Cairo University
Faculty of Engineering
Credit Hour System

SBEN330 Embedded Systems In Medical Equipment

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Document: **Project Report**

"Integrated Assistive Technology System for Brain Disease Patients "

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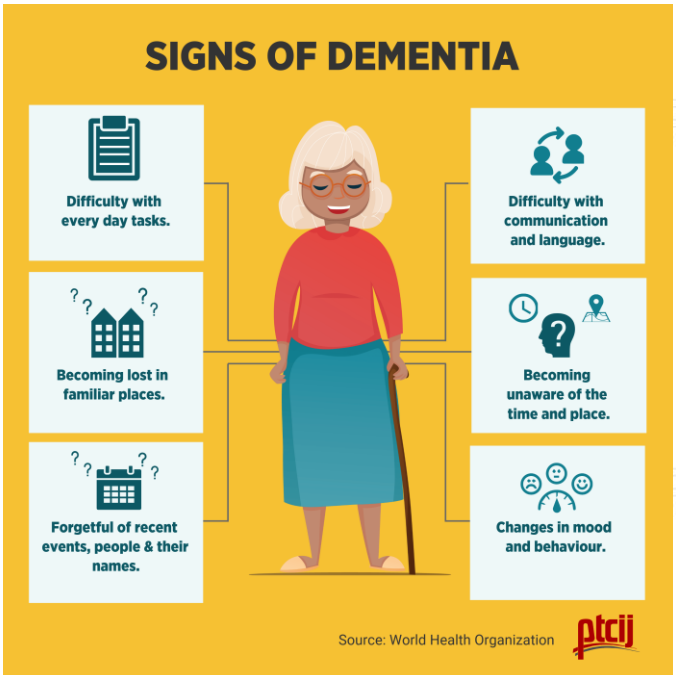
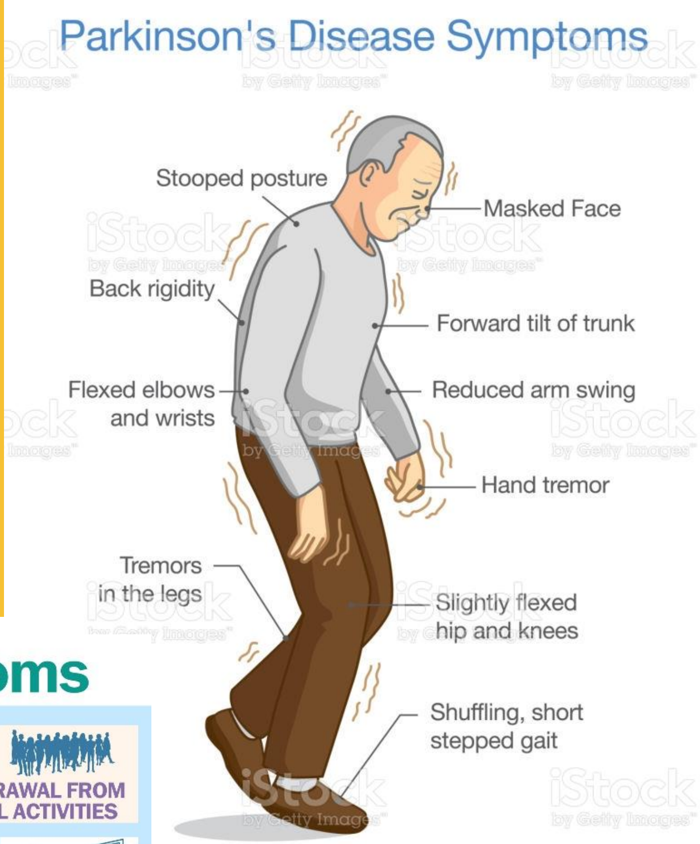
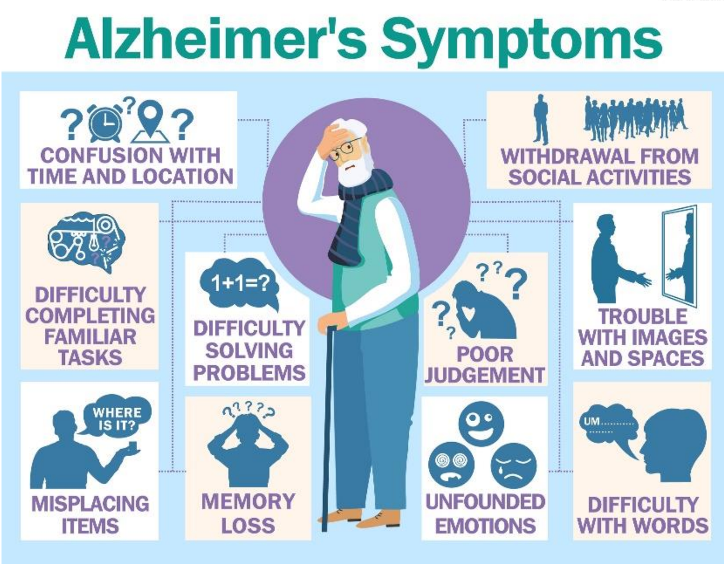
1) Introduction:

Brain diseases could be caused due to several things like brain injury or physiological problems such brain diseases like Alzheimer or Parkinson's or dementia need to be assisted because they can obstruct someone's daily life.

