehensively in a very reliable manner.

CHAPTER 3: Design and Development

3.1 Project Design

The design of the project is discussed as follow:

3.1.1 Required Modules

- **Voice recognition V3**
- **GSM Module – Huawei GTM 900C**
- **Arduino Mega 2560**
- **Pulse sensor**
- **Temperature sensor DHT11**
- **LCD (40X4)**

3.1.1.1 Voice Recognition V3:

Figure 3-01 V3 Voice Recognition Module

Like a library, voice commands are stored on V3 in a one large group. Recognizer can be filled with any 7 voice commands because only 7 commands are effective at the same time.

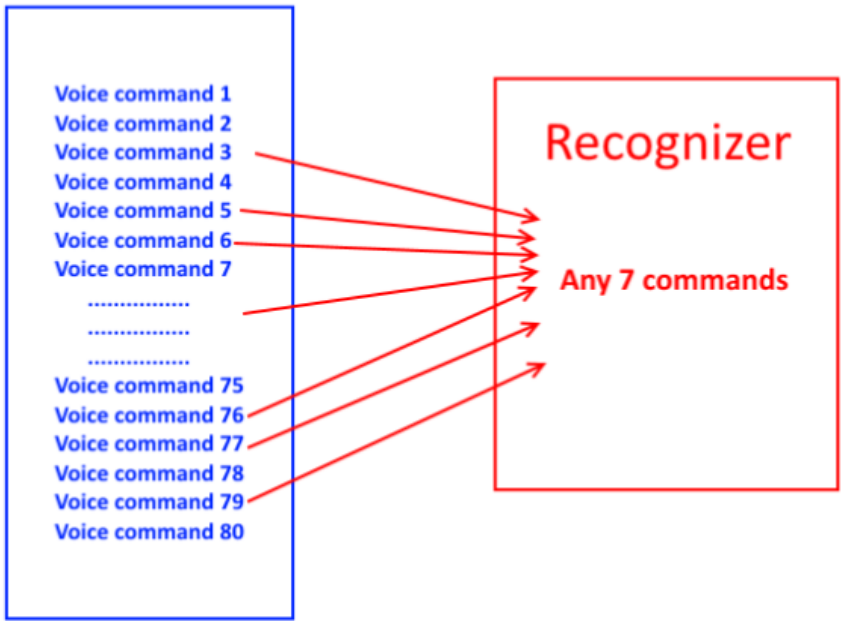


Figure 3-02 Recognizer Format

3.1.1.1.1 Parameters:

- Voltage required lies in between 4.5-5.5V
- Current require is less than 40mA
- Digital Interface use for UART interface is 5V TTL level and GPIO
- Microphone pin interface plus 3.5mm mono-channel microphone connector Size: 31mm x 50mm are used as an Analog Interface
- Under ideal environment, Recognition accuracy is 99%

3.1.1.1.2 Features:

- Support maximum eighty voice (with each voice 1500ms) commands.
- At the same time only seven voice commands are effective.
- Easy Control: GPIO/UART

- General Pin Output is User-control

3.1.1.1.3 How to train:

- To train record 0 with signature "On", send sigtrain 0 On command.
- Speak your command, when the Serial Monitor prints "Speak now".
- Speak your command again, when the Serial Monitor prints "Speak again".
- the Serial Monitor shows "Success", and "record 0" is trained, If the two voices match
- Repeat the process until successful, if the voices is not matched.
- For the voice command, a Signature is a piece of text description. For example, if your 7 voice commands are “11,12,1 3,14,15,16 and 17” you could train in the following way:
  sigtrain 0 eleven, sigtrain 1 twelve, sigtrain 2 thirteen ,sigtrain 3 fourteen ,sigtrain 4 fifteen, sigtrain 5 sixteen ,sigtrain 6 seventeen. When command was called, the signature would be displayed

3.1.1.1.4 How to load:

After training the commands, we load the commands in to the recognizer by using command like “load 0 1” at the serial monitor to load 0 and 1 voice command etc.

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3.1.1.2 GSM Module:

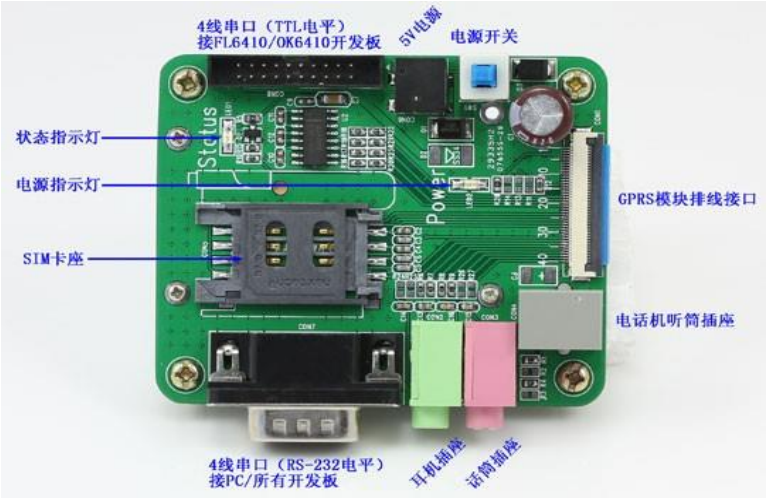


Figure 3-03 GSM Module GTM900-C

3.1.1.2.1 Functional Characteristics of GTM900:

GTM900 has the following functional characteristics:

- At 800 MHz, It supports the single band operation.
- At 900 MHz and 1800 MHz, it supports the dual band operation.
- At 800 MHz, 900 MHz, and 1800 MHz, it supports the tri-band operation.
- Through software, switchover between the above three bands is possible.
- Through hardware replacement, it Supports 850MHz and 1900 MHz
- UART interface is provided
- Maximum speed of the serial interfaces at 115.2 kbps is supported.
- GPRS CLASS 10 packet data services are supported.
- In the modes of FR, HR, EFR, and AM, it Supports speech encoding.
- Both enhanced AT command sets and standard AT command sets Providing interfaces, including UART, Audio, SIM, Power, Control and ADC are supported.

3.1.1.2.2 Services Supported by GTM900

GTM900 supports the following services:

- In the modes of FR, HR, EFR, and AMR ,it supports High quality voice services and speech encoding.
- It supports Wireless data services, including PS data services ,CS data services
- It also supports GPRS CLASS 10 Packet data services
- It supports SMS with MO and MT
- It also supports Supplementary Services, including call transfer, call display, call hold, call forward, call wait, and 3-party conversation .
- It also supports Trunking services, including point-to-point communications, private call and voice group call

3.1.1.3 DHT11:

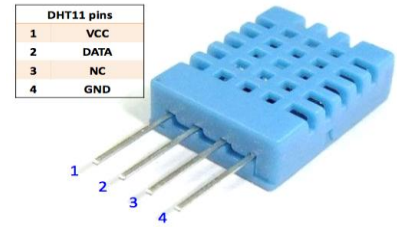


Figure 3-04 DHT11

It is Digital humidity and thermometer sensor that is used for measuring humidity and temperature

3.1.1.4 Pulse sensor:

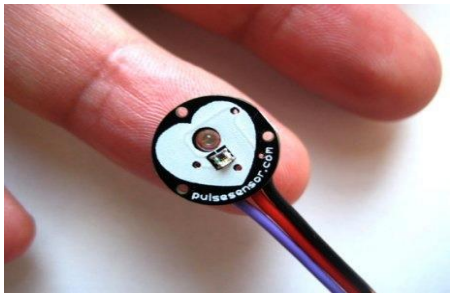


Figure 3-05 Pulse Sensor

The cable has a female header connector and is twenty four inches flat colour coded.
It has three wires i.e RED,BLACK AND PURPLE.
Red one is connected to three to five volts while black one is connected to ground and purple wire is connected to analog pin zero.

The connections of pulse sensor to Arduino can be made by the jumpers.

The Pulse sensor can be attached to the ear clip or finger tip.

There is a small aperture on the front of the heart beat sensor which is the point where the light shines through from its back. Also there is a square present under the LED which is the light sensor that is used to adjust the screen brightness. It works in such a way that LED light falls on the finger tip or earlobe and the sensor reads the light that is being reflected from finger tip or ear lobe. It gives Beats Per Minute (BPM) value as an output.

3.1.1.5 Arduino Mega 2560

ATmega2560 forms the basis of Arduino Mega 2560 which is essentially a microcontroller board. It has 70 input & output pins in total of which 16 are analog inputs and 54 are digital inputs/outputs ; 15 PWM outputs can be obtained through the digital outputs, a crystal oscillator operating at 16 MHz, 4 hardware serial ports known as UARTs, USB connection, a power jack, a reset button and ICSP header. It contains all the essentials required to support the microcontroller. I t can be operated using a USB cable connected to a PC or by providing power using DC adapter or battery

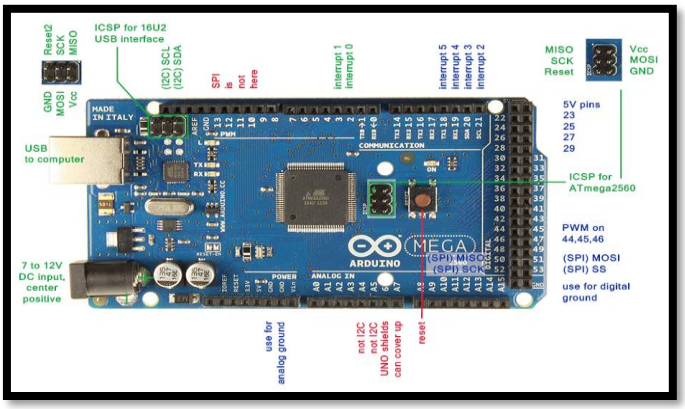


Figure 3-06 Label Diagram of Arduino Mega 2560

3.1.1.5.1 Technical Specifications

Technical Specifications of Arduino Mega 2560 are shown in the table:

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

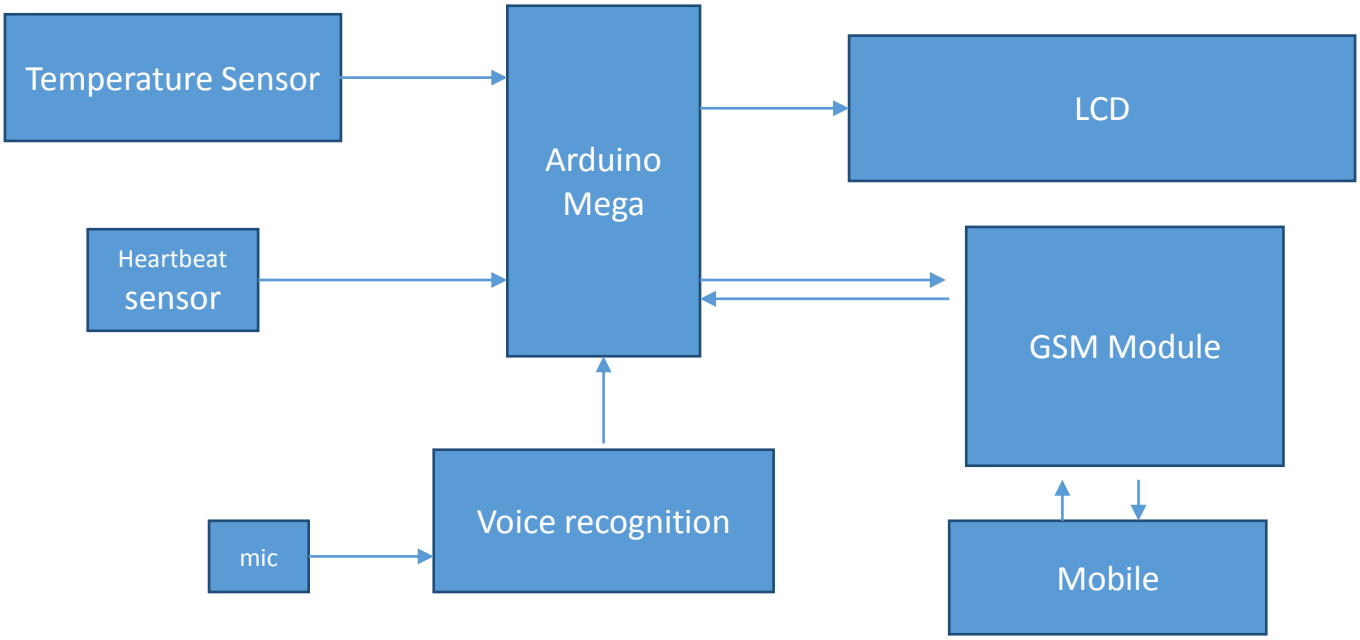
Table 3.1 Technical Specifications of Arduino Mega 2560

Design Specifications:

- Embedded system kit : Arduino Mega 2560
- OS for Arduino Mega 2560: Arduino IDE
- Communication system: GSM Huawei GTM900-C
- Voice recognition module: Voice recognition V3
- Programming language: C++
- BPM (beats per min) monitor: Pulse Sensor
- Temperature monitor: DHT11
- LCD for display

3.2 Detailed Design:

3.2.1 Block Diagram:



3.2.2 How project works?

1. How to make call?

A patient simply says 'call' then say the 'name of a person whom to call'

2. How to answer call

Whenever there is an incoming call, patient simply says 'answer'.

