Mechatronics Term Project
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Summary

- DTMF enables use of mobile phone as controller
- Wirelessly control robot
- Use sensors to detect
  - High temperatures
  - Gas leaks
- Use Ultrasonic sensor to avoid collisions

DTMF Theory

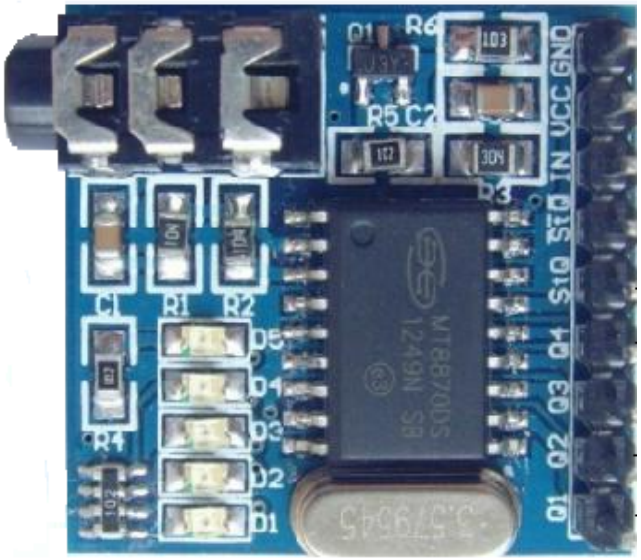
- Dual Tone – Multi Frequency
- Frequencies correspond to row and column of button
- Each button generates two corresponding frequencies
- No buttons generate the same combination of frequencies

1	2	3	697 Hz
4	5	6	770 Hz
7	8	9	852 Hz
*	0	#	941 Hz
1209 Hz	1336 Hz	1477 Hz	

Simultaneously generated frequencies for each corresponding key

DTFM Theory

- When dialing phone number, generated frequency from each key press instruct system to connect your call to correct destination
- Dual Tone signals generated are converted into 4-bit binary representation
- Distinct outputs can be used to control device



DTMF MT8870DS Decoder module

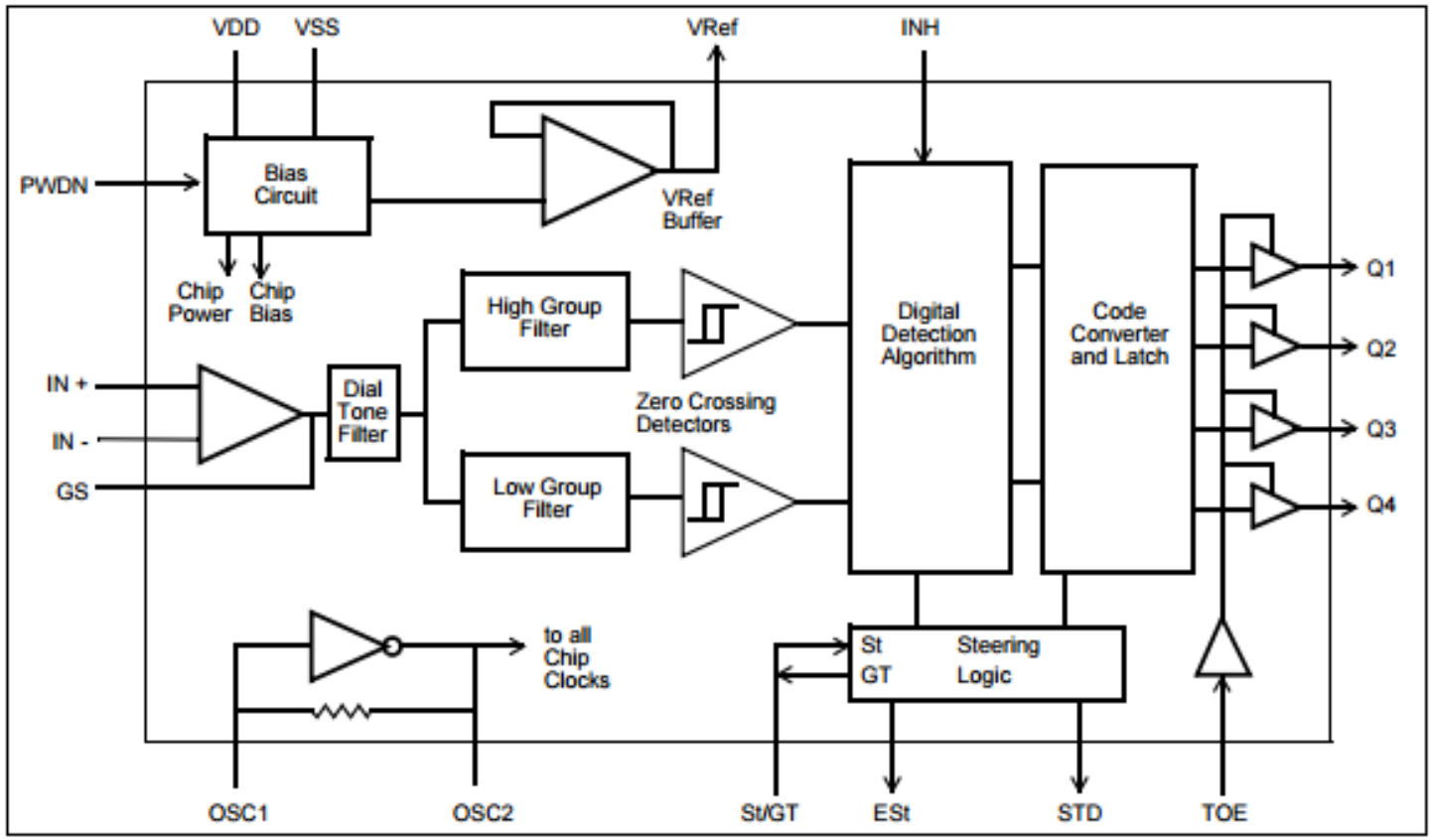
Sensor and IC Technical Data

- **MT8870DS DTFM Decoder**

- Uses 7 Pins and 3.5mm male to male cable
- 2 Pins for Power and Ground
- 3.5mm jack for input
- 5 Pins for output
  - STQ indicates if button is pressed
  - Q1, Q2, Q3, Q4 represents input signal in binary

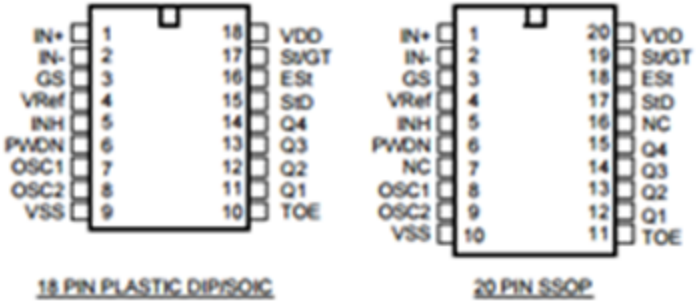
Sensor and IC Technical Data

- MT8870DS DTFM Decoder Block Diagram



Sensor and IC Technical Data

- **MT8870DS DTFM Decoder Pin Descriptions**



18 PIN PLASTIC DIP/SOIC — 20 PIN SSOP

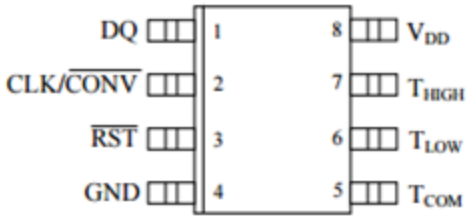
Pin Description

Pin #		Name	Description
18	20		
1	1	IN+	**Non-Inverting Op-Amp (Input).**
2	2	IN-	**Inverting Op-Amp (Input).**
3	3	GS	**Gain Select.** Gives access to output of front end differential amplifier for connection of feedback resistor.
4	4	V_{Ref}	**Reference Voltage (Output).** Nominally $V_{DD}/2$ is used to bias inputs at mid-rail (see Fig. 6 and Fig. 10).
5	5	INH	**Inhibit (Input).** Logic high inhibits the detection of tones representing characters A, B, C and D. This pin input is internally pulled down.
6	6	PWDN	**Power Down (Input).** Active high. Powers down the device and inhibits the oscillator. This pin input is internally pulled down.
7	8	OSC1	**Clock (Input).**
8	9	OSC2	**Clock (Output).** A 3.579545 MHz crystal connected between pins OSC1 and OSC2 completes the internal oscillator circuit.
9	10	V_{SS}	**Ground (Input).** 0 V typical.
10	11	TOE	**Three State Output Enable (Input).** Logic high enables the outputs Q1-Q4. This pin is pulled up internally.
11-14	12-15	Q1-Q4	**Three State Data (Output).** When enabled by TOE, provide the code corresponding to the last valid tone-pair received (see Table 1). When TOE is logic low, the data outputs are high impedance.
15	17	StD	**Delayed Steering (Output).** Presents a logic high when a received tone-pair has been registered and the output latch updated; returns to logic low when the voltage on St/GT falls below V_{TSt}.
16	18	ESt	**Early Steering (Output).** Presents a logic high once the digital algorithm has detected a valid tone pair (signal condition). Any momentary loss of signal condition will cause ESt to return to a logic low.

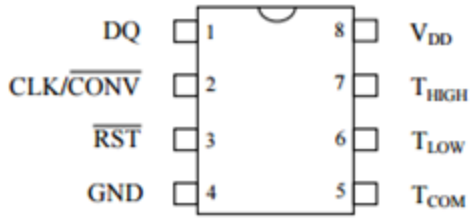
Sensor and IC Technical Data

- **DS1620 Temperature Sensor**
- Measures temperature of surroundings
- Measurement range (–55°C, 125°C)
- 0.5°C resolution

PIN ASSIGNMENT



DS1620S 8-Pin SOIC (208-mil)



DS1620 8-Pin DIP (300-mil)

PIN DESCRIPTION

DQ	- 3-Wire Input/Output
CLK/$\overline{CONV}$	- 3-Wire Clock Input and Stand-alone Convert Input
$\overline{RST}$	- 3-Wire Reset Input
GND	- Ground
T_{HIGH}	- High Temperature Trigger
T_{LOW}	- Low Temperature Trigger
T_{COM}	- High/Low Combination Trigger
V_{DD}	- Power Supply Voltage (3V - 5V)

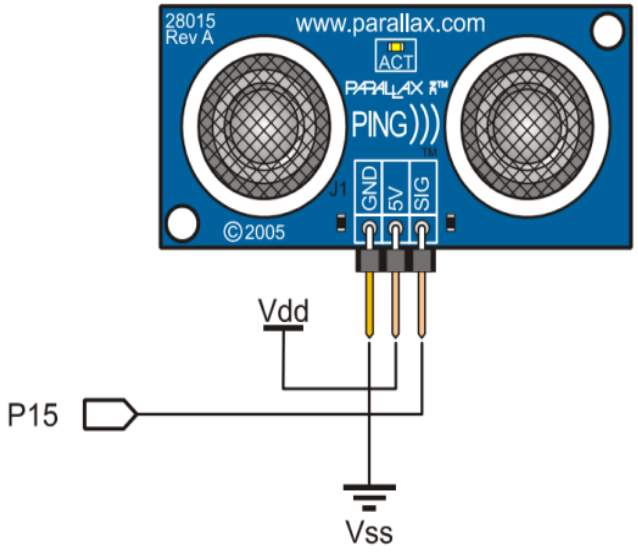
Sensor and IC Technical Data

- **DS1620 Temperature Sensor**
- Provides 9-bit temperature readings
- MSB represents (+,-)
- 8-bits represents temperature value
  - 1bit = 0.5°C

TEMP	DIGITAL OUTPUT (Binary)	DIGITAL OUTPUT (Hex)
+125°C	0 11111010	00FA
+25°C	0 00110010	0032h
+½°C	0 00000001	0001h
+0°C	0 00000000	0000h
-½°C	1 11111111	01FFh
-25°C	1 11001110	01CEh
-55°C	1 10010010	0192h

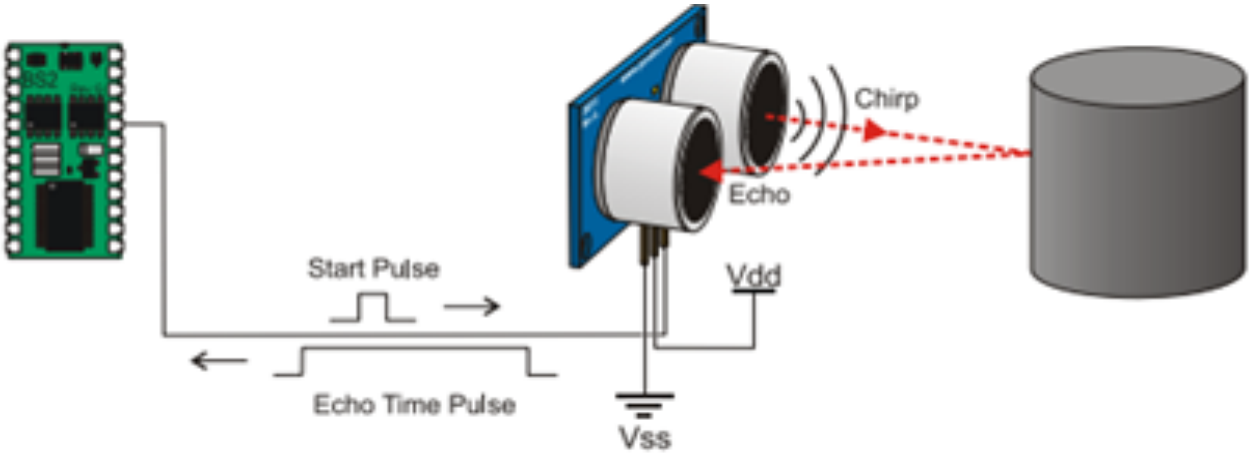
Sensor and IC Technical Data

- **Parallax Ping)))**
- Uses ultrasonic pulse to determine distance between robot and obstacle
- Ensures safety of robot, prevents from crashing into wall



Sensor and IC Technical Data

- **Parallax Ping)))**
- Sends out series of chirps and measure time taken for signal to return
- If speed of sound is know, Distance between sensor and obstacle can be determined

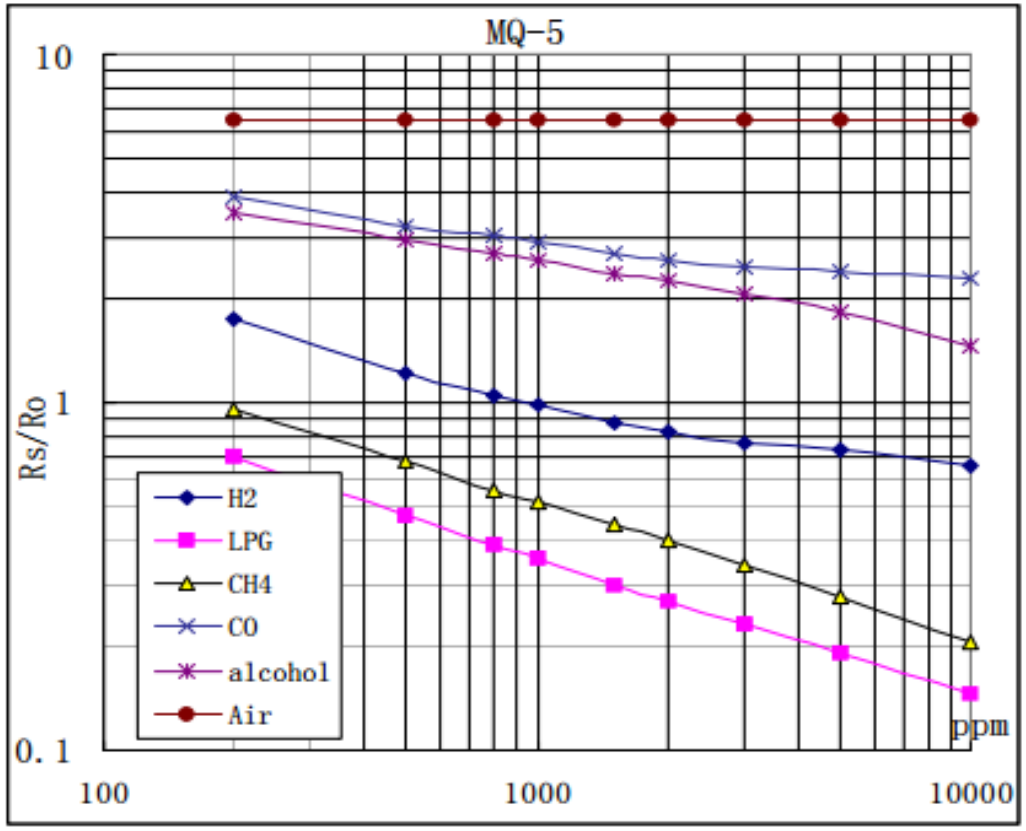


Sensor and IC Technical Data

- **MQ-5 (Gas Sensor)**
- Detects presence of Liquefied Petroleum Gas, butane and other gases
- Sensor resistance changes in the presence of certain gases
- For fixed load resistance, voltage output will vary in presence of gas

Sensor and IC Technical Data

- **MQ-5 (Gas Sensor)**
- Sensitivity to various gases



Justification of Material

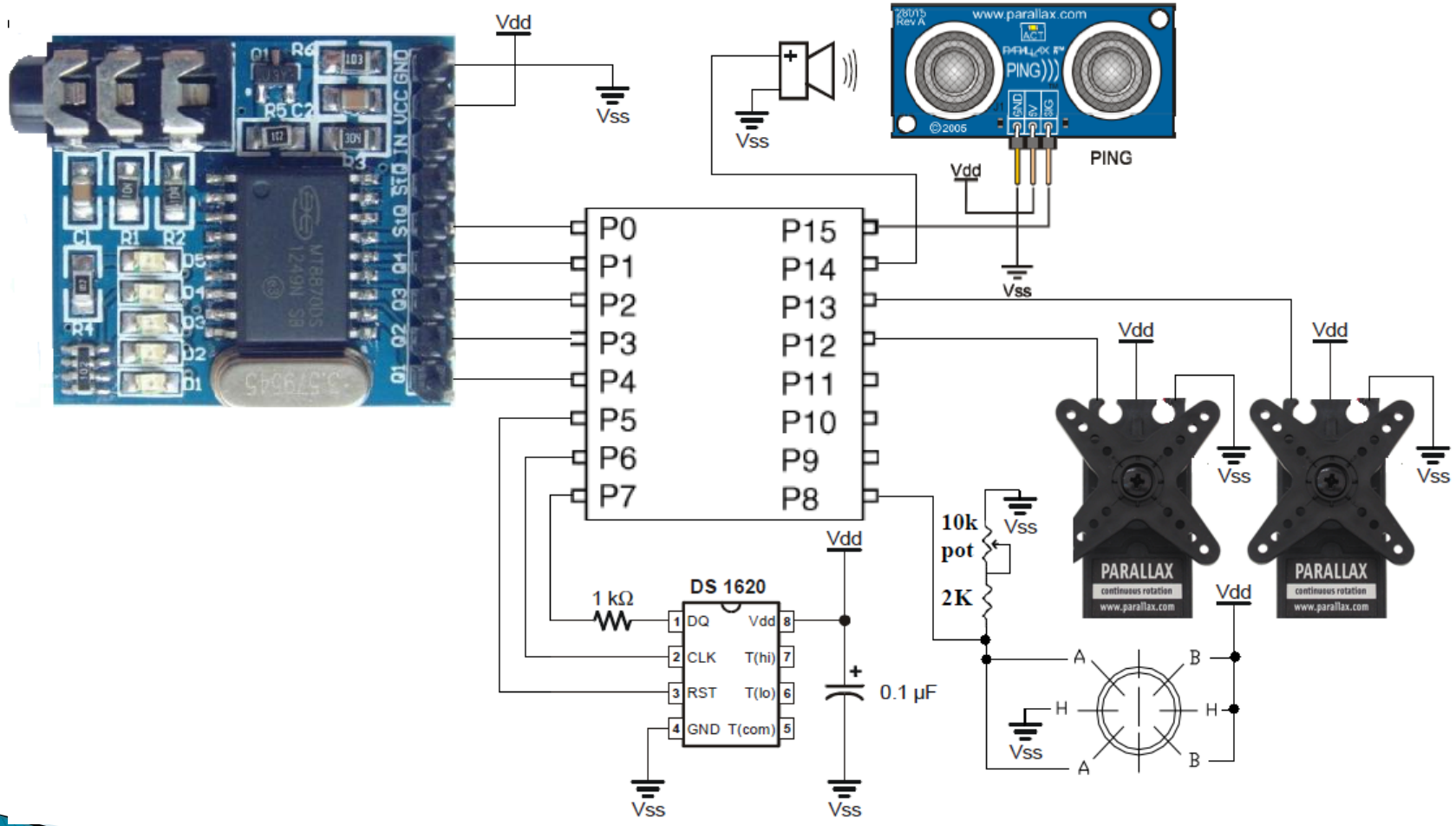
- Boe-Bot selected as main system
  - Financially ideal choice
  - Low cost package
  - Controllers, actuators, basic electronic equipments included in purchase
- Basic Stamp 2
  - Simple programming
  - Integrated breadboard
  - Allows rapid prototyping

Justification of Material

- MT8870DS DTMF
  - Cost effective for its functionality
  - Sends signals through keypad of mobile phone

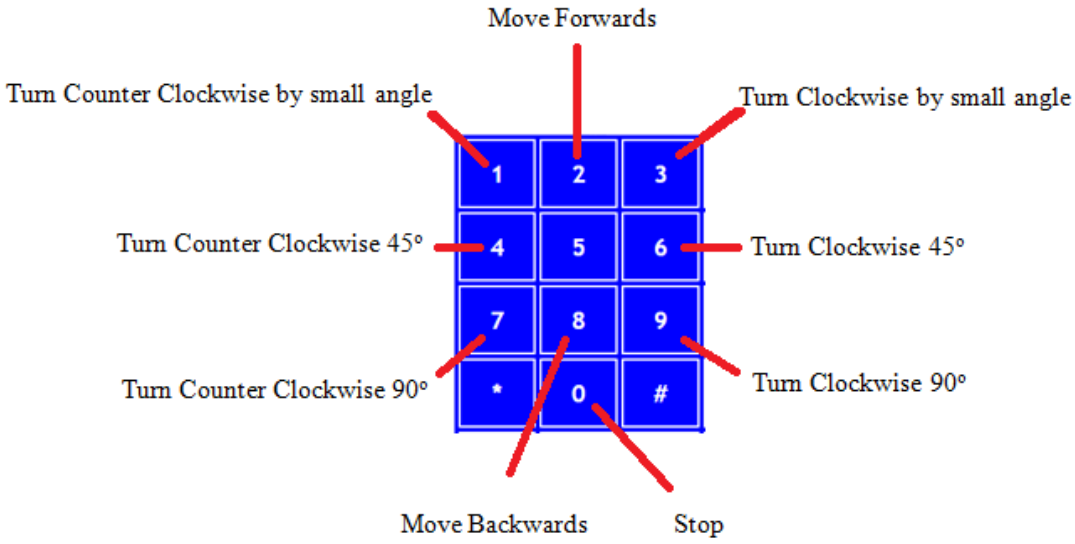
- MQ-5
  - Capable of detecting variety of gases

Circuit Schematic



Code Rundown

- Read Temperature sensor
  - Waits for stable temperature
  - If too high, output piezo transducer
- Reads output from gas sensor
  - If reading is HIGH, output piezo transducer
- Read distance from object
  - If too close, disable servos forward motion
- Waits for input to DTFM



Code

```
' {$STAMP BS2}
' {$PBASIC 2.5}

'Variables for DTMF
DTMFread VAR Byte 'read 4-bit signal from DTMF
counter VAR Word 'General purpose variable for increments
STQ PIN 0 'Pin indicates whether DTMF detects a signal from input device
Q1  PIN 4 '2^0 position in binary
Q2  PIN 3 '2^1 position in binary
Q3  PIN 2 '2^2 position in binary
Q4  PIN 1 '2^3 position in binary

'Variables for Ultrasonic Sensor
ultsonic PIN 15 'Pin used to interface Ultrasonic sensor
time VAR Word 'Time of flight measurement [2 microsecond units]
cmDist VAR Word 'Stores distance [cm] between Ultrasonic and object
'D[cm] = (1/2)*(100*344.8)*(T*2*10^-6)
'D[cm] = T*0.03448, multiply high *65536
'D[cm] = T[s]**2260
cmConst CON 2260

'Variables for Gas sensor MQ-5
Gasread PIN 8 'Used to read gas sensor voltage
```

Code

```
'Variables for DS1620
RST PIN 5 'Activate DS1620 conversion
CLK PIN 6 'Clock
DQ PIN 7  'Receive data bytes
ds VAR Byte 'stores temperature measurement
degC VAR Byte 'temperature measurement in degrees celsius
waiting VAR Nib 'variable used to avoid chatter
waiting = 0
OUTS=%0000000000000000 'initialize all pin as low
HIGH RST 'start conversion sequence
SHIFTOUT DQ, CLK, LSBFIRST, [238] 'Command to convert temperature into digital code
LOW RST  'end conversion sequence

DO
'Temperature measurement using DS1620
HIGH RST 'start conversion sequence
SHIFTOUT DQ, CLK, LSBFIRST, [170] 'Command to send temperature reading to bs2
SHIFTIN DQ, CLK, LSBPRE, [ds] 'Stores measurement in variable ds
LOW RST  'end conversion sequence
degC = ds / 2 'Convert DS1620 reading to degrees celsius
IF ds>=55 THEN
  IF waiting<15 THEN
    waiting = waiting + 1 'waits for temperature reading to stablize above threshold
  ENDIF
ELSE
  IF waiting>0 THEN
    waiting = waiting - 1 'waits for temperature reading to stablize below threshold
  ENDIF
ENDIF
IF waiting>=10 THEN
  FREQOUT 14, 50, 1900 'Buzzes piezo transducer when temperature reading above threshold
ENDIF
PAUSE 5
```

Code

```
IF Gasread = 1 THEN
  'if gas is sensed, Gasread goes high
  FREQOUT 14, 50, 1900
ENDIF


'Distance measurement using Ultrasonic
PULSOUT ultsonic, 5 'send out pulse for 10 microseconds
PULSIN ultsonic, 1, time 'record time taken for signal to return [2 microseconds]
cmDist=time**cmConst 'calculates distance [cm] using time and conversion factor
PAUSE 5

'Read signal from DTMF
IF STQ=1 THEN 'if keytone is pressed
  DTMFread = 0
  'converts binary returned by DTMF to decimal
  IF Q1=1 THEN
    DTMFread = DTMFread + 1
  ENDIF
  IF Q2=1 THEN
    DTMFread = DTMFread + 2
  ENDIF
  IF Q3=1 THEN
    DTMFread = DTMFread + 4
  ENDIF
  IF Q4=1 THEN
    DTMFread = DTMFread + 8
  ENDIF

  IF (DTMFread = 1) THEN
    'Rotates counterclockwise for as long as 1 is pressed
    PULSOUT 12, 650
    PULSOUT 13, 650
    PAUSE 20
  ENDIF
```

Code

```
IF (DTMFread = 4) THEN
  PAUSE 20
  'Rotates counterclockwise 45 degrees
  FOR counter = 1 TO 8
    PULSOUT 12, 650
    PULSOUT 13, 650
    PAUSE 20
  NEXT
ENDIF

IF (DTMFread = 7) THEN
  PAUSE 20
  'Rotates counterclockwise 90 degrees
  FOR counter = 1 TO 19
    PULSOUT 12, 650
    PULSOUT 13, 650
    PAUSE 20
  NEXT
ENDIF

IF (DTMFread = 3) THEN
  'Rotates clockwise for as long as 3 is pressed
  PULSOUT 12, 850
  PULSOUT 13, 850
  PAUSE 20
ENDIF

  IF (DTMFread = 6) THEN
    PAUSE 20
    'Rotates clockwise 45 degrees
    FOR counter = 1 TO 8
      PULSOUT 12, 850
      PULSOUT 13, 850
      PAUSE 20
    NEXT
  ENDIF

  IF (DTMFread = 9) THEN
    PAUSE 20
    'Rotates clockwise 90 degrees
    FOR counter = 1 TO 19
      PULSOUT 12, 850
      PULSOUT 13, 850
      PAUSE 20
    NEXT
  ENDIF

ENDIF

IF cmDist>20 THEN
  'as long as robot is greater than 20cm away from object
  IF (DTMFread = 2) THEN
    'moves forward
    PULSOUT 12, 850
    PULSOUT 13, 650
    PAUSE 20
  ENDIF
ENDIF
IF (DTMFread = 8) THEN
  'moves backwards
  PULSOUT 12, 650
  PULSOUT 13, 850
  PAUSE 20
ENDIF
LOOP
```

Advantages/Disadvantages

- Advantage
  - Cost
  - Ease of use
  - Long range use capacity (within mobile range)
  - Adaptability
  - Availability
- Disadvantages
  - Needs to be within line of sight
  - Limited by mobile range
  - Only use 4-bits
  - Security (accessible to anyone)
  - Gas sensor not accurate after long duration
  - Cannot climb
  - Cannot detect wall approaching from an angle

Cost analysis

- Components came along with Boe-Bot Kit ($280)
- DTFM Decoder very low cost ($10)
- Other sensors are of negligible cost
- Mass production can further decrease price

Further Developments

- Implement line following capabilities
- Improve accuracy of Gas sensors even in long duration of use
- If gas leak detected, make specific call using DTFMOUT functionality in BS2

References

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