- Alzheimer symptoms such as Increased memory loss and confusion Inability to learn new things, Difficulty with language.
- Parkinson's symptoms such as Increased memory loss and confusion, Inability to learn new things, Difficulty with language and Sialorrhoea.
- Dementia symptoms such as Increased memory loss and confusion, Inability to learn new things, Difficulty with language.







2) Project Idea:

Our idea consists of a system that technologically assists patients with terminal brain diseases like Alzheimer's, Parkinson's and Dementia, who are unable to perform basic life functions or take correct reactions to basic life situations due sensational or perceptual deficiencies caused by those diseases which target the master mind of the body, the brain.

Since the brain controls many bodily functions, an abnormality in it, results in many abnormal uncontrollable symptoms among the different human sensations which affect the normal lifestyle of those patients.

Our system consists of several modules, integrated together, each target a deficiency in a sensation or a control, so we provide assistance to either enhance the weak sensation or increase awareness and control of the abnormal symptom.

1) **Sialorrhoea Assistive Subsystem:**

   We use a water detection sensor to alarm patients of unintentional loss of saliva from their mouth due to its excessive accumulation to wipe it.

2) **Hand-Vibration Assistive Subsystem:**

   We use a vibration detection sensor to alarm patients of uncontrollable vibration of their hand due to motor neurons dysfunction to stop any function that needs a steady hand such as eating or driving.

3) **Hearing Weakness Assistive Subsystem:**

   We use a sound sensor to alarm speakers to patients if the sound intensity of their speech is not high enough for patients to hear well to respond accordingly.

Sialorrhoea Assistive Subsystem

Hand Vibration Assistive Subsystem

Hearing Weakness Assistive Subsystem

Our Integrative Technologically Assistive System

3) Sialorrhoea Assistive Subsystem:

A) Problem:

Sialorrhoea is a frequent symptom of neurological diseases (e.g. Parkinson's disease, motor neuron disease, cerebral palsy, and stroke) and is defined as excessive saliva accumulation leading to unintentional loss of saliva from the mouth. Sialorrhoea increases the overall burden on the patient and their caregivers, the impact of which can be both physical and psychosocial.

B) Subsystem Function:

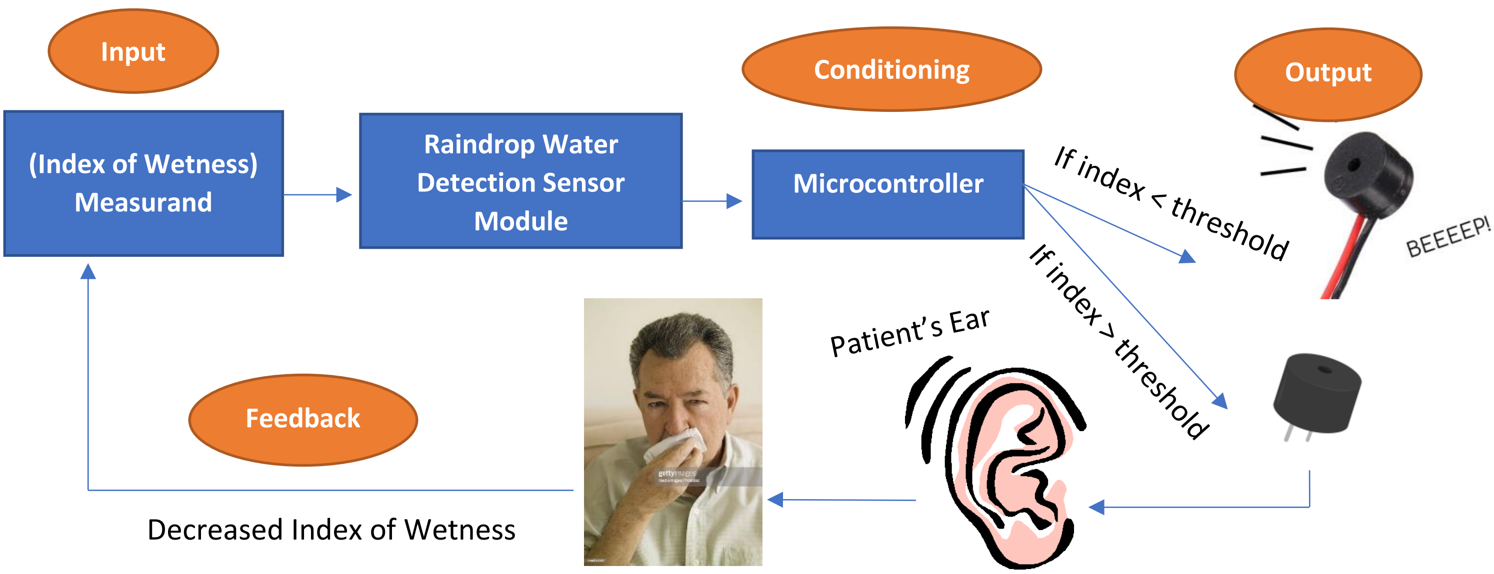
The module employs a water sensor that measures an index of wetness all over its area placed near/under the mouth and chin of the patient. If this index increases over a certain level, this means there is excessive saliva all over the patient's mouth and chin. Therefore, the subsystem alarms him/her through a buzzer to wipe himself/herself, then the changed index of wetness is fed as feedback into the system as it decreases to inform the patient if they are sufficiently dry.

C) Input (Measurand): Index of wetness

D) Conditioning: If measurand indicates that patient's mouth is too wet and needs wiping

E) Output: Buzzer sound of level of dryness is insufficient

F) Feedback: New index of wetness as patient continues to wipe their mouth and chin



4) Hand-Vibration Assistive Subsystem:

A) Problem:

Essential tremor is a neurological (nervous system) disorder characterised by the involuntary shaking or trembling of particular parts of the body, such as the hands. The tremors typically worsen when the hands are being used (kinetic tremor) and reduce significantly or stop altogether when the hands are resting. This makes it hard for patients to perform daily functions that involve movement of their hands, which has a negative psychological impact on them.

B) Subsystem Function:

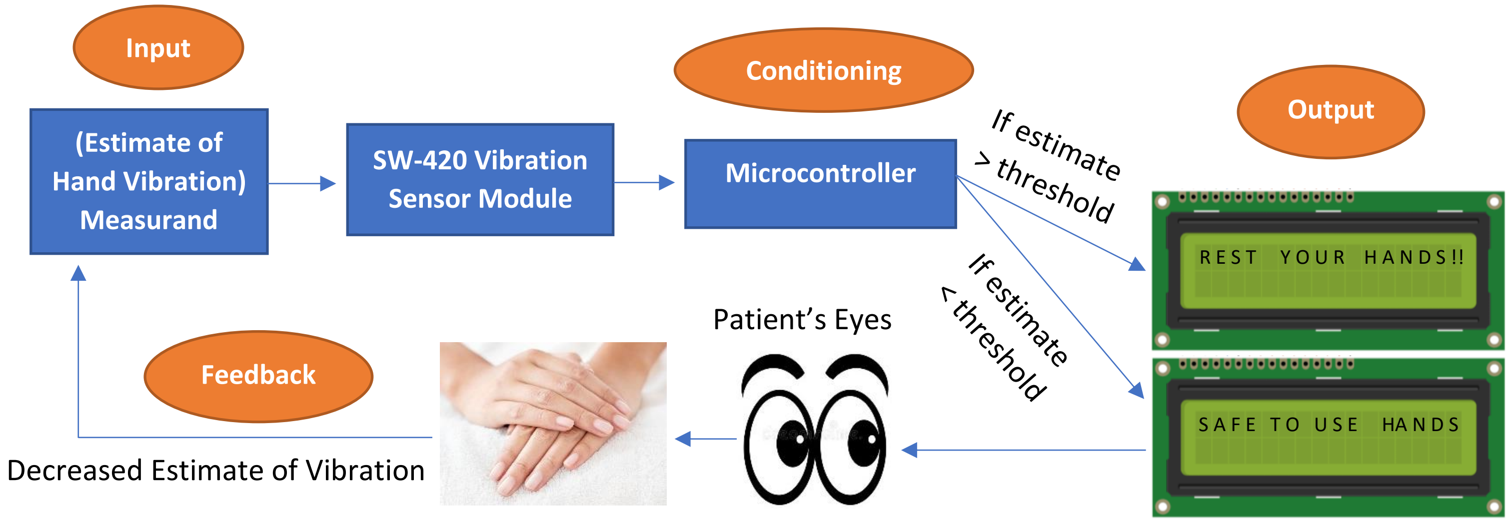
The module employs a vibration sensor which gives an estimate of the level of excessive vibration/shaking of a patient's hand placed on it. If tis estimate increases above a certain level, this means that hand movement is not normal and in uncontrollable vibration. Therefore, the subsystem alarms the patient of this through a message on an LCD in order to stop using their hands. The decreased value of this estimate as the patient's hand rests when they stop what they are doing is fed into the system as feedback back to inform the patient when they are ready to continue their task.

C) Input (Measurand): Estimate of hand vibration level

D) Conditioning: If this estimate is higher than a normal value and patient needs to stop using their hand

E) Output: A stop message on LCD

F) Feedback: New value of hand vibration estimate as patient's hand rest when they stop using it



5) Hearing Weakness Assistive Subsystem:

A) Problem:

A person who is not able to hear as well as someone with normal hearing – hearing thresholds of 20 dB or better in both ears – is said to have hearing loss. Hearing loss may be mild, moderate, severe, or profound. It can affect one ear or both ears, and leads to difficulty in hearing conversational speech or loud sounds, 'Hard of hearing' refers to people with hearing loss ranging from mild to severe. People who are hard of hearing usually communicate through spoken language and can benefit from hearing aids, cochlear implants, and other assistive devices as well as captioning.