3. How to text

A patient simply says 'text' then says that message which is to be sent

4. How to read message

When a message receives, number of messages will be displayed on the LCD screen along with the beep sounds.

To read text, a person simply says 'show message' .That will display the first message received .And to read next message a person simply says 'next' to read and display the next message in order.

5. How to control appliances

A patient simply 'automation' then name of the appliance to control then says the switching function

6. How automated messages are sent

When the patient does not respond to the incoming call, beats are measured by pulse sensor. If BPM value is in between 40-50 then "a patient is sleeping. Please try later" text will be sent to that person who is calling. .If BPM value is in below 10 then "No Beat detected .please check the patient" text will be sent to that person who is calling.

7. Automatic switching of fan

DHT11 temperature sensor measure the temperature. If the temperature is below 27 centigrade fan will be switched off. if the temperature is 27 or above it it will automatically switch the fan on.

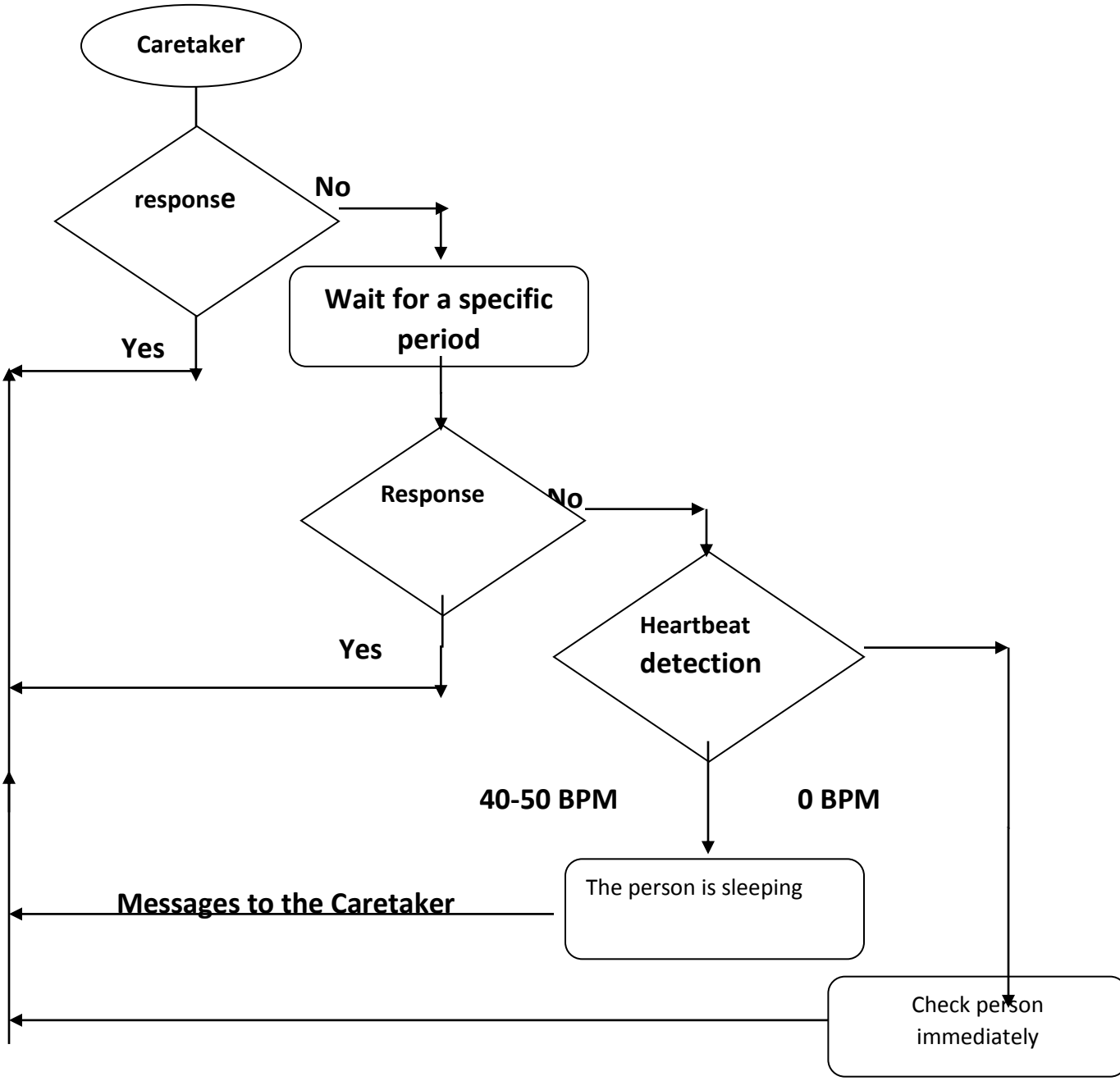
3.2.3 Project Summary:

Calling and messaging functions are carried out by the voice recognition system.

A database is fed into the voice recognition module V3 and this module is trained before operating the device. The patient will command the V3 which in turn will recognize those commands and respond to the Arduino Mega. For calling and messaging purposes, Arduino will transmit the commands to GSM for completion of the commanded task. In case a caller calls or messages, a buzz will be generated accordingly and information (caller's number etc) or the text message will be displayed on LCD. In case the patient doesn't answer an incoming call, automatic messages will be generated and sent back to the caller depending on the patient's state. These states are monitored by the pulse sensor and depending on the BPM reading, it is determined whether the patient is sleeping or not. In case heartbeat isn't detected by the sensor, an automated message is delivered to the caretaker alerting him.

Commands are fed in the recognition module to enable the patient switch electrical appliances around him using his voice. A **temperature sensor (DHT11)** will constantly monitor room temperature .whenever room temperature will increase beyond a certain limit, Fan will automatically switch on depending on the sensor's readings and vice versa.

Flow chart:


Caretaker
response
No
Wait for a specific period
Yes
Response
No
Yes
Heartbeat detection
40-50 BPM
0 BPM
The person is sleeping
Messages to the Caretaker
Check person immediately

CHAPTER 4: Conclusion

4.1 Achievements:

An independent, stand alone, hands-free assistant has been developed fulfilling with efficiency the requirements discussed earlier in the thesis. The assistant designed developed requires low power with no internet requirements. It doesn't need an interface with a PC though it can be added as an additional feature. A voice recognition module is also interfaced to ensure that ASAP is up and ready to receive commands at all times. A 40x4 LCD is interfaced to ensure that display is clear enough and readable from some distance. Furthermore, automation options are provided to the patient so that he can control a number of devices with one worded voice commands. A system of automated messages has been implemented based on patient's pulse to inform caretaker of the patient's state.This assistant provides the patient with a level of independence and increased self-reliance. This eliminates the need of a caretaker's presence at all times for effective communication.

4.1 Applications:

ASAP can be employed in the following areas:

- Armed forces institute of rehabilitation
- Nursing homes with paralyzed patients
- hospitals
- at patient's home

4.3 Suggestions for Future Work:

This project can be regarded as just a start up or a platform from where bigger ideas can evolve. In addition to its current features a complete and comprehensive patient monitoring system can be added. Certain health parameters like blood pressure, temperature etc of the patient can be checked regularly. A video camera can be interfaced to monitor patient using live video feed for safety and security purposes. This system can be implemented in the Health-Centers, Rehabilitation centers or nursing homes. With upgraded display, internet connectivity can be provided for web surfing and video calling.

CHAPTER 5: References

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Selim Aras; Mehmet Öztürk; Ali Gangal 2014 22nd Signal Processing and Communications Applications Conference (SIU), 2014

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Appendix A: Synopsis

Extended Title: **Automated Smart Assistant for a Paralyzed Person (ASAP^2)**

Brief Description of The Project / Thesis with Salient Specifications:

This project is primarily aimed to serve the communication needs of a paralyzed person. It keeps the caretaker aware and in touch with the paralyzed person. It depends solely on the voice commands generated by the person's speech and enables him/her to communicate with the caretaker. He/she can also receive messages from the caretaker and respond accordingly. The person can also switch basic electrical appliances using voice commands when alone.

Scope of Work: This project will be used to transmit and receive text messages using GSM technology. To counter the limitations of a paralyzed person, we will use voice recognition techniques to communicate with the caretaker. Using voice recognition and sensing, it will also be used to switch basic electrical appliances

Academic Objectives :

- To use programming in implementing practical systems.
- To learn GSM based communication
- To learn how voice recognition occurs

Application / End Goal Objectives :

- To design an efficient smart assistant for a paralyzed patient.
- To design a reliable communication system for a paralyzed person.
- To keep the person connected with the caretaker when alone

Previous Work Done on The Subject : none

Material Resources Required:

- GSM module
- Arduino
- Voice recognition module

No of Students Required : 4

Group Members: **NC Haroon ul Rasheed**

NC Usama Attaullah

NC Abdullah Fauz

NC Irfan Wasim

Special Skills Required:

C/C++,Circuit designing, Arduino IDE

Appendix B: Project Progress