Obstacle avoidance car Design

Team 4

Arafa Arafa
Bassel Yasser Mahmoud
Mahmoud Sarhan
Youssef Ahmed Abbas

Table Of Content:

1 : Detailed Requirements

System Requirements:

1. The car starts initially from 0 speed
2. The default rotation direction is to the right
3. Press PB2 to start or stop the robot
4. After Pressing Start:
    1. The LCD will display a centered message in line 1 “Set Def. Rot.”
    2. The LCD will display the selected option in line 2 “Right”
    3. The robot will wait for 5 seconds to choose between Right and Left
        1. When PB1 is pressed once, the default rotation will be Left and the LCD line 2 will be updated
        2. When PB1 is pressed again, the default rotation will be Right and the LCD line 2 will be updated
        3. For each press, the default rotation will be changed and the LCD line 2 is updated
        4. After the 5 seconds, the default value of rotation is set
    4. The robot will move after 2 seconds from setting the default direction of rotation.
    5. For No obstacles or object is far than 70 centimeters:
        1. The robot will move forward with 30% speed for 5 seconds
        2. After 5 seconds it will move with 50% speed as long as there was no object or objects are located at more than 70 centimeters distance
        3. The LCD will display the speed and moving direction in line 1: “Speed:00% Dir: F/B/R/S”, F: forward, B: Backwards, R: Rotating, and S: Stopped
        4. The LCD will display Object distance in line 2 “Dist.: 000 Cm”
    6. For Obstacles located between 30 and 70 centimeters
        1. The robot will decrease its speed to 30%
        2. LCD data is updated
    7. For Obstacles located between 20 and 30 centimeters
        1. The robot will stop and rotates 90 degrees to right/left according to the chosen configuration
        2. The LCD data is updated
    8. For Obstacles located less than 20 centimeters

1. The robot will stop, move backwards with 30% speed until distance is greater than 20 and less than 30
2. The LCD data is updated
3. Then preform point 8

9. Obstacles surrounding the robot (Bonus)
    1. If the robot rotated for 360 degrees without finding any distance greater than 20 it will stop
    2. LCD data will be updated.
    3. The robot will frequently (each 3 seconds) check if any of the obstacles was removed or not and move in the direction of the furthest object

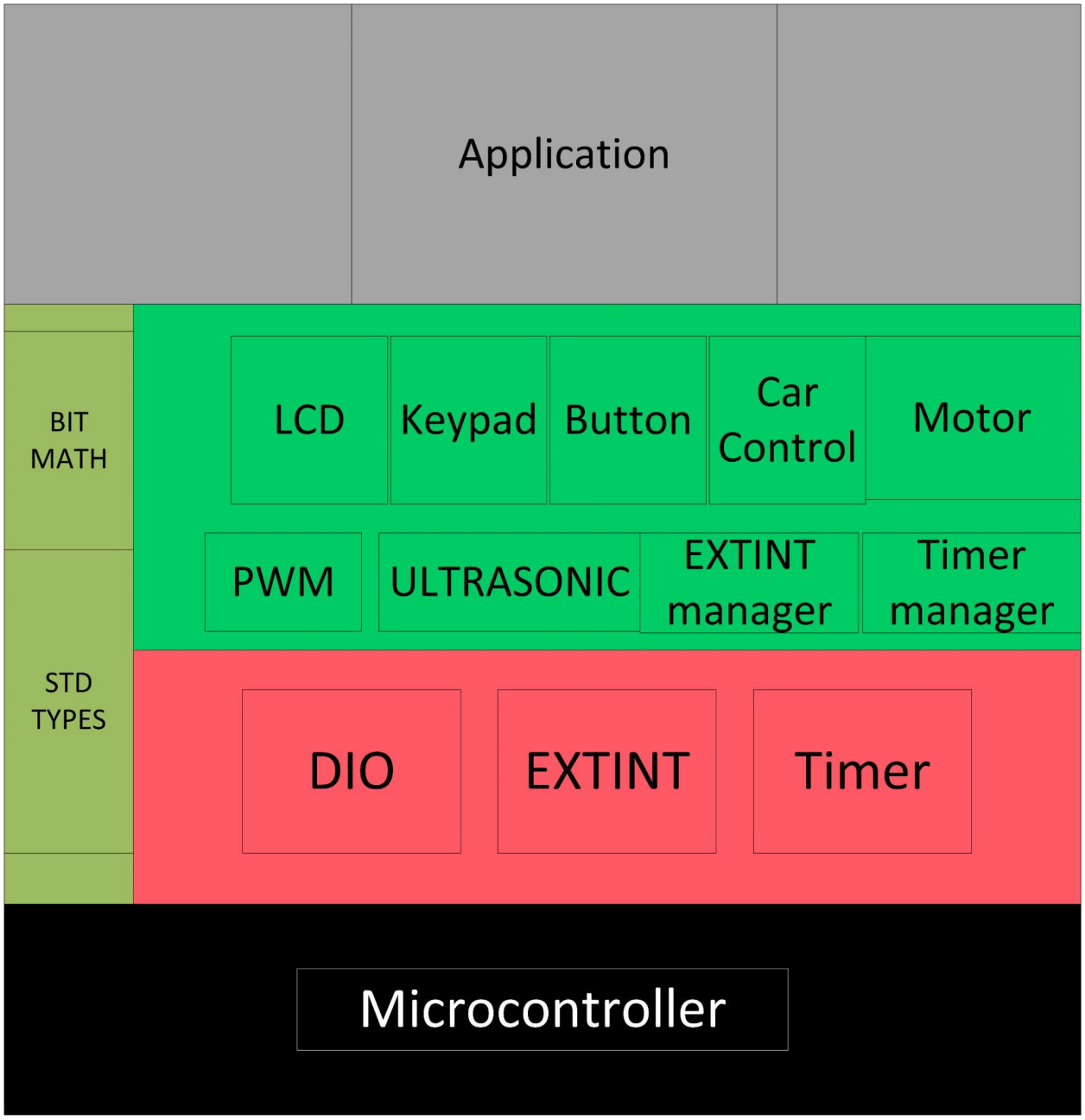
2 : Layered architecture

APP Layer: written in high level languages like java, C++, C# with rich GUI support. The application layer calls the middleware API in response to action by the user or an event.

HAL Layer: are a way to provide an interface between hardware and software, so applications can be device independent.

MCAL Layer: is a software module that directly accesses on-chip MCU peripheral modules and external devices that are mapped to memory, and makes the upper software layer independent of the MCU. Details of the MCAL software module are shown below.

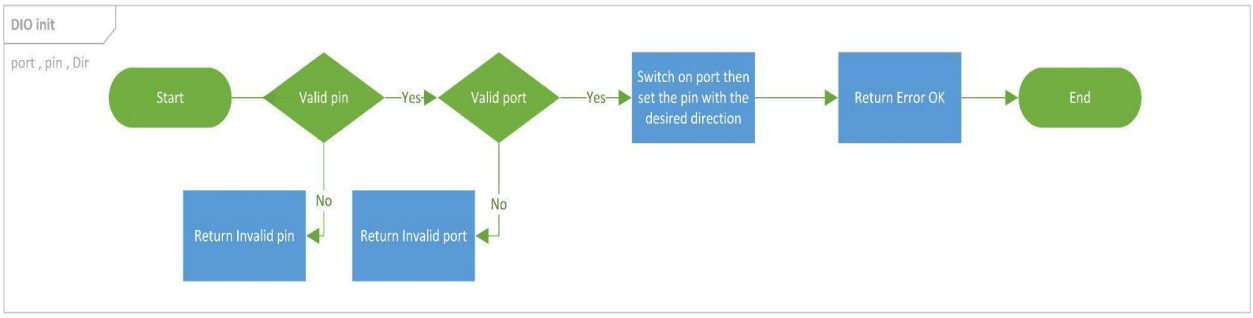
Common Layer: is the layer which consists of BIT_MATH and STD types

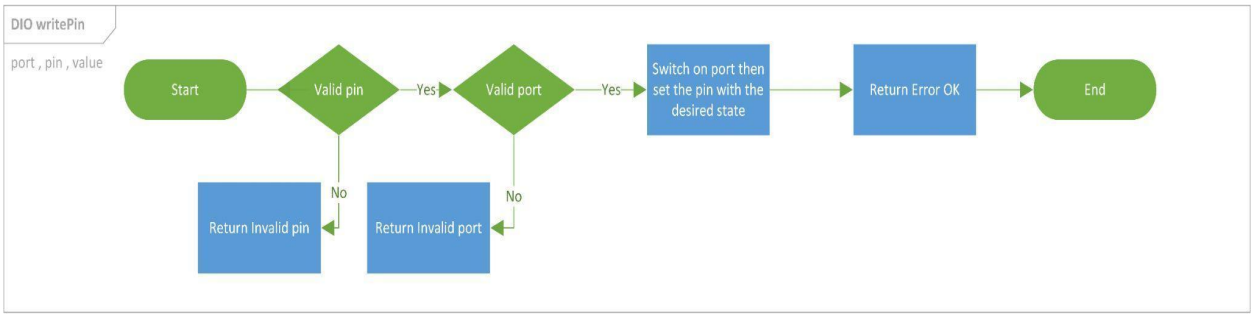

Application
BIT MATH
LCD
Keypad
Button
Car Control
Motor
PWM
ULTRASONIC
EXTINT manager
Timer manager
STD TYPES
DIO
EXTINT
Timer
Microcontroller

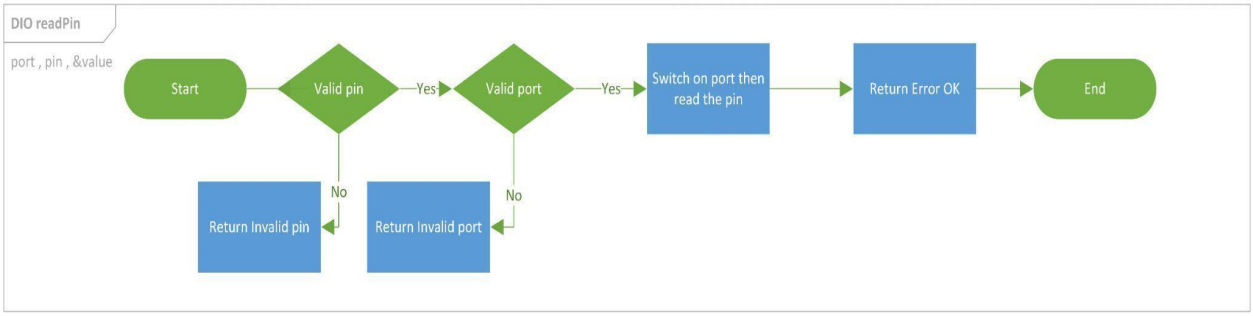
3.2: MCAL APIs

3.2.1: DIO API:

3.2.1.1 :Flowcharts:







3.2.1.2 : Type definitions:

- en_dioPinsType

Name	en_dioPinsType
Type	Enumeration
Range	Shall contain all pins ID
Description	en_dioPinsType
Available via	dio.h

- en_dioPortsType

Name	en_dioPortsType
Type	Enumeration
Range	Shall contain all ports ID
Description	en_dioPortsType
Available via	dio.h

- u8_en_dioErrors

Name	u8_en_dioErrorsType		
Type	Enumeration		
Range	DIO_E_OK	0x00	DIO error OK
	DIO_InvalidPin	0x01	DIO error, invalid pin number.
	DIO_InvalidPort	0x02	DIO error, invalid port number.
Description	u8_en_dioErrors		
Available via	dio.h		

- u8_en_dioLevelType

Name	u8_en_dioLevelType

Type	Enumeration		
Range	STD_LOW	0x00	Physical state 0V
	STD_HIGH	0x01	Physical state 5V or 3.3V.
Description	u8_en_dioLevelType		
Available via	dio.h		

- u8_en_dioDirType

Name	u8_en_dioDirType		
Type	Enumeration		
Range	STD_INPUT	0x00	Set pin as input pin
	STD_OUTPUT	0x01	Set pin as output pin
Description	u8_en_dioDirType		
Available via	dio.h		

3.2.1.3 : Services affecting the hardware unit:

- DIO_readPIN

Service name	DIO_readPIN
Syntax	u8_en_dioErrors DIO_readPIN (en_dioPortsType port, en_dioPinsType pin, uint8_t* value);

Parameters (in)	Port, pin	Channel ID	
	value	Pointer to store the level	STD_HIGH
			STD_LOW
Return	u8_en_dioErrors	DIO_E_OK	
		DIO_InvalidPin	
		DIO_InvalidPort	
Description	This Function gets the level of the pin		

- This function shall return DIO_InvalidPin if pin number is invalid.
- This function shall return DIO_InvalidPort if port number is invalid.