B) Subsystem Function:

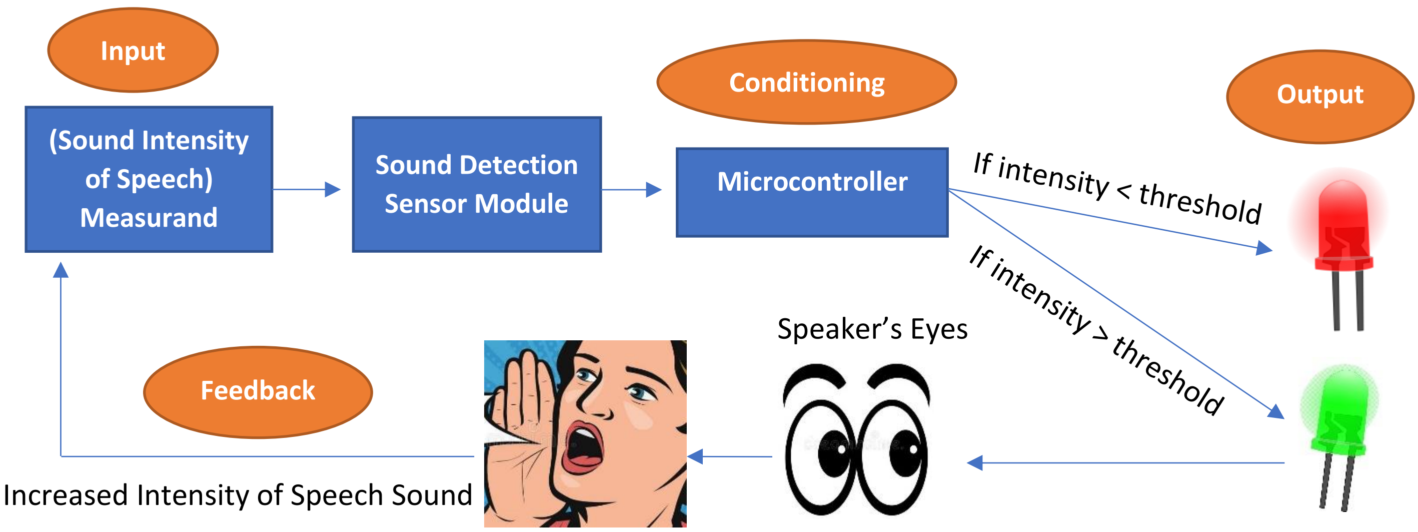
The module employs a sound sensor which will assist people with hearing impairment in which the sound sensor is connected to the ears. If the estimation of the sound reaching the patient decreases below a certain level, Therefore, the subsystem alarms the person who is speaking of this through a red LED in order to raise their voice to a certain level until a green LED works which indicates the voice is within hearing range of the patient.

C) Input (Measurand): Estimate of value of sound level

D) Conditioning: If this estimate is lower than the hearing range of the patient and the person needs to raise their voice

E) Output: Red LED indicates the sound is lower than the range and the green one indicates the sound is within the normal range

F) Feedback: the new sound intensity as the speaker raises his voice talking to the patient



6) Market Relevance:

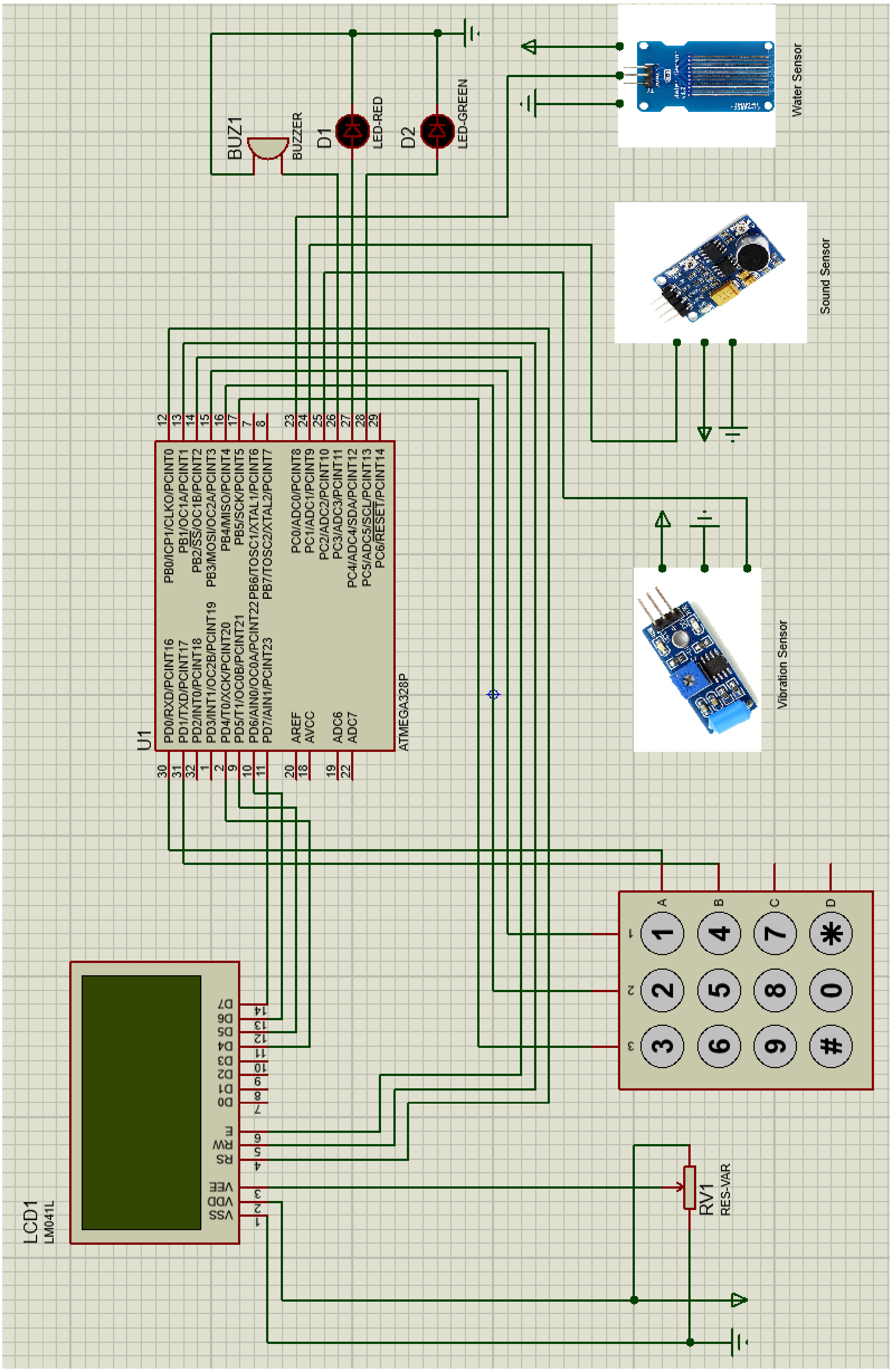
According to the **international standard ISO 9999:2011**, **An Assistive Product** is *"Any product (including devices, equipment, instruments and software), especially produced or generally available, used by or for persons with disability: for participation; to protect, support, train, measure or substitute for body functions/structures and activities; or to prevent impairments, activity limitations or participation restrictions"*.

The market is mostly filled with products that are designed to perform one particular function or address one specific disability, such as hearing aids, adaptive utensils, word prediction software, memory aids, pill organizers ..etc. while integrative assistive systems are not common or expensive, such as Personal Assistive Systems.

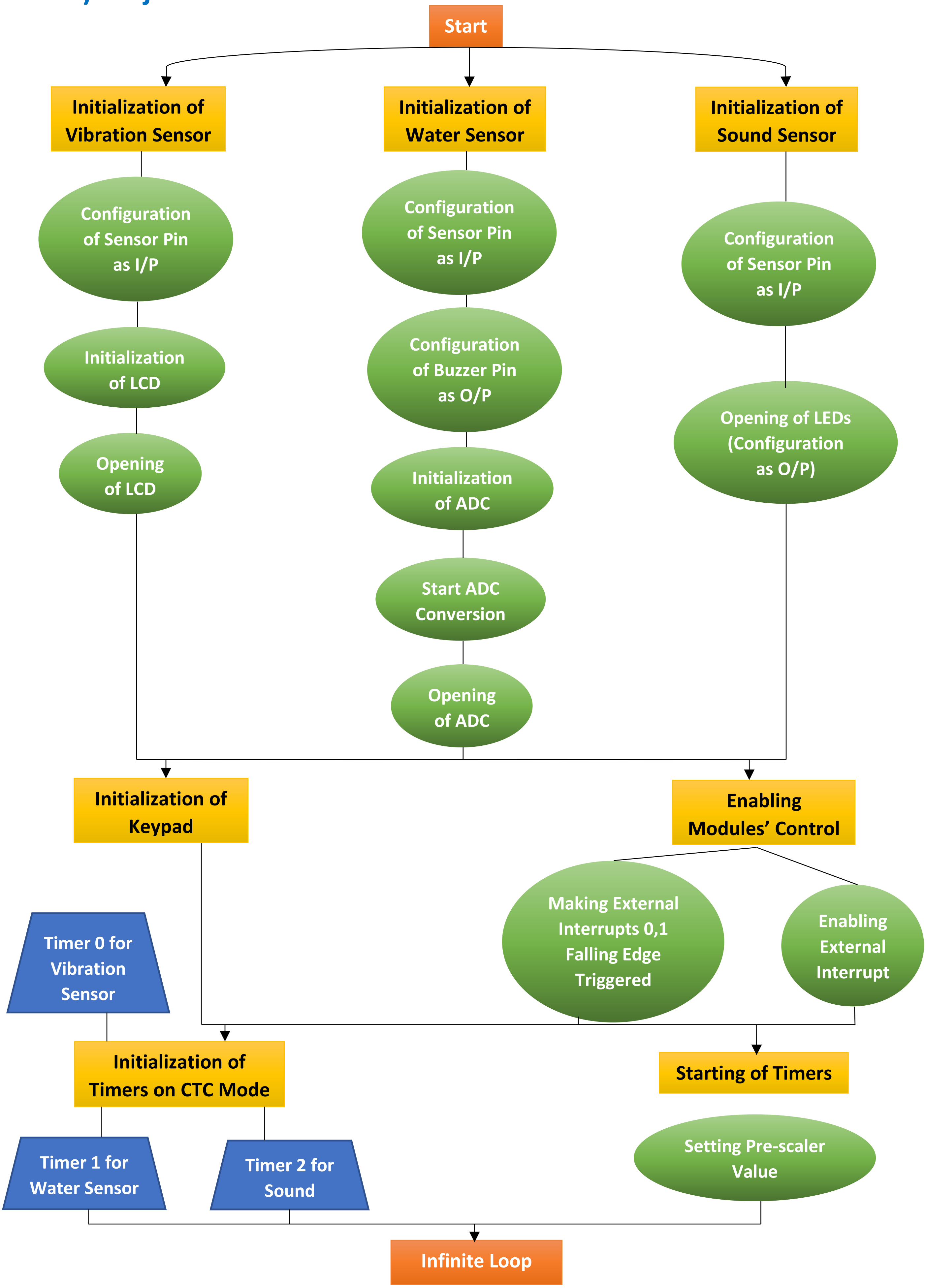
From our market research we found that more than **1 billion** people need **1 or more assistive products**, globally. With an ageing global population and a rise in noncommunicable diseases, more than **2 billion** people will need **at least 1 assistive product by 2030**, with **many older people needing 2 or more**. **Today, only 1 in 10 people in need have access to assistive products due to their inability of affording them.**

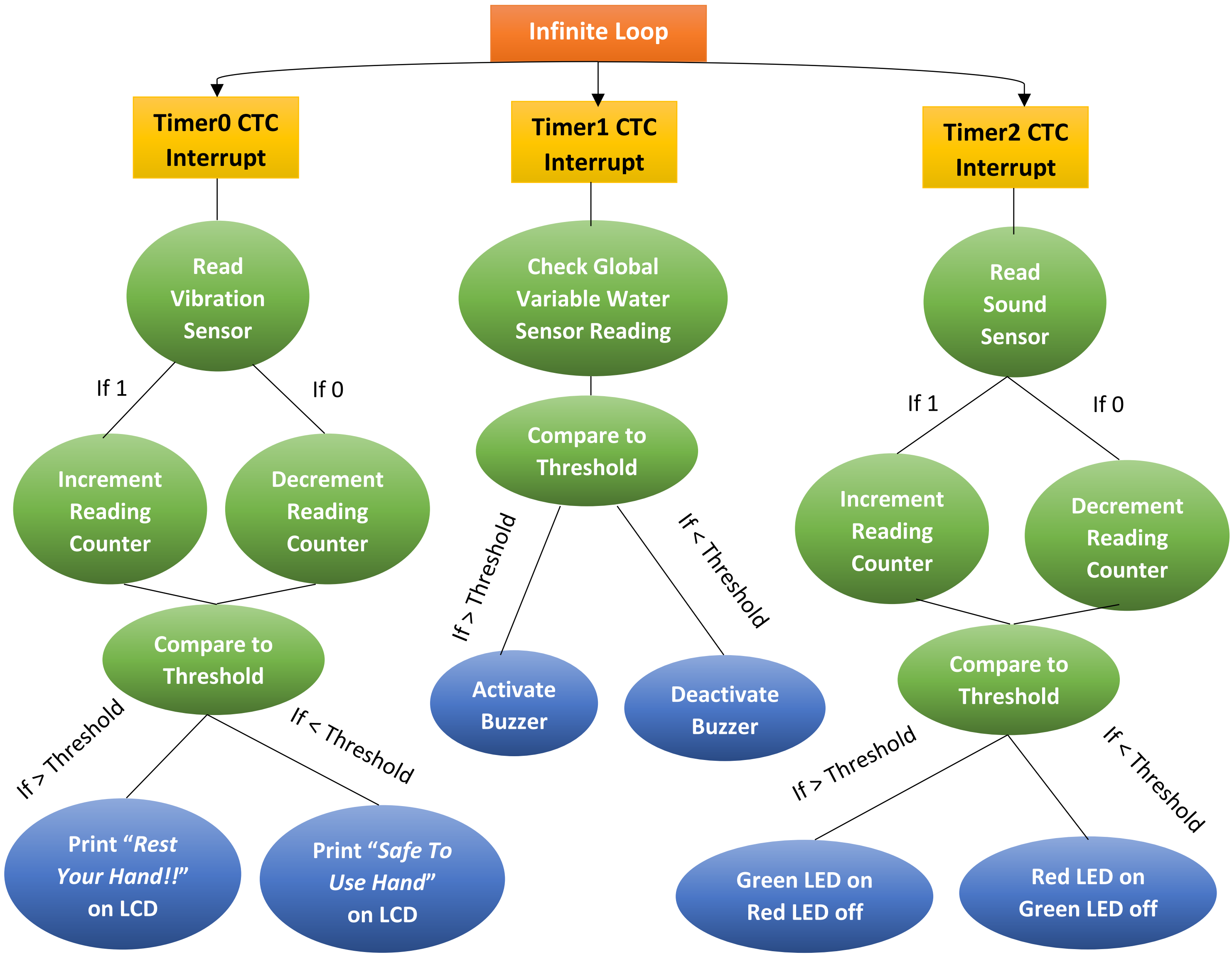
Therefore, **we offer a low-cost technological assistive system** with simple components which we combine their values to produce an integrated assistive system with moderate technology to provide **the sufficient assistance to brain disease patients who cannot afford the expensive complex system they may need.**

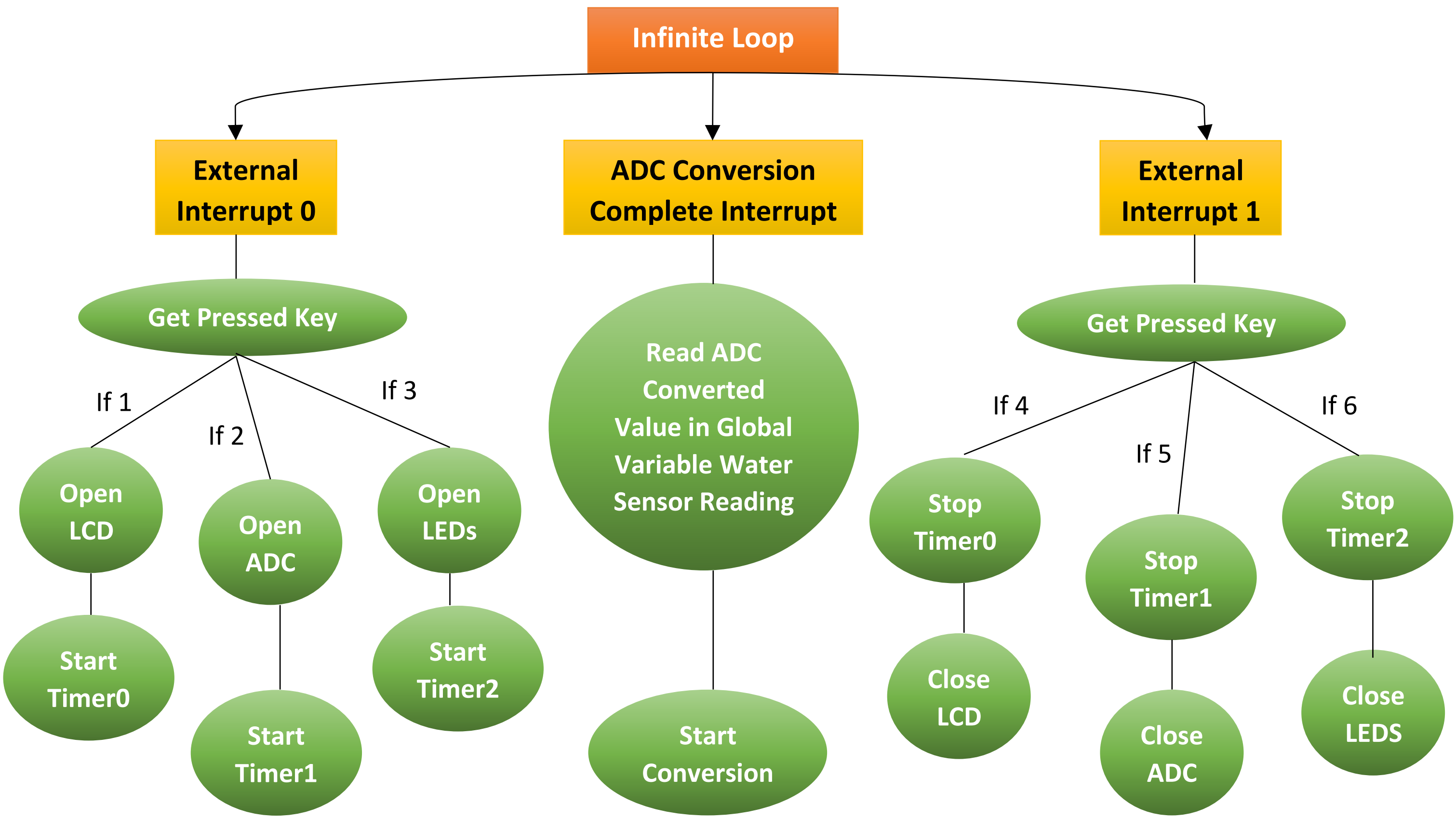
7) Project Circuit Diagram:



8) Project Flowchart:




Infinite Loop
Timer0 CTC Interrupt
Timer1 CTC Interrupt
Timer2 CTC Interrupt
Read Vibration Sensor
If 1
If 0
Increment Reading Counter
Decrement Reading Counter
Compare to Threshold
If > Threshold
If < Threshold
Print "Rest Your Hand!!" on LCD
Print "Safe To Use Hand" on LCD
Check Global Variable Water Sensor Reading
Compare to Threshold
If > Threshold
If < Threshold
Activate Buzzer
Deactivate Buzzer
Read Sound Sensor
If 1
If 0
Increment Reading Counter
Decrement Reading Counter
Compare to Threshold
If > Threshold
If < Threshold
Green LED on Red LED off
Red LED on Green LED off


Infinite Loop
External Interrupt 0
ADC Conversion Complete Interrupt
External Interrupt 1
Get Pressed Key
If 1
If 2
If 3
Open LCD
Open ADC
Open LEDs
Start Timer0
Start Timer1
Start Timer2
Read ADC Converted Value in Global Variable Water Sensor Reading
Start Conversion
Get Pressed Key
If 4
If 5
If 6
Stop Timer0
Stop Timer1
Stop Timer2
Close LCD
Close ADC
Close LEDS

9) Some of Project Code:

Initialization of Vibration Sensor

```
void Vibration_Sensor_Init() {

    DIO_SetPinDirection('C', 1, INPUT);
    LCD_Init();
    LCD_SetCursorAt(1,1);

}
```

Initialization of Water Sensor

```
void Water_Sensor_Init() {

    DIO_SetPinDirection('C', 0, INPUT);
    DIO_SetPinDirection('C', 3, OUTPUT);
    ADC_Init();
    ADC_Open();
    ADC_SelectChannel(0);
    ADCSRA |= (1 << 6);

}
```

Initialization of Sound Sensor

```
void Sound_Sensor_Init() {

    DIO_SetPinDirection('C', 2, INPUT);
    Open_LEDs();

}
```

Initialization of Keypad

```
void Keypad_Init(void) {

    for(unsigned char i=COL1; i<=COL4; i++)
    {
        DIO_SetPinDirection(KEYPAD_COLS, i, OUTPUT);
    }

    for(unsigned char i=ROW1; i<=ROW2; i++)
    {
        DIO_SetPinDirection(KEYPAD_ROWS, i, INPUT);
        DIO_WritePin(KEYPAD_ROWS, i, 1);     // Activate Pull-Up Resistor
    }
}
```

Enabling Modules' Control

```
void Enable_Modules_Control() {

    EICRA |= ( (1<<ISC01)|(1<<ISC11) );
    EIMSK |= ( (1<<INT0)|(1<<INT1) );

}
```

Initialization of Timers on CTC Mode

```
void Timer0_CTC_Init() {

    OCR0A = 0XC3; // decimal: 61 --> 62 clk (CHANGE ACCORDING TO NEED)
    TCCR0A |= (1<< WGM01); // Setting CTC mode only
    TIMSK0 |= (1<<OCIE0A); // Enable interrupt flag

}
void Timer1_CTC_Init() {

    OCR1A = 0XC3; // decimal: 61 --> 62 clk (CHANGE ACCORDING TO NEED)
    TCCR1B |= (1<< WGM12); // Setting CTC mode only
    TIMSK1 |= (1<<OCIE1A); // Enable interrupt flag

}
```

```
void Timer2_CTC_Init() {

    OCR2A = 0X5D; // decimal: 102 --> 103 clk (CHANGE ACCORDING TO NEED)
    TCCR2A |= (1<< WGM21); // Setting CTC mode only
    TIMSK2 |= (1<<OCIE2A); // Enable interrupt flag

}
```

Starting of Timers

```
void Start_Timer0() {

    TCCR0B |=  (1<<CS00) | (1<<CS02) ; // Set prescaler (clk/1024)
}
void Start_Timer1() {

    TCCR1B |=  (1<<CS10) | (1<<CS12) ; // Set prescaler (clk/1024)

}
void Start_Timer2() {

    TCCR2B |=  ( (1<<CS20) | (1<<CS21) | (1<<CS22) ) ; // Set prescaler
                                                        (clk/1024)
}
```

Timer0 CTC Interrupt

```
ISR (TIMER0_COMPA_vect)
{
  vibration_sensor_time_counter ++;

  if (vibration_sensor_time_counter == 15) {

    vibration_sensor_time_counter = 0;

    unsigned char measurement = Read_Vibration_Sensor();
    if (measurement == 1) {

        if (vibration_sensor_reading_counter < 8) {
            vibration_sensor_reading_counter ++;
        }
    }
```

```
    else {

        if (vibration_sensor_reading_counter > 0) {
            vibration_sensor_reading_counter --;
        }
    }

    if (vibration_sensor_reading_counter >=3 ) {
       LCD_Print("Rest Your Hand!!");
       LCD_SendCommand(0x02);
       _delay_ms(220);
    }
    else if (vibration_sensor_reading_counter < 3) {
       LCD_Print("Safe To Use Hand");
       LCD_SendCommand(0x02);
    }
  }
}
```

Timer1 CTC Interrupt

```
ISR (TIMER1_COMPA_vect) {

    if (water_sensor_reading <= 500) {

        DIO_WritePin('C', 3, 1);
        _delay_ms(185);
        DIO_WritePin('C', 3, 0);

    }
    else if (water_sensor_reading > 500)
    {
        DIO_WritePin('C', 3, 0);
    }
}
```

Timer2 CTC Interrupt

```
ISR (TIMER2_COMPA_vect)
{

  sound_sensor_time_counter ++;

  if (sound_sensor_time_counter == 19) {

    sound_sensor_time_counter = 0;

    unsigned char measurement = Read_Sound_Sensor();
    if (measurement == 1) {

        if (sound_sensor_reading_counter < 11) {
            sound_sensor_reading_counter ++;
        }
    }
    else {

        if (sound_sensor_reading_counter > 0) {
            sound_sensor_reading_counter --;
        }
    }

    if (sound_sensor_reading_counter >=3 ) {
       DIO_WritePin('C', 5, 1);              // turn on green LED
       DIO_WritePin('C', 4, 0);              // turn off red LED
        _delay_ms(750);
    }
    else if (sound_sensor_reading_counter <3 ) {
       DIO_WritePin('C', 4, 1);              // turn on red LED
       DIO_WritePin('C', 5, 0);              // turn off green LED
    }
  }
}
```

ADC Conversion Complete Interrupt

```
ISR(ADC_vect) {

  water_sensor_reading = Read_Water_Sensor();
  ADCSRA|=(1<<ADSC);

}
```

External Interrupt 0

```c
ISR (INT0_vect)
{
    unsigned char key = Keypad_GetKey();
    if (key == '1') {
        LCD_Open();
        Start_Timer0();
        return;
    }
    if (key == '2') {
        ADC_Open();
        Start_Timer1();
        return;
    }
    if (key == '3') {
        Open_LEDs();
        Start_Timer2();
        return;
    }
}
```

External Interrupt 1

```c
ISR (INT1_vect)
{
    unsigned char key = Keypad_GetKey();
    if (key == '4') {
        Stop_Timer0();
        LCD_Close();
        return;
    }
    if (key == '5') {
        Stop_Timer1();
        ADC_Close();
        return;
    }
    if (key == '6') {
        Stop_Timer2();
        Close_LEDs();
        return;

    }
}
```