- DIO_writePIN

Service name	DIO_writePIN		
Syntax	u8_en_dioErrors DIO_writePIN (en_dioPortsType port, en_dioPinsType pin, u8_en_dioLevelType state);		
Parameters (in)	Port, pin	Channel ID	
	state	Value to be set	STD_HIGH
			STD_LOW
Return	u8_en_dioErrors	DIO_E_OK	
		DIO_InvalidPin	
		DIO_InvalidPort	
Description	This Function sets the level of the pin		

- This function shall return DIO_InvalidPin if pin number is invalid.
- This function shall return DIO_InvalidPort if port number is invalid.

- DIO_init

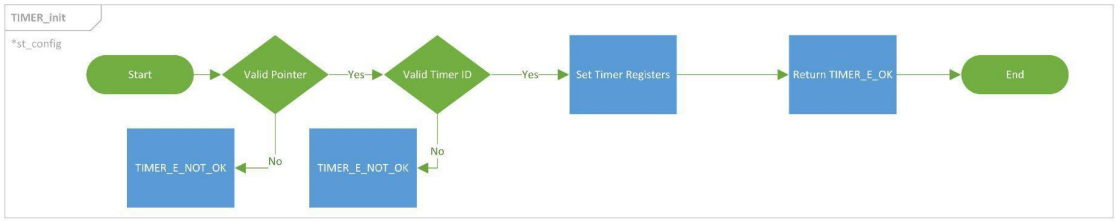
Service name	DIO_init

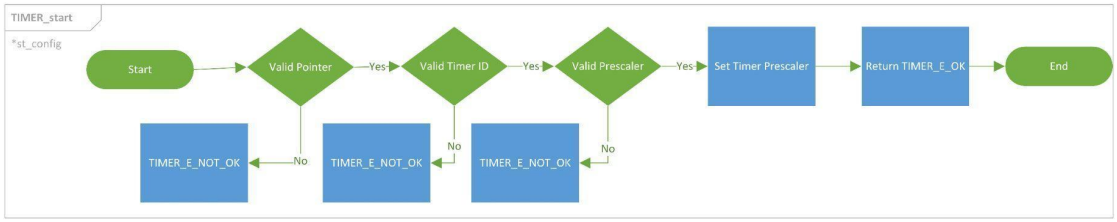
<table>
<tr><td>Syntax</td><td colspan="3">u8_en_dioErrors DIO_init (
en_dioPortsType port,
en_dioPinsType pin,
u8_en_dioDirType direction
);</td></tr>
<tr><td rowspan="3">Parameters (in)</td><td>Port, pin</td><td colspan="2">Channel ID</td></tr>
<tr><td rowspan="2">direction</td><td rowspan="2">Value to be set</td><td>STD_INPUT</td></tr>
<tr><td>STD_OUTPUT</td></tr>
<tr><td>Return</td><td colspan="3"><table><tr><td rowspan="3">DIO_Errors</td><td>DIO_E_OK</td></tr><tr><td>DIO_InvalidPin</td></tr><tr><td>DIO_InvalidPort</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="3">This Function sets the Direction of the pin</td></tr>
</table>

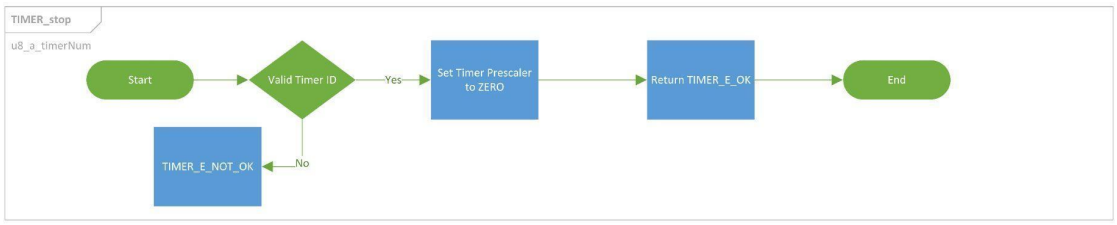
- This function shall return DIO_InvalidPin if pin number is invalid
- This function shall return DIO_InvalidPort if port number is invalid.

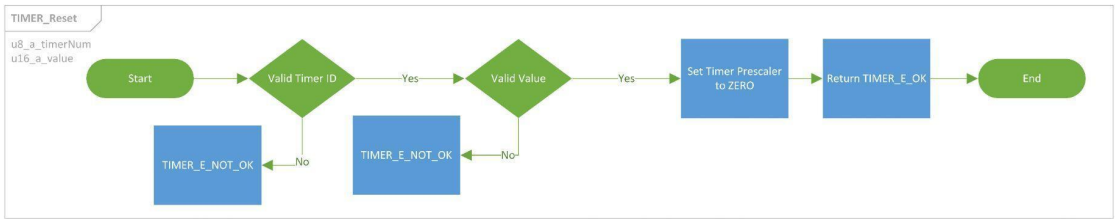
3.2.2: Timer API:

3.2.2.1 :Flowcharts:









3.2.2.2 : Type definitions:

- st_timerConfigType

Name	st_timerConfigType
Type	Structure
Range	Shall contain required timer configuration

Description	st_timerConfigType
Available via	timer_types.h

- u8_en_timerErrorsType

Name	u8_en_timerErrorsType		
Type	Enumeration		
Range	TIMER_E_OK	0x00	Timer error OK
	TIMER_E_NOT_OK	0x03	Timer error
Description	u8_en_timerErrorsType		
Available via	timer_types.h		

- u8_en_timerPrescalerType

Name	u8_en_timerPrescalerType
Type	Enumeration
Range	Shall Contain all Prescaler values
Description	u8_en_timerPrescalerType
Available via	timer_types.h

- u8_en_timerNumberType

Name	u8_en_timerNumberType
Type	Enumeration
Range	Shall Contain all Timers IDs
Description	u8_en_timerNumberType

Available via	timer_types.h

3.2.2.3 : Services affecting the hardware unit

- TIMER_init

Service name	TIMER_init	
Syntax	u8_en_timerErrorsType TIMER_init (st_timerConfigType* st_config);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function Initialize TIMER module	

  - This function shall return TIMER_E_NOK if st_config is NULL
  - This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

- TIMER_start

Service name	TIMER_start	
Syntax	u8_en_timerErrorsType TIMER_start (st_timerConfigType* st_config);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function start TIMER	

  - This function shall return TIMER_E_NOK if st_config is NULL
  - This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

- TIMER_stop

Service name	TIMER_stop	
Syntax	u8_en_timerErrorsType TIMER_stop (u8_en_timerNumberType u8_a_timerNum);	
Parameters (in)	u8_a_timerNum	Pointer to the configuration structure
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function stop TIMER	

  - This function shall return TIMER_E_NOK if u8_a_timerNum is invalid

- TIMER_reset

Service name	TIMER_reset	
Syntax	u8_en_timerErrorsType TIMER_reset (st_timerConfigType* st_config);	
Parameters (in)	st_config	Timer ID
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function reset the TIMER	

  - This function shall return TIMER_E_NOK if st_config is NULL
  - This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

- TIMER_setCallBack

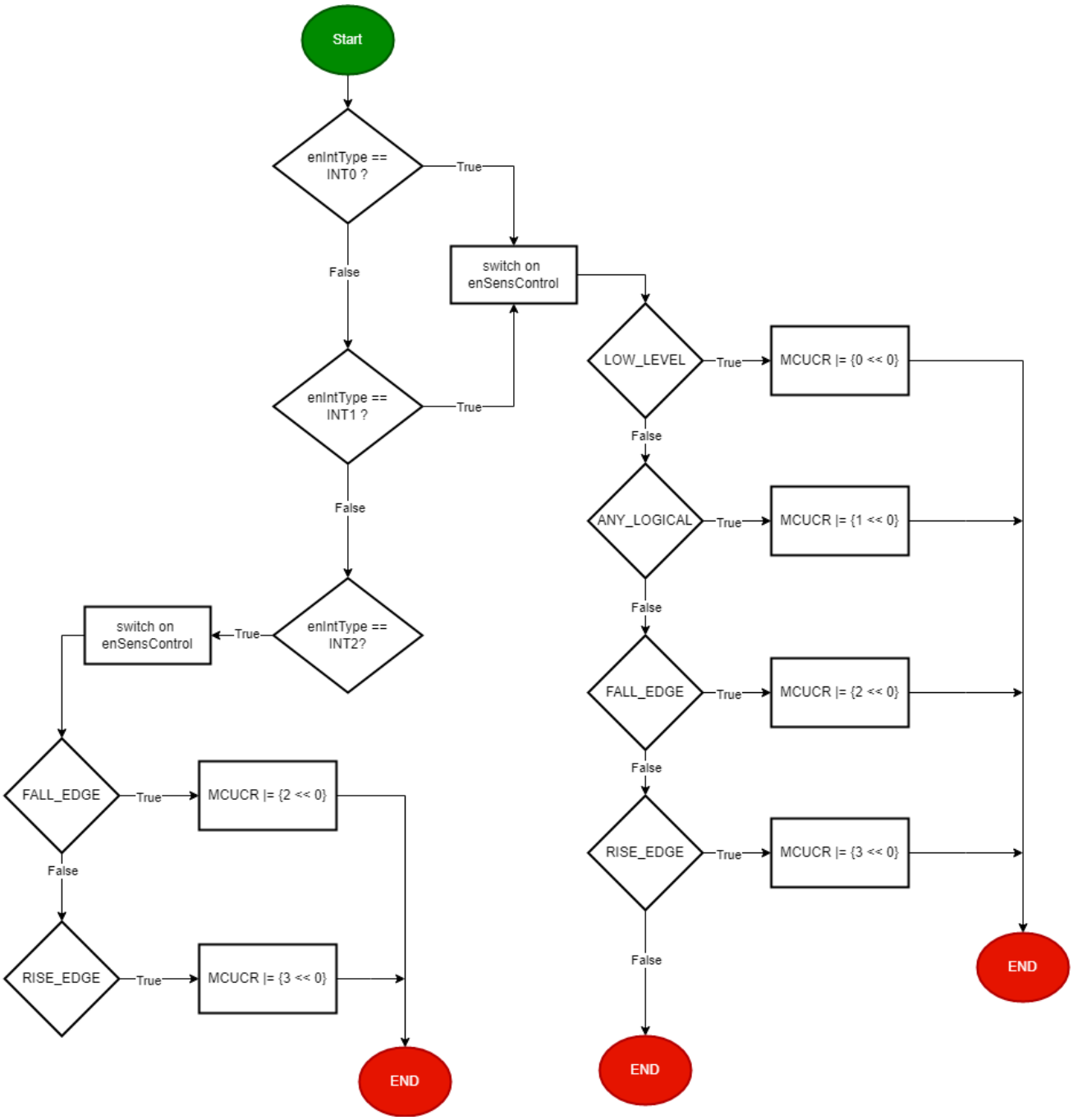
<table>
<tr><td>Service name</td><td colspan="2">TIMER_setCallBack</td></tr>
<tr><td>Syntax</td><td colspan="2">u8_en_timerErrorsType TIMER_setCallBack (
void(*a_timerCallBack)(void),
u8_en_timerNumberType u8_a_timerNum
);</td></tr>
<tr><td rowspan="2">Parameters (in)</td><td>*a_timerCallBack</td><td>Pointer to the Callback function</td></tr>
<tr><td>u8_a_timerNum</td><td>Timer ID</td></tr>
<tr><td>Return</td><td colspan="2"><table><tr><td rowspan="2">u8_en_timerErrorsType</td><td>TIMER_E_OK</td></tr><tr><td>TIMER_E_NOT_OK</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="2">This Function reset the TIMER</td></tr>
</table>

  - This function shall return TIMER_E_NOK if a_timerCallBack is NULL
  - This function shall return TIMER_E_NOK if u8_a_timerNum is invalid.

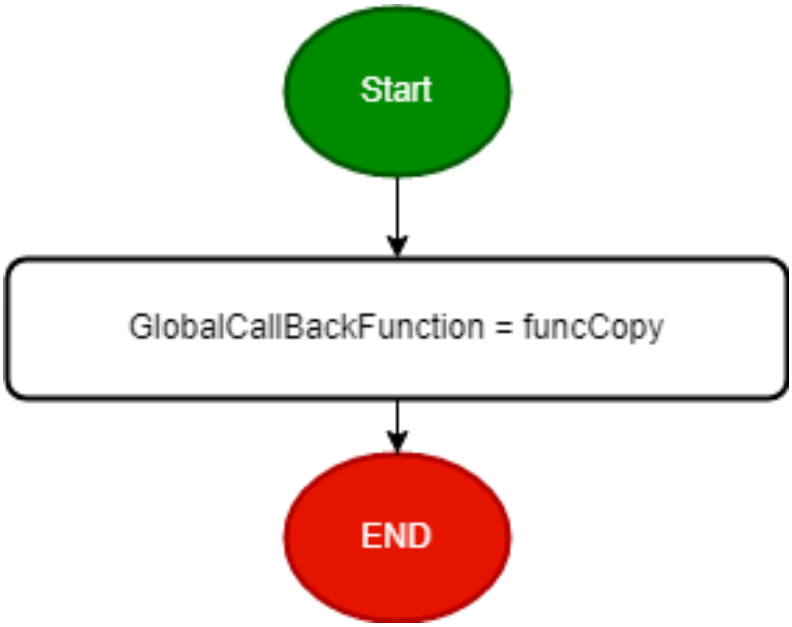
3.2.3: ExtInt API:

3.2.3.1 :Flowcharts:

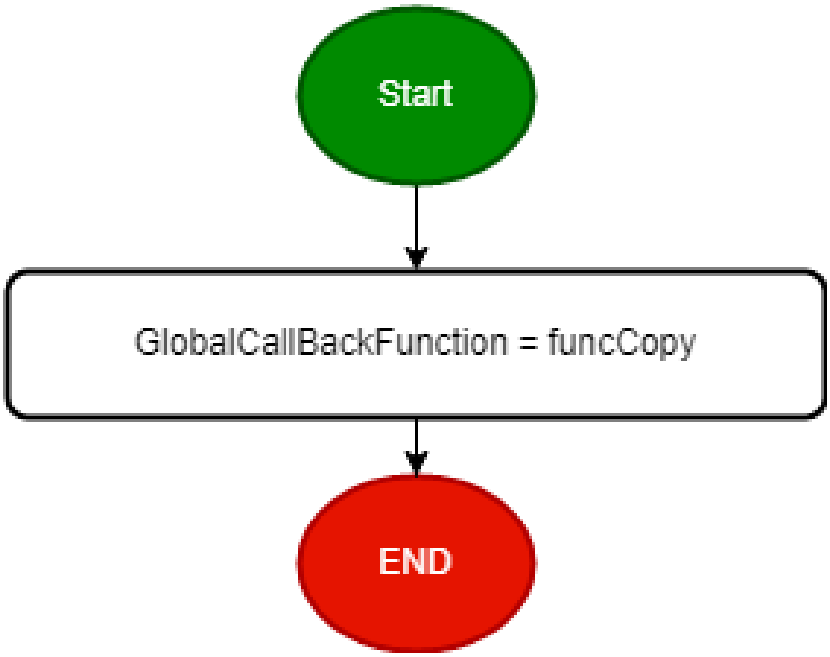
Uint8_t vidExtInt_init (enu_int_type_t, enu_sns_ctrl_t)



```
void vidCallBackFunc (ptr_func funcCopy)
```



```
void vidCallBackFuncInt1(ptr_func funcCopy);
```



3.2.3.2 : Services affecting the hardware unit

Uint8_t vidExtInt_init (en_int_type_t, en_sns_ctrl_t);

Service name	vidExtInt_init	
Parameters (in)	en_int_type_t	Interrupt type [INT0, INT1. INT2]
	en_sns_ctrl_t	snsCtrl : Sense Control {ANY_LOGICAL, FALL_EDGE, RISE_EDGE}
Return	Uint8_t	MEXTINT_OK MEXTINT_NOK
Description	External Interrupt Initialization	

Uint8_t vidCallBackFunc (ptr_func funcCopy);

Service name	vidCallBackFunc	
Parameters (in)	ptr_func	Pointer to function
Return	Uint8_t	MEXTINT_OK MEXTINT_NOK
Description	Take pointer to function to be executed in ISR when it fires	

Uint8_t vidCallBackFuncInt1(ptr_func funcCopy);

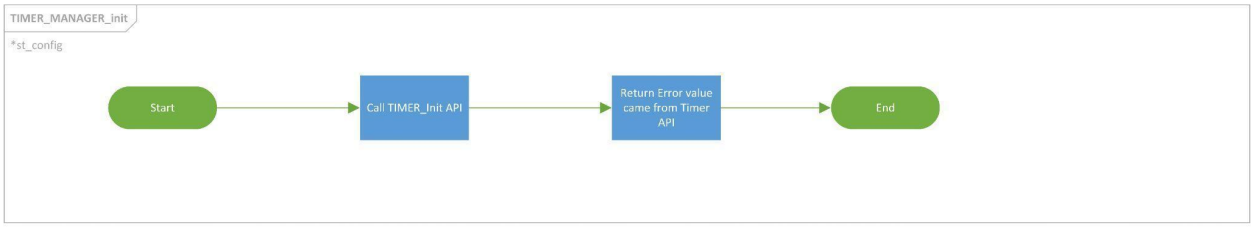
Service name	vidCallBackFuncInt1

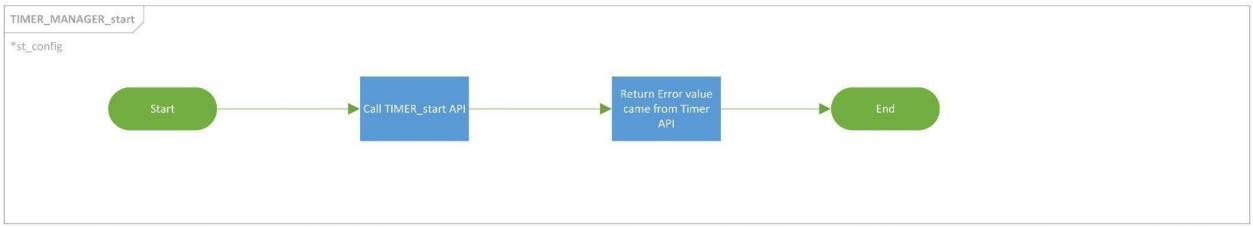
<table>
<tr><td>Parameters (in)</td><td>ptr_func</td><td>Pointer to function</td></tr>
<tr><td>Return</td><td colspan="2"><table><tr><td>Uint8_t</td><td>MEXTINT_OK</td></tr><tr><td></td><td>MEXTINT_NOK</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="2">Take pointer to function to be executed in ISR when it fires for Int 1</td></tr>
</table>

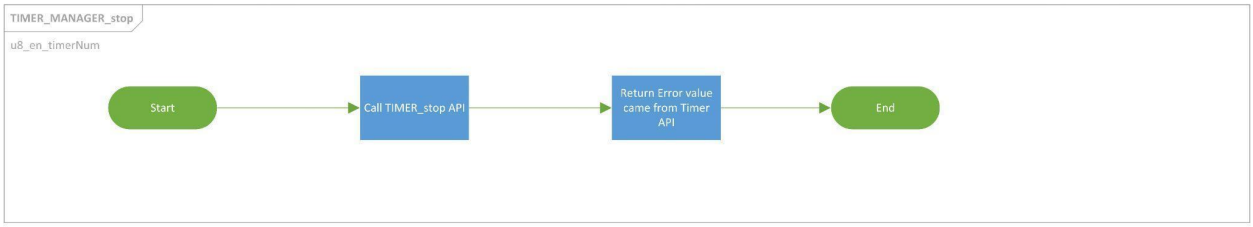
3.3 : HAL APIs

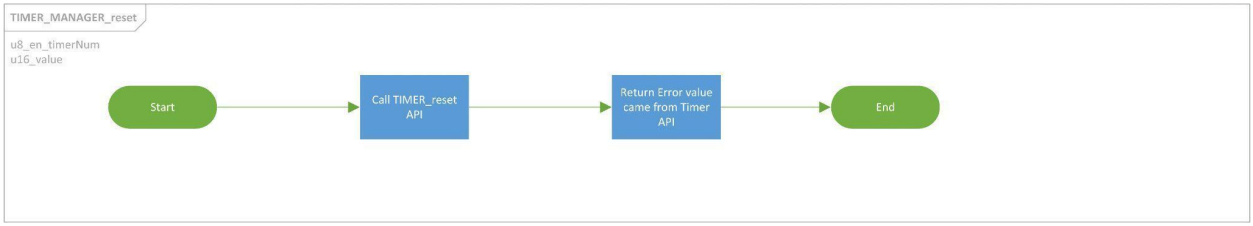
3.3.1: Timer Manager API:

3.3.1.1 :Flowcharts:









3.3.1.2 : Type definitions:

Imported from Timer Module

3.3.1.3 : Services affecting the hardware unit

- TIMER_Manager_init

Service name	TIMER_Manager_init	
Syntax	u8_en_timerErrorsType TIMER_Manager_init (st_timerConfigType* st_config);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function Initialize TIMER module	

- This function shall return TIMER_E_NOK if st_config is NULL
- This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

- TIMER_Manager_start

Service name	TIMER_Manager_start	
Syntax	u8_en_timerErrorsType TIMER_Manager_start (st_timerConfigType* st_config);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_timerErrorsType	TIMER_E_OK TIMER_E_NOT_OK
Description	This Function start TIMER	

- This function shall return TIMER_E_NOK if st_config is NULL
- This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

- TIMER_Manager_stop

Service name	TIMER_Manager_stop
Syntax	u8_en_timerErrorsType TIMER_Manager_stop (u8_en_timerNumberType u8_en_timerNum);

<table>
<tr><td>Parameters (in)</td><td>u8_en_timerNum</td><td>Timer ID</td></tr>
<tr><td>Return</td><td colspan="2"><table><tr><td>u8_en_timerErrorsType</td><td>TIMER_E_OK</td></tr><tr><td></td><td>TIMER_E_NOT_OK</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="2">This Function stop TIMER</td></tr>
</table>

- This function shall return TIMER_E_NOK if u8_en_timerNum is invalid

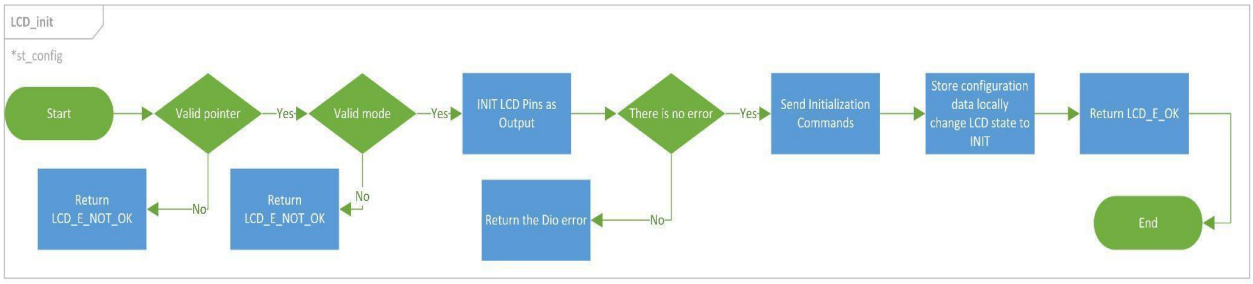
- TIMER_Manager_reset

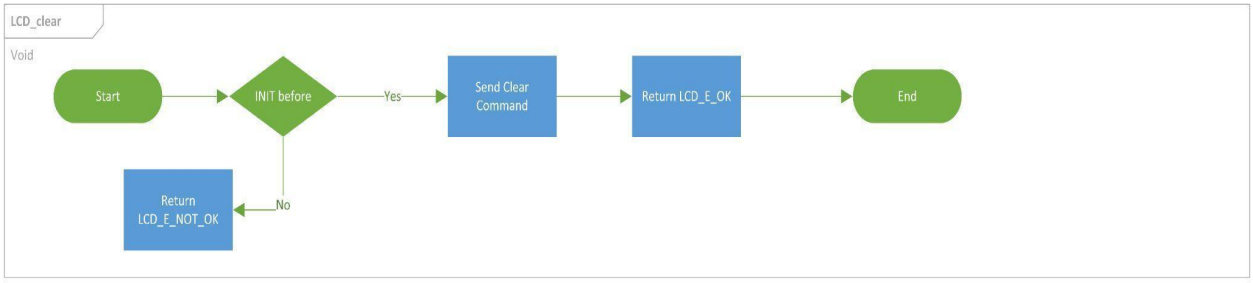
<table>
<tr><td>Service name</td><td colspan="2">TIMER_Manager_reset</td></tr>
<tr><td>Syntax</td><td colspan="2">u8_en_timerErrorsType TIMER_Manager_reset (
st_timerConfigType* st_config
);</td></tr>
<tr><td>Parameters (in)</td><td>st_config</td><td>Pointer to the configuration structure</td></tr>
<tr><td>Return</td><td colspan="2"><table><tr><td>u8_en_timerErrorsType</td><td>TIMER_E_OK</td></tr><tr><td></td><td>TIMER_E_NOT_OK</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="2">This Function reset the TIMER with the initial value</td></tr>
</table>

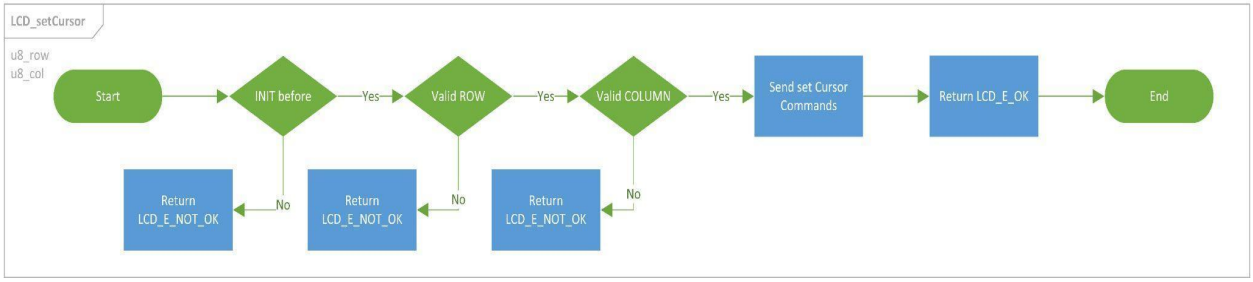
- This function shall return TIMER_E_NOK if st_config is NULL
- This function shall return TIMER_E_NOK if any of the configuration elements is invalid.

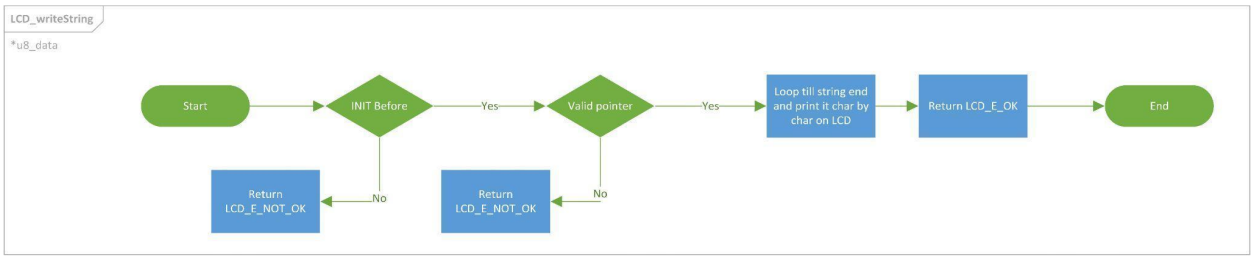
3.3.2: LCD API:

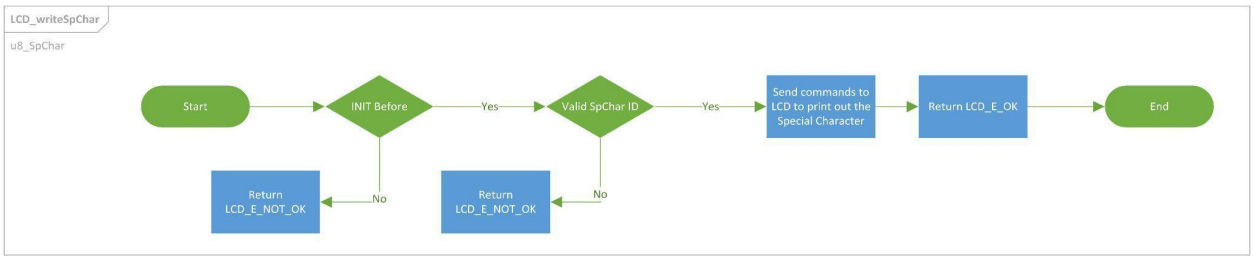
3.3.2.1 :Flowcharts:











3.3.2.2 : Type definitions:

- st_lcdConfigType

Name	st_lcdConfigType
Type	Structure
Range	Shall contain required LCD configuration
Description	st_lcdConfigType
Available via	lcd.h

- u8_en_lcdErrorsType

Name	u8_en_lcdErrorsType		
Type	Enumeration		
Range	LCD_E_OK	0x00	LCD error OK
	LCD_E_NOT_OK	0x05	LCD error
Description	u8_en_lcdErrorsType		
Available via	lcd.h		

- u8_en_lcdModeType

Name	u8_en_lcdModeType		
Type	Enumeration		
Range	LCD_4_BIT_MODE	0x00	LCD 4-bit mode
	LCD_8_BIT_MODE	0x01	LCD 8-bit mode
	LCD_INVALID_MODE	0X02	LCD invalid mode
Description	u8_en_lcdModeType		
Available via	lcd.h		

- u8_en_lcdSpCharType

Name	u8_en_lcdSpCharType
Type	Enumeration
Range	Shall contain all special characters IDs
Description	u8_en_lcdSpCharType
Available via	lcd.h

3.3.2.3 : Services affecting the hardware unit

- LCD_init

<table>
<tr><td>Service name</td><td colspan="2">LCD_init</td></tr>
<tr><td>Syntax</td><td colspan="2">u8_en_lcdErrorsType LCD_init (
st_lcdConfigType* st_config
);</td></tr>
<tr><td>Parameters (in)</td><td>st_config</td><td>Pointer to the configuration structure</td></tr>
<tr><td>Return</td><td colspan="2"><table><tr><td rowspan="2">u8_en_lcdErrorsType</td><td>LCD_E_OK</td></tr><tr><td>LCD_E_NOT_OK</td></tr></table></td></tr>
<tr><td>Description</td><td colspan="2">This Function Initialize LCD module</td></tr>
</table>

  - This function shall return LCD_E_NOK if st_config is NULL
  - This function shall return LCD_E_NOK if any of the configuration elements is invalid.

- LCD_clear

Service name	LCD_clear	
Syntax	u8_en_lcdErrorsType LCD_clear (void);	
Parameters (in)	None	
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	This Function Clear LCD	

- LCD_setCursor

Service name	LCD_setCursor	
Syntax	u8_en_lcdErrorsType LCD_setCursor (uint8_t u8_row, uint8_t u8_col);	
Parameters (in)	u8_row	The desired row to set cursor
	u8_col	The desired column to set cursor
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	This Function sets the cursor location on LCD	

- LCD_writeString

Service name	LCD_writeString	
Syntax	u8_en_lcdErrorsType LCD_writeString (uint8_t* u8_data);	
Parameters (in)	u8_data	Pointer to string to it print on screen

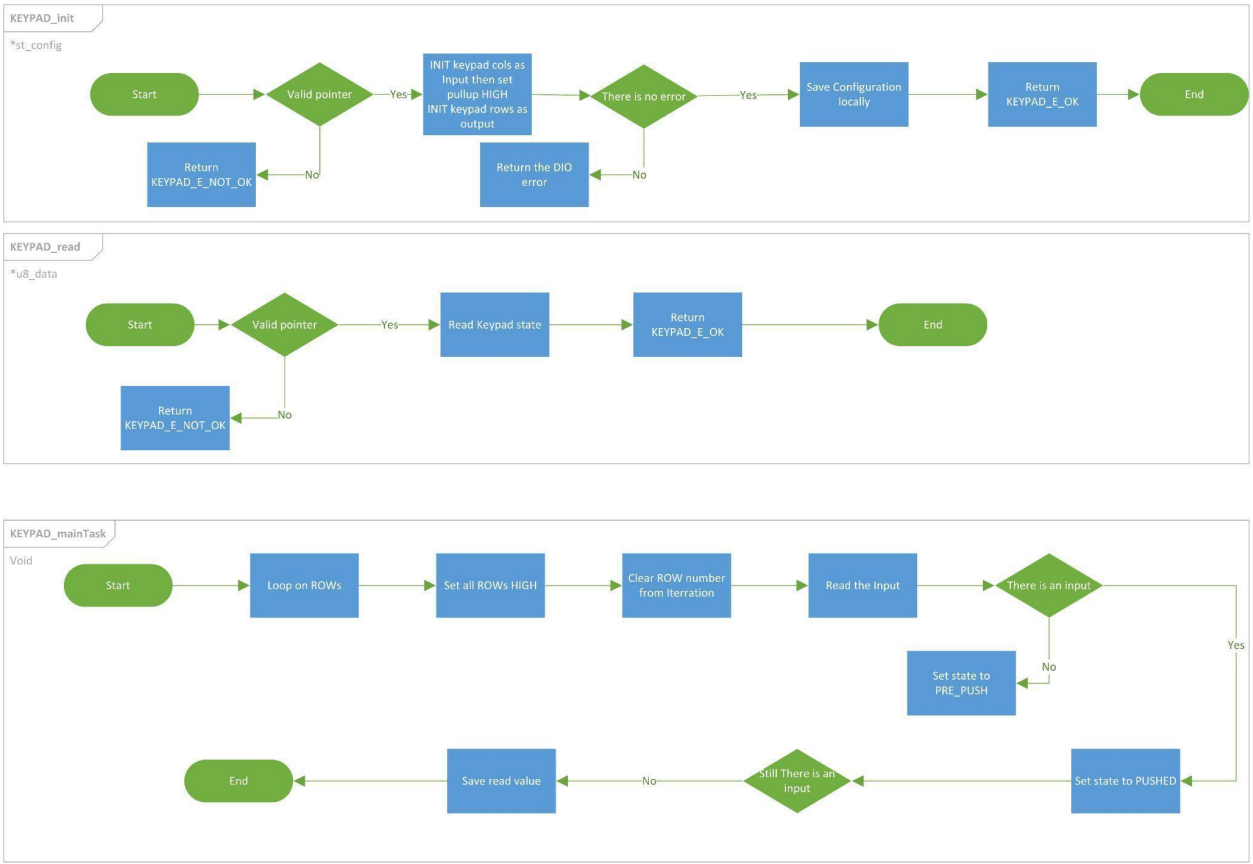
Return	u8_en_lcdErrorsType	LCD_E_OK
		LCD_E_NOT_OK
Description	This Function write a string on LCD	

- LCD_writeSpChar

Service name	LCD_writeSpChar	
Syntax	u8_en_lcdErrorsType LCD_writeSpChar (u8_en_lcdSpCharType u8_SpChar);	
Parameters (in)	u8_SpChar	Special character ID to it print on screen
Return	u8_en_lcdErrorsType	LCD_E_OK
		LCD_E_NOT_OK
Description	This Function write a special character on LCD	

3.3.3 : Keypad API :

3.3.3.1 :Flowcharts:



3.3.3.2 : Type definitions:

- st_keypadConfigType

Name	st_keypadConfigType
Type	Structure
Range	Shall contain required Keypad configuration
Description	st_keypadConfigType
Available via	keypad.h

- u8_en_keypadErrorsType

Name	u8_en_keypadErrorsType		
Type	Enumeration		
Range	KEYPAD_E_OK	0x00	Keypad error OK
	KEYPAD_E_NOT_OK	0x07	Keypad error
Description	u8_en_keypadErrorsType		
Available via	keypad.h		

3.3.3.3 : Services affecting the hardware unit

- KEYPAD_init

Service name	KEYPAD_init	
Syntax	u8_en_keypadErrorsType KEYPAD_init (st_keypadConfigType* st_config);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_keypadErrorsType	KEYPAD_E_OK
		KEYPAD_E_NOT_OK
Description	This Function Initialize Keypad module	

  - This function shall return KEYPAD_E_NOK if st_config is NULL
  - This function shall return KEYPAD_E_NOK if any of the configuration elements is invalid.
  - This function shall return DIO_E_NOT_OK if failed to initialize the pin direction to be OUTPUT or INPUT

- KEYPAD_read

Service name	KEYPAD_read
Syntax	u8_en_keypadErrorsType KEYPAD_read (uint8_t * u8_data);

Parameters (in)	u8_data	Pointer to variable where to store value read from keypad
Return	u8_en_keypadErrorsType	KEYPAD_E_OK KEYPAD_E_NOT_OK
Description	This Function read Keypad	

3.3.4 : Car Control API :

3.3.4.1: Flowcharts:

3.3.4.2 : Type definitions:

- st_carControlConfigType

Name	st_carControlConfigType
Type	Structure
Range	Shall contain required car motors configuration
Description	st_carControlConfigType
Available via	car_control.h

- u8_en_carControlErrorsType

Name	u8_en_carControlErrorsType		
Type	Enumeration		
Range	CAR_E_OK	0x00	CAR error OK
	CAR_E_NOT_OK	0x07	CAR error
Description	u8_en_carControlErrorsType		

Available via	car_control.h

3.3.4.2 : Services affecting the hardware unit

- CAR_init

Service name	CAR_init	
Syntax	u8_en_carControlErrorsType CAR_init (st_carControlConfigType* st_config_R, st_carControlConfigType* st_config_L);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_carControlErrorsType	CAR_E_OK CAR_E_NOT_OK
Description	This Function Initialize car module	

- CAR_moveForward

Service name	• CAR_moveForward	
Syntax	u8_en_carControlErrorsType CAR_moveForward(st_carControlConfigType* st_config_R, st_carControlConfigType* st_config_L);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_carControlErrorsType	CAR_E_OK CAR_E_NOT_OK
Description	This Function moving the car forward	

- CAR_turnRight

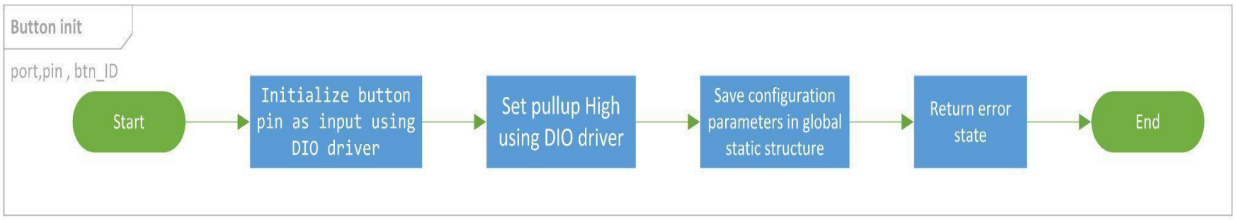
Service name	CAR_turnRight	
Syntax	u8_en_carControlErrorsType CAR_turnRight(st_carControlConfigType* st_config_R, st_carControlConfigType* st_config_L);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_carControlErrorsType	CAR_E_OK CAR_E_NOT_OK
Description	This Function turn the car right	

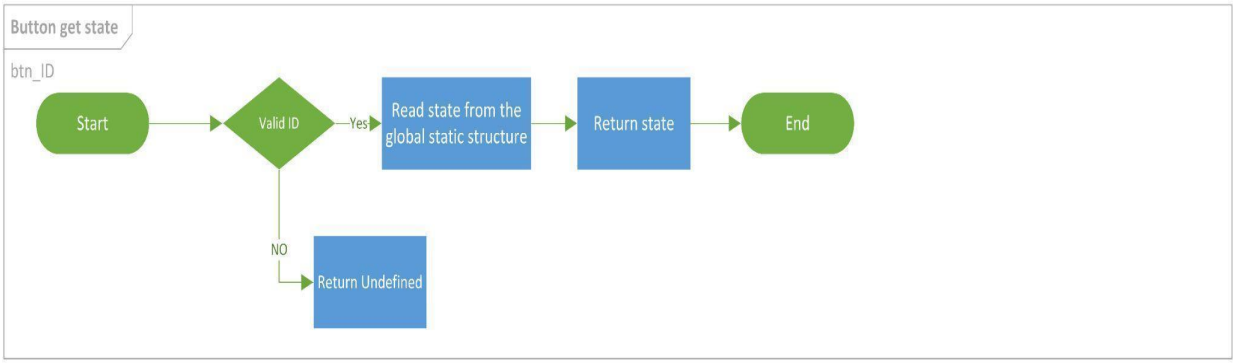
- CAR_turnLeft

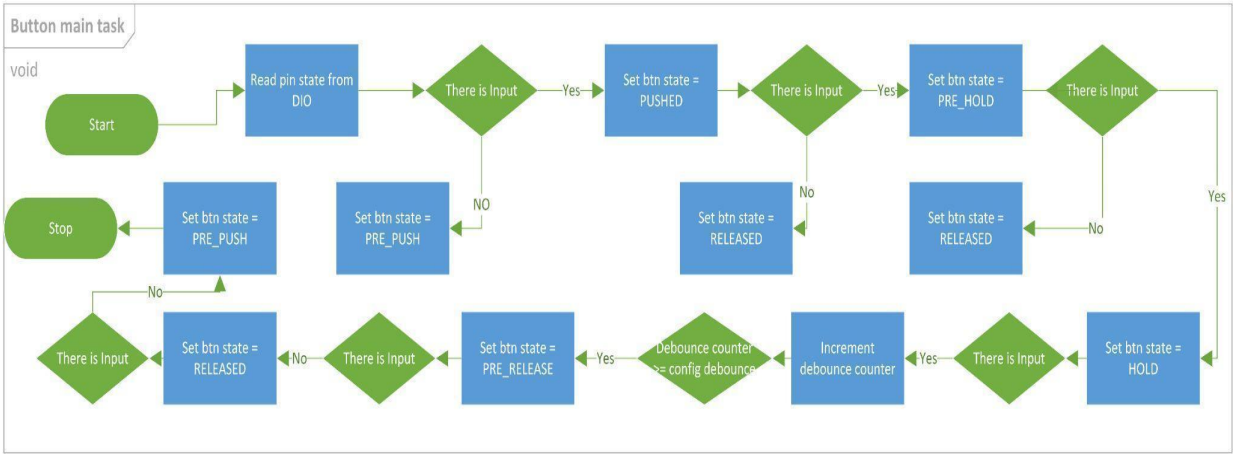
Service name	CAR_turnLeft	
Syntax	u8_en_carControlErrorsType CAR_turnLeft(st_carControlConfigType* st_config_R, st_carControlConfigType* st_config_L);	
Parameters (in)	st_config	Pointer to the configuration structure
Return	u8_en_carControlErrorsType	CAR_E_OK CAR_E_NOT_OK
Description	This Function turn the car left	

3.3.5: Button API:

3.3.5.1: Flowcharts:







3.3.5.2 : Type definitions:

- st_btnConfigType

Name	st_btnConfigType
Type	Structure
Description	This is the type of the external data structure containing the overall configuration data for the Button API
Available via	button_types.h

- u8_en_btnLevelType

Name	u8_en_btnLevelType		
Type	Enumeration		
Range	BT_PUSH_LEVEL	0x00	Push Level
	BT_RELEASE_LEVEL	0x01	Release Level
Description	Button Level Enum		
Available via	button_types.h		

- u8_en_btnStateType

Name	u8_en_btnStateType		
Type	Enumeration		
Range	BT_PRE_PUSH	0x00	Pre Push Level
	BT_PUSHED	0x01	Pushed Level
	BT_PRE_HOLD	0x02	Pre Hold Level
	BT_HOLD	0x03	Hold Level
	BT_PRE_RELEASE	0x04	Pre Release Level
	BT_RELEASED	0x05	Released Level
	BT_UNDEFINED	0x06	Undefined
Description	Button state Enum		
Available via	button_types.h		

- Button_IdType

Name	u8_en_btnIdType		
Type	Enumeration		
Range	Button_Start	0x00	Start Button
Description	Button ID Enum		
Available via	button_types.h		

3.3.5.2 : Services affecting the hardware unit

- BUTTON_getState

Service name	BUTTON_getState	
Syntax	u8_en_btnStateType BUTTON_getState(u8_en_btnIdType en_btnId);	
Parameters (in)	en_btnId	Start 0x00
Return	Button_StateTyp	BT_PRE_PUSH BT_PUSHED BT_PRE_HOLD BT_HOLD BT_PRE_RELEASE BT_RELEASED BT_UNDEFINED
Description	This Function gets the Button state.	

- button_Main_Task

Service name	button_Main_Task

Syntax	void button_Main_Taskt(void);
Parameters (in)	NONE
Return	NONE
Description	This Function update all button states Shall call periodic

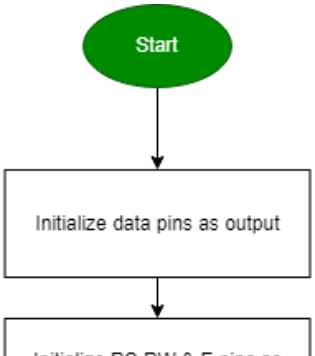
- BUTTON_init

Service name	BUTTON_init	
Syntax	u8_en_btnStateType BUTTON_init(uint8_t u8_a_port, uint8_t u8_a_pin, u8_en_btnIdType en_btnId);	
Parameters (in)	Port, pin	Channel ID
	en_btnId	Start 0x00
Return	Button_StateTyp	BT_PRE_PUSH
		BT_UNDEFINED
Description	This Function sets the Direction of the button pin as input	

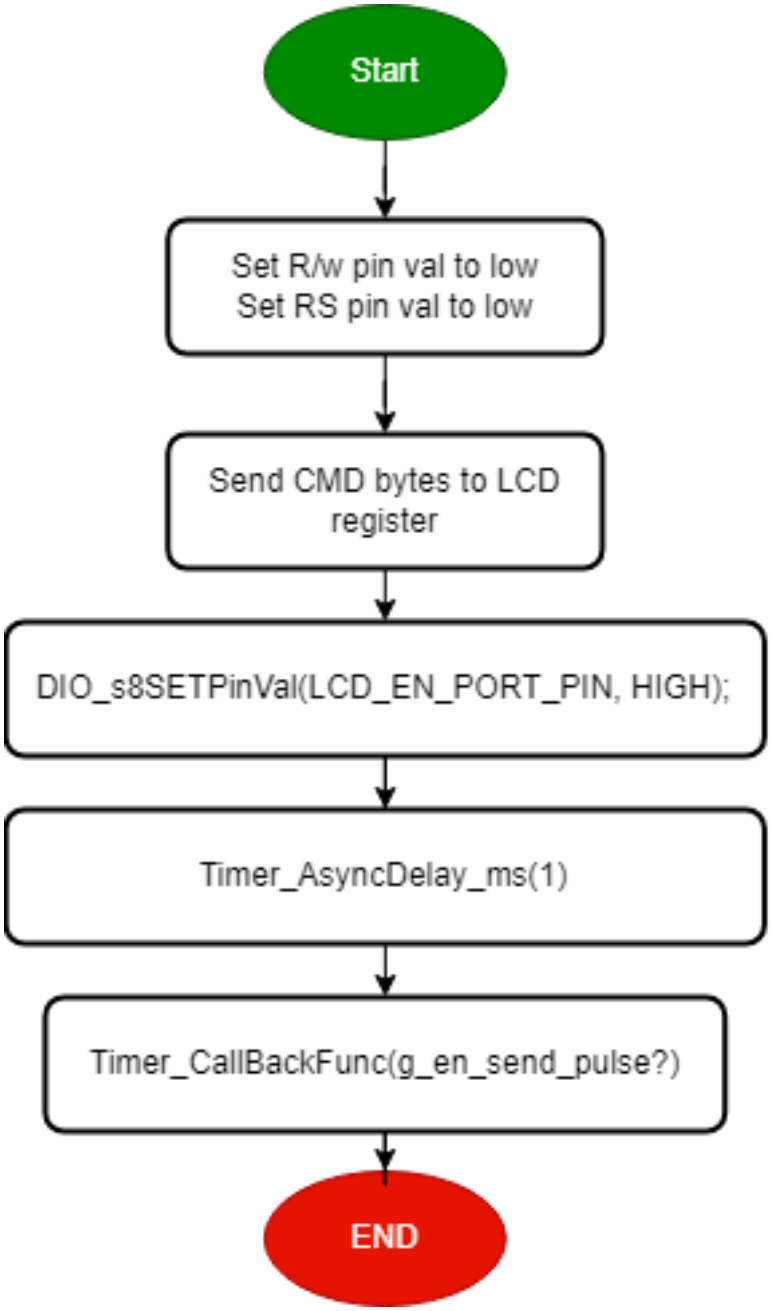
3.3.6 : LCD API :

3.3.6.1 :Flowcharts:

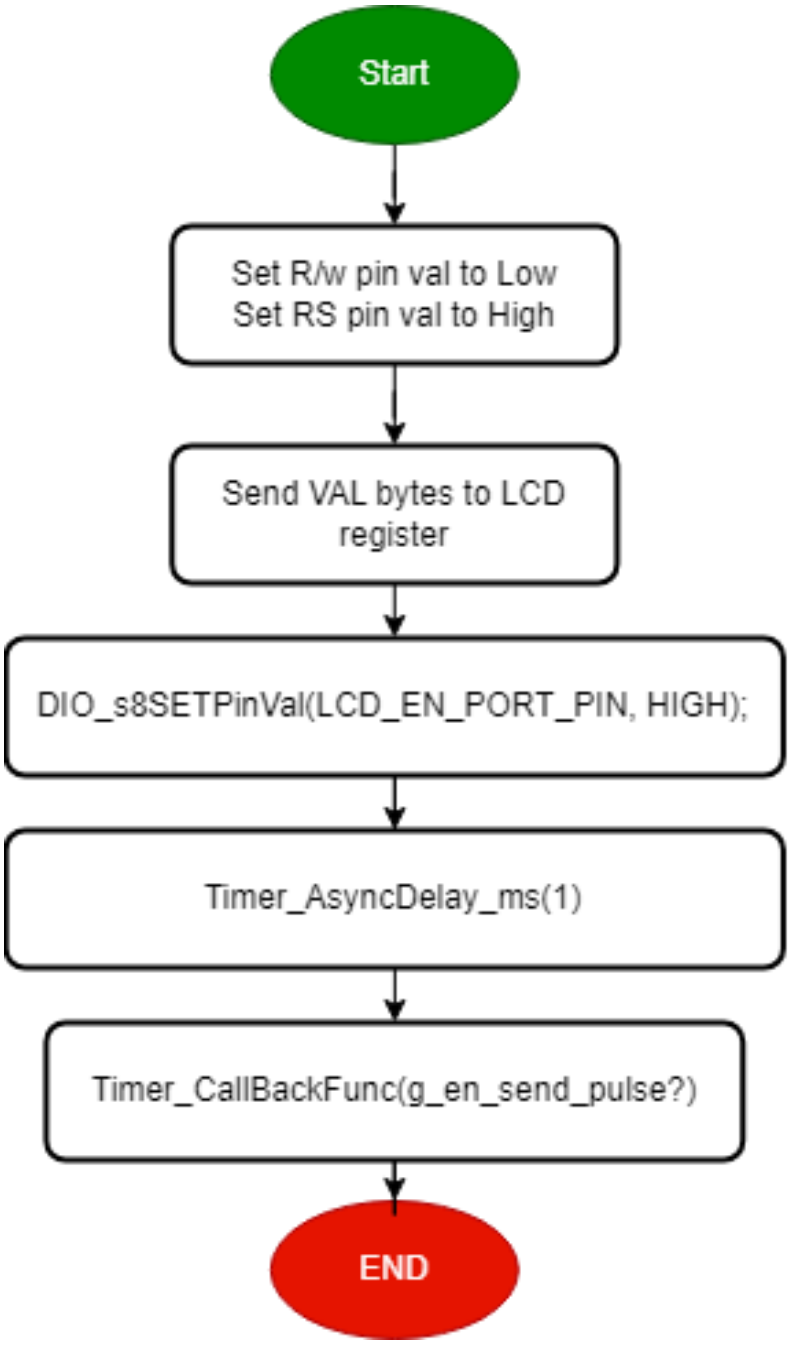
`lcdErrorsType` **HLCD_vidInit(void)**



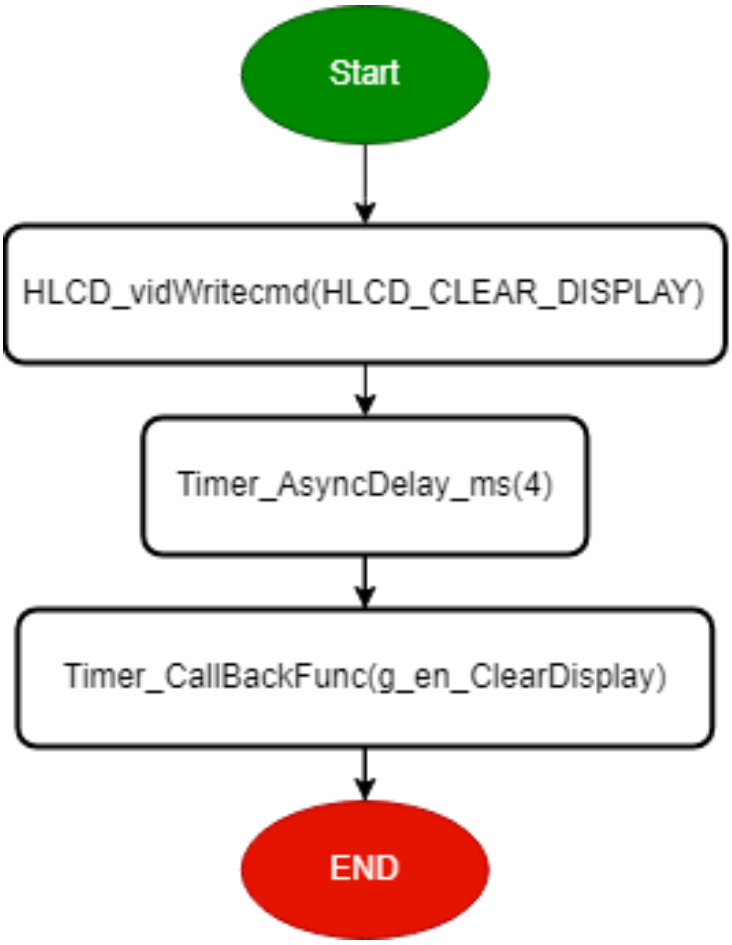
`lcdErrorsType` **HLCD _vidWritecmd (Uint8_t u8commandCopy)**



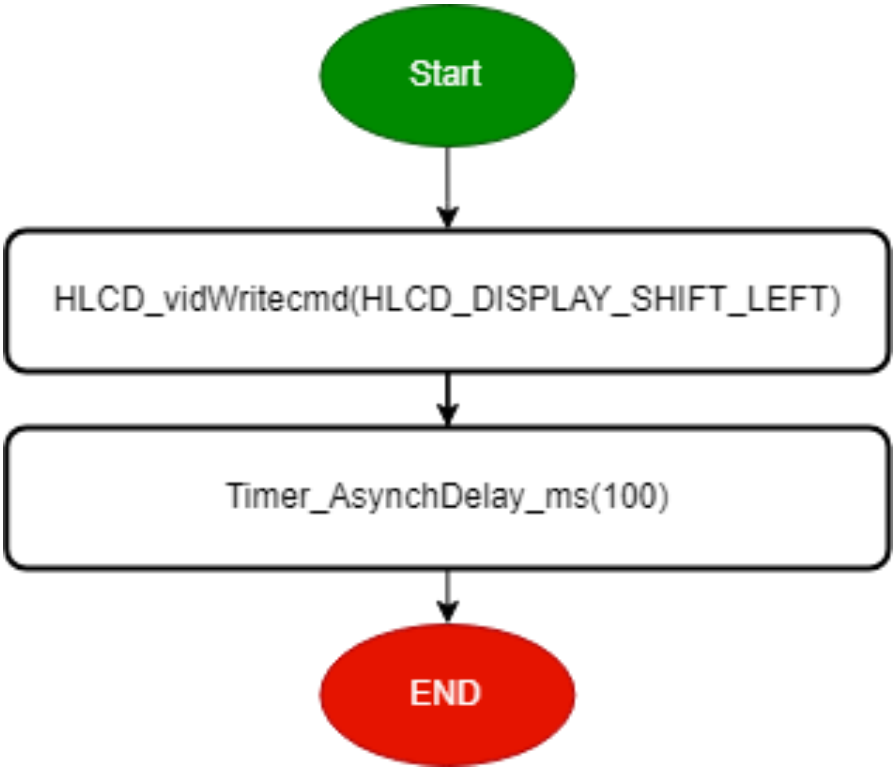
`lcdErrorsType` **HLCD_vidWriteChar (Uint8_t u8CharCopy)**



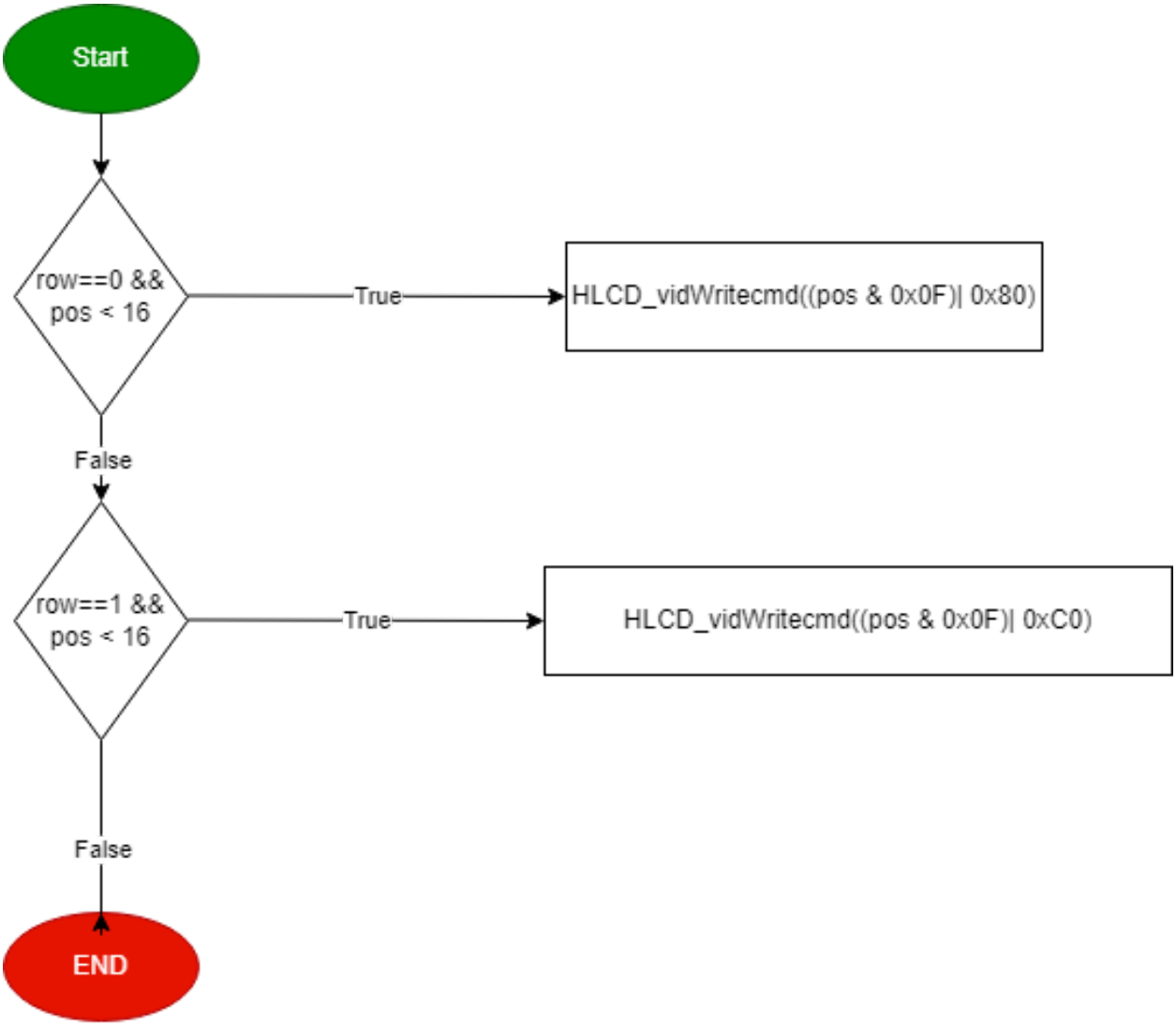
`lcdErrorsType` **HLCD_ClrDisplay(void)**



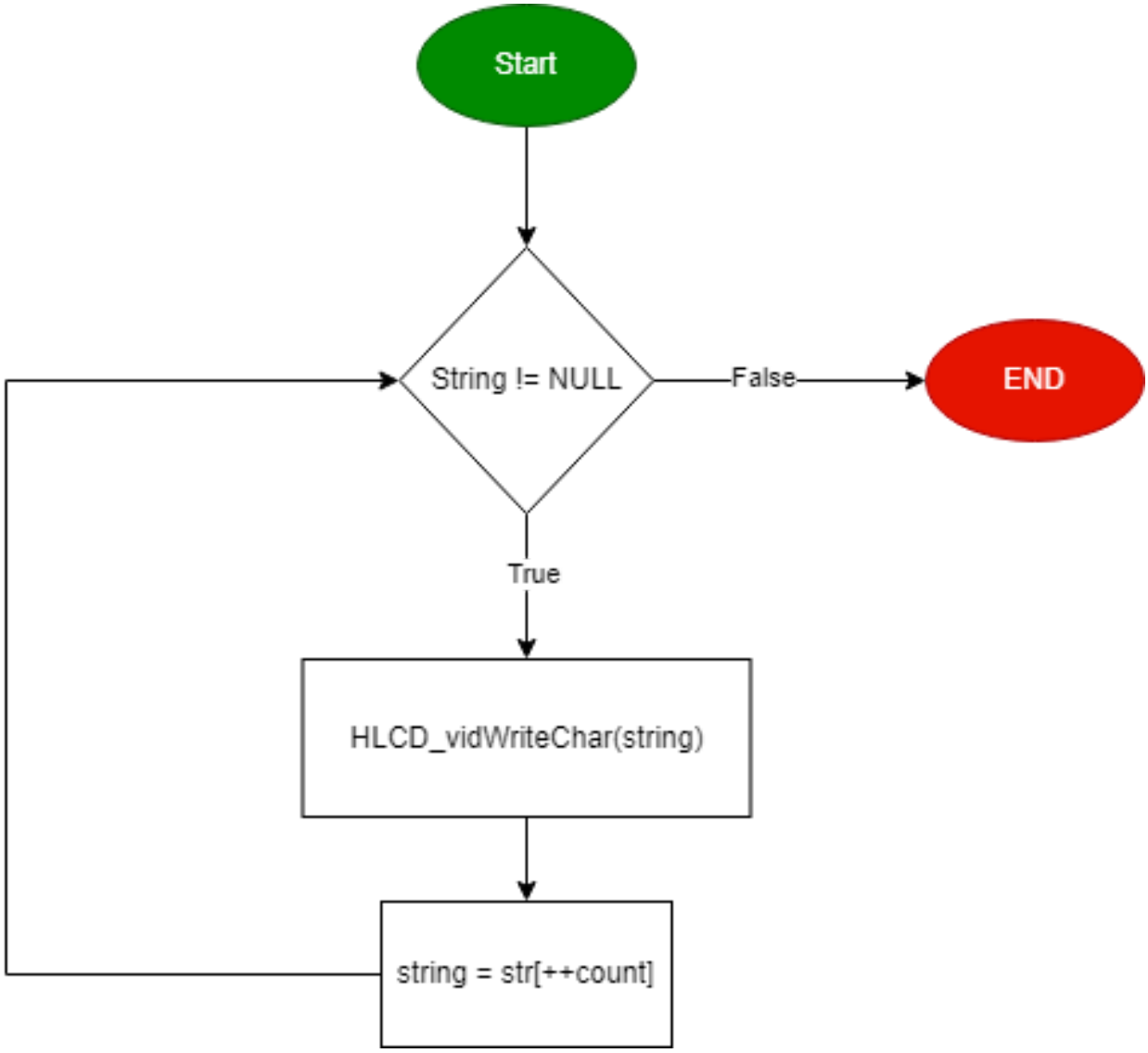
`lcdErrorsType` **HLCD_ShiftLeft(void)**



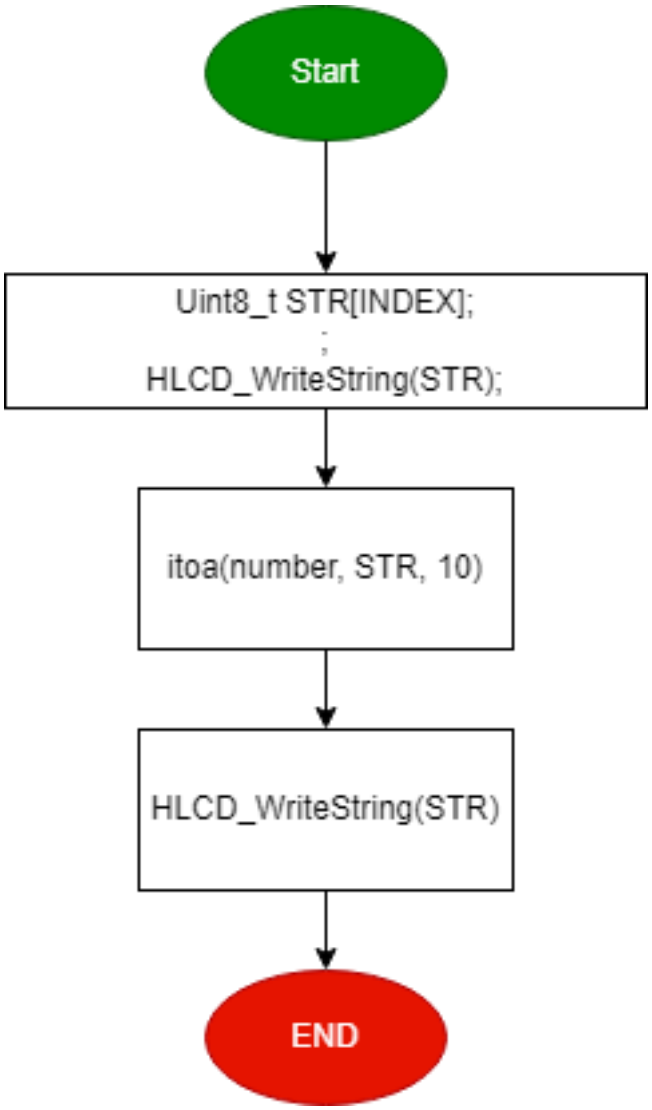
`lcdErrorsType` **HLCD_gotoXY (Uint8_t row, Uint8_t pos)**



`lcdErrorsType` **HLCD_WriteString (Uint8_t* str)**



`lcdErrorsType` **HLCD_WriteInt (Uint32_t number)**



3.3.6.2 : Services affecting the hardware unit

```
u8_en_lcdErrorsType HLCD_vidInit(void);
```

Service name	HLCD_vidInit	
Parameters (in)	**void**	
Return	u8_en_lcdErrorsType	LCD_E_OK
		LCD_E_NOT_OK
Description	func to set LCD initialization	

```
u8_en_lcdErrorsType HLCD_vidWritecmd(uint8_t u8commandCopy);
```

Service name	HLCD_vidWritecmd	
Parameters (in)	uint8_t	u8commandCopy --> take lcd cmd instructions from instruction table <https://components101.com/sites/default/files/component_datasheet/16x2%20LCD%20Datasheet.pdf>}
Return	u8_en_lcdErrorsType	LCD_E_OK
		LCD_E_NOT_OK
Description	func to configure some commands on lcd	

```
u8_en_lcdErrorsType HLCD_vidWriteChar(uint8_t u8CharCopy);
```

Service name	HLCD_vidWriteChar	
Parameters (in)	uint8_t	u8CharCopy -> take ascii code of char or char address on CGROM
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	func to write char on lcd	

```
u8_en_lcdErrorsType HLCD_ClrDisplay(void);
```

Service name	HLCD_ClrDisplay	
Parameters (in)	**void**	
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	func to clear anything on lcd	

```
u8_en_lcdErrorsType HLCD_ShiftLeft(void);
```

Service name	HLCD_ShiftLeft	
Parameters (in)	**void**	
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	func to shift the lcd display from right to left	

```
u8_en_lcdErrorsType HLCD_gotoXY(uint8_t row, uint8_t pos);
```

Service name	HLCD_gotoXY	
Parameters (in)	uint8_t	row -> take row number 0 or 1

	uint8_t	pos -> take colom number from 0 ~ 16
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	func to determine position which char print at this position on lcd ### NOTE : (2rows x 16coloms)	

```
u8_en_lcdErrorsType HLCD_WriteString(uint8_t* str);
```

Service name	HLCD_WriteString	
Parameters (in)	uint8_t*	str --> which take string as argument
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK
Description	func to write string on lcd	

```
u8_en_lcdErrorsType HLCD_WriteInt(Uint32_t number);
```

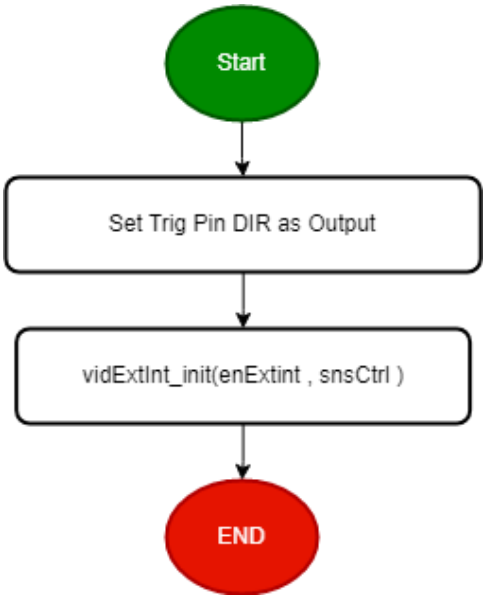
Service name	HLCD_WriteInt	
Parameters (in)	Uint32_t	number --> which take number as argument
Return	u8_en_lcdErrorsType	LCD_E_OK LCD_E_NOT_OK

Description	func to write integer number on lcd

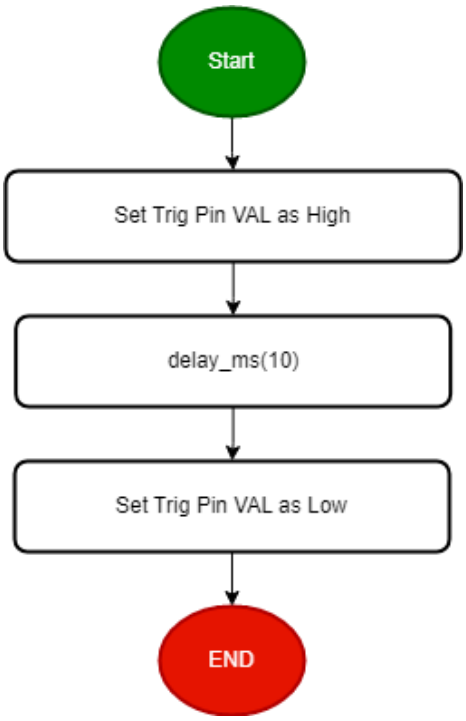
3.3.7 : Ultrasonic API :

3.3.7.1 :Flowcharts:

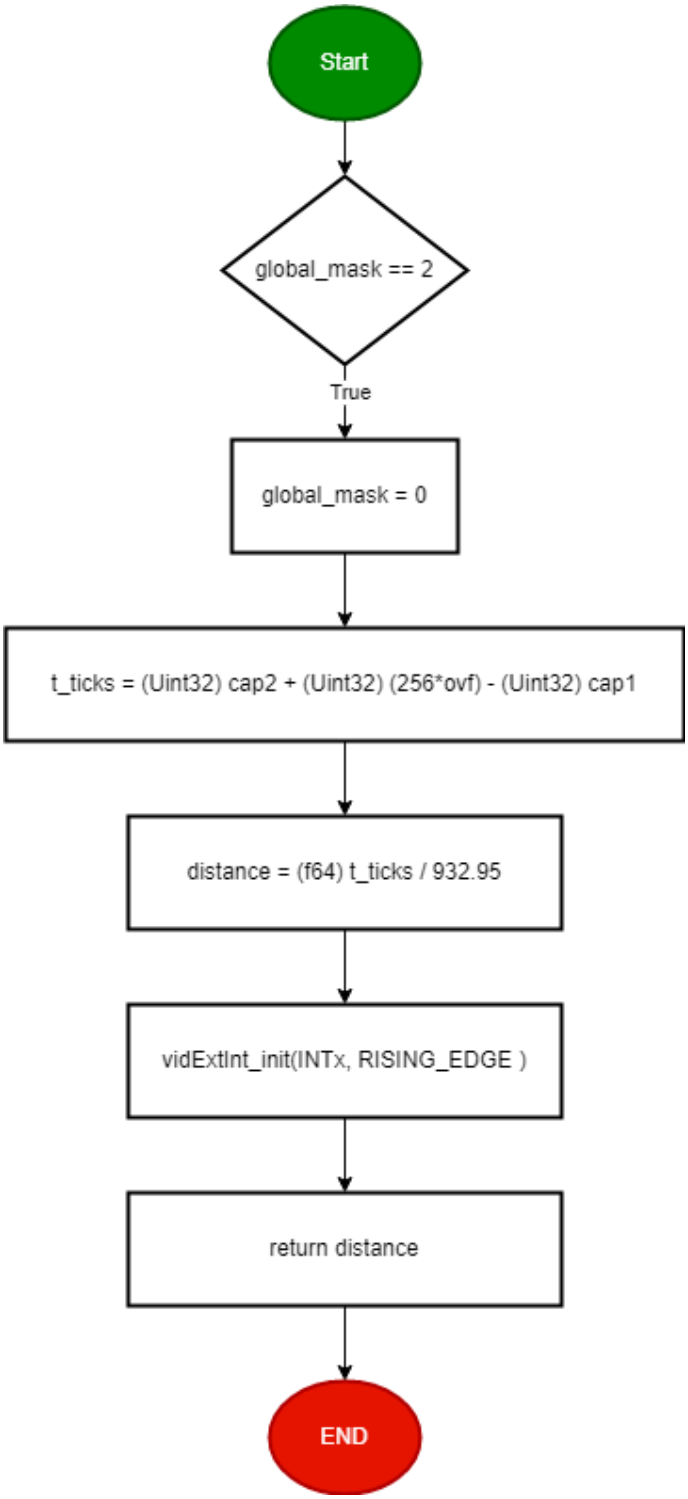
void HULTRASONIC_vidInit (enu_int_type_t enExtint, enu_sns_ctrl_t snsCtrl)



void HULTRASONIC_vidTrigger(**void**)



Uint8_t HULTRASONIC_u8Read(void)



3.3.7.2 : Services affecting the hardware unit

void HULTRASONIC_vidInit (en_int_type_t enExtint, en_sns_ctrl_t snsCtrl);

Service name	HULTRASONIC_vidInit	
Parameters (in)	en_int_type_t	Interrupt type [INT0, INT1. INT2]
	en_sns_ctrl_t	snsCtrl : Sense Control {ANY_LOGICAL, FALL_EDGE, RISE_EDGE}
Return	void	
Description	Set Echo pin as input Set trig pin as output Initialize external interrupt Initialize timer2	

void HULTRASONIC_vidTrigger(void);

Service name	HULTRASONIC_vidTrigger
Parameters (in)	void
Return	void
Description	Sending pulse

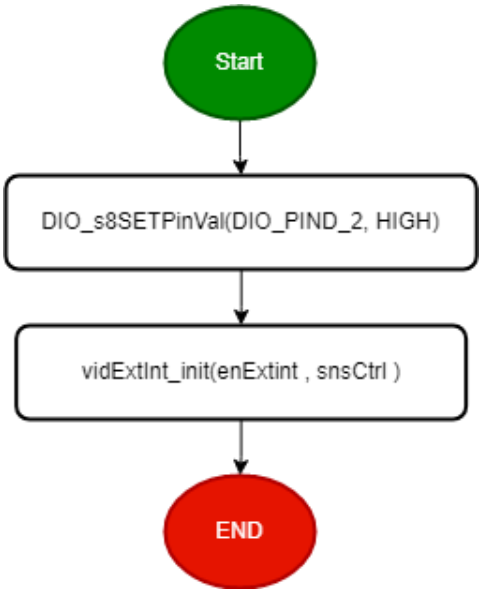
Uint8_t HULTRASONIC_u8Read(void);

Service name	HULTRASONIC_u8Read	
Parameters (in)	void	
Return	Uint8_t	Distance from Ultrasonic sensor
Description	Read distance from ultrasonic sensor	

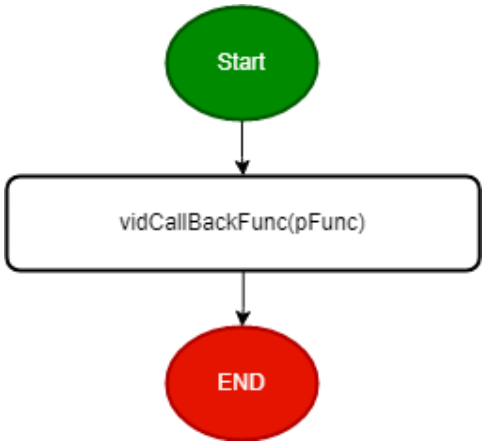
3.3.8 : HEXTINT API :

3.3.8.1 :Flowcharts:

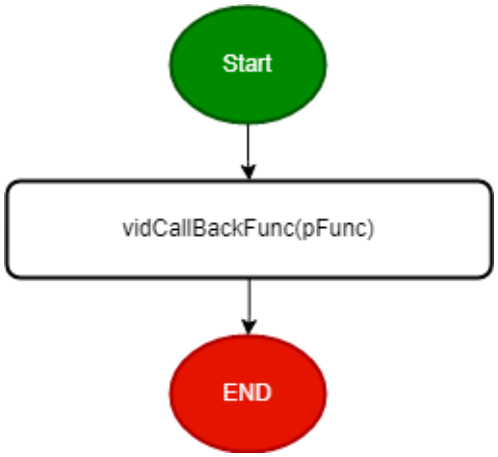
enu_HExtIntError_t HExtInt_enInit (enu_int_type_t enExtint, enu_sns_ctrl_t snsCtrl)



enu_HExtIntError_t HExtInt_enCBF (ptr_func pFunc)



enu_HExtIntError_t HExtInt_enCBFInt1(**ptr_func** pFunc)



3.3.8.2 : Services affecting the hardware unit

enu_HExtIntError_t HExtInt_enInit (enu_int_type_t enExtint, enu_sns_ctrl_t snsCtrl);

Service name	**HExtInt_enInit**	
Parameters (in)	**enu_int_type_t**	Interrupt type [INT0, INT1. INT2]
	enu_sns_ctrl_t	snsCtrl : Sense Control {ANY_LOGICAL, FALL_EDGE, RISE_EDGE}
Return	**enu_HExtIntError_t**	HEXTINT_OK HEXTINT_NOK
Description	External Interrupt Initialization	

enu_HExtIntError_t HExtInt_enCBF (ptr_func pFunc);

Service name	**HExtInt_enCBF**	
Parameters (in)	**ptr_func**	Pointer to function
Return	**enu_HExtIntError_t**	HEXTINT_OK HEXTINT_NOK
Description	Take pointer to function to be executed in ISR when it fires	

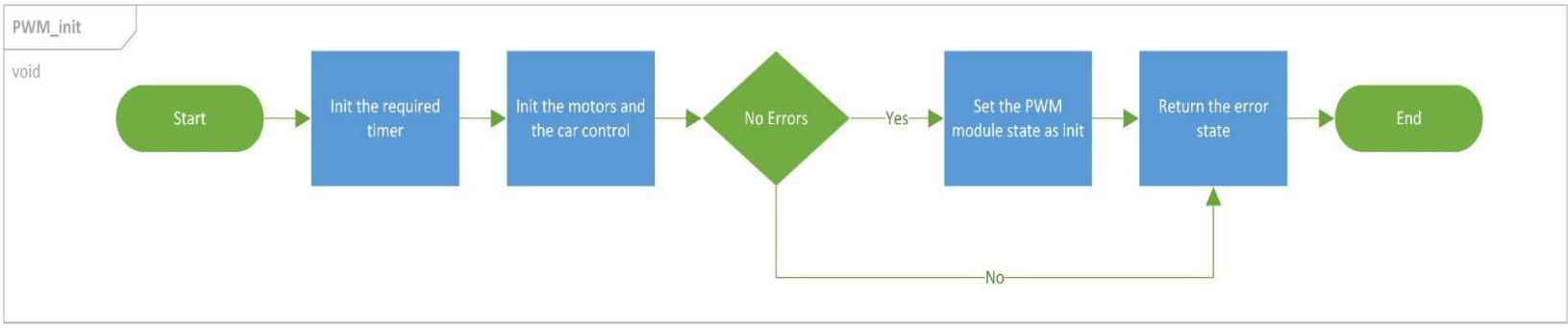
enu_HExtIntError_t HExtInt_enCBFInt1(ptr_func pFunc);

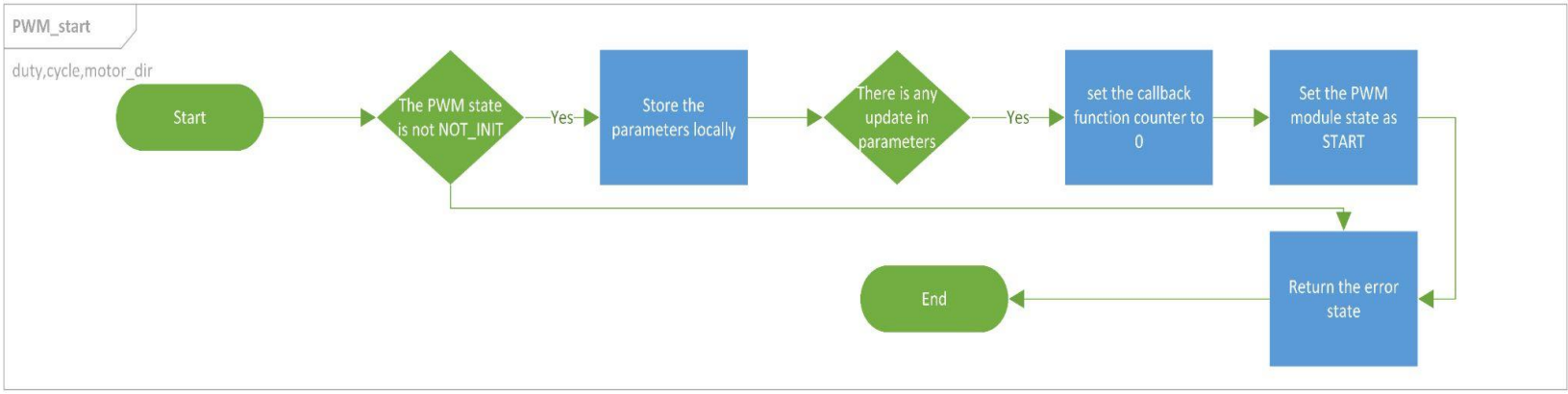
Service name	**HExtInt_enCBFInt1**

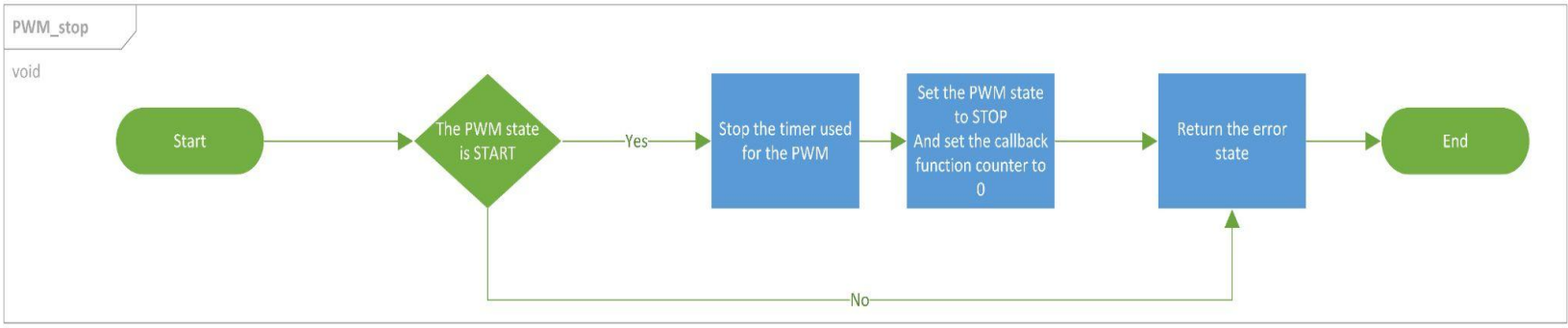
Parameters (in)	**ptr_func**	Pointer to function
Return	**enu_HExtIntError_t**	HEXTINT_OK HEXTINT_NOK
Description	Take pointer to function to be executed in ISR when it fires for ExtInt_1	

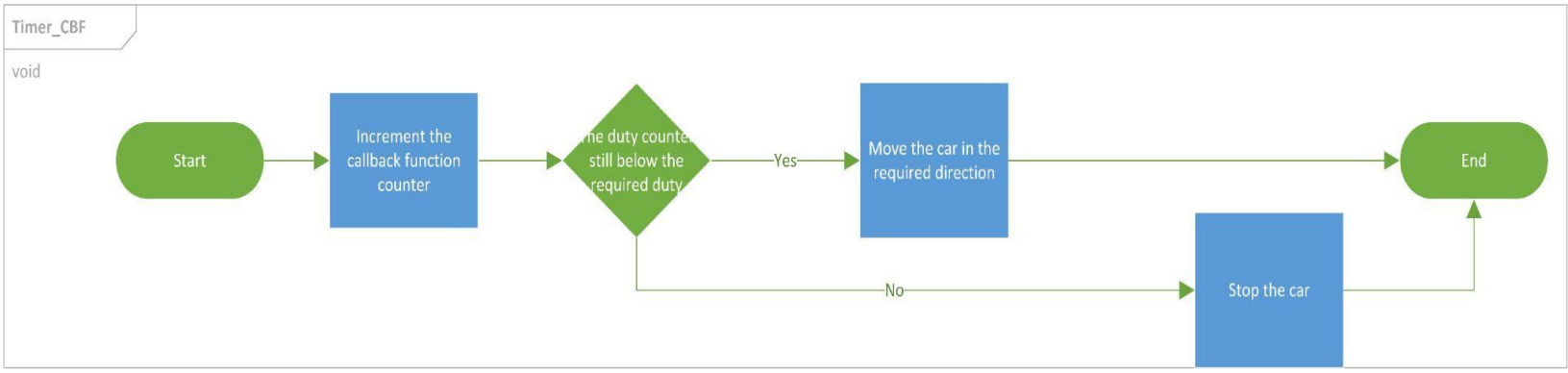
3.3.9 : PWM API :

3.3.9.1 : Flowcharts:









3.3.9.2 : Type definitions:

- st_timer0Config

Name	st_timer0Config
Type	Structure
Description	This is the type of the timers data structure containing the overall configuration data for the timer that used in PWM API
Available via	pwm_cfg.h

- u8_pwmErrorType

Name	u8_pwmErrorType		
Type	Enumeration		
Range	PWM_ERROR_OK	0x00	PWM error OK
	PWM_ERROR_NOT_OK	0x0A	PWM error
Description	u8_pwmErrorType		
Available via	pwm.h		

- en_motor_dir_t

Name	en_motor_dir_t		
Type	Enumeration		
Range	FORWARD	0x00	Motor forward
	BACKWARD	0x01	Motor backward
Description	en_motor_dir_t		
Available via	pwm.h		

3.3.9.3 : Services affecting the hardware unit

- PWM_init

Service name	PWM_init
Syntax	u8_pwmErrorType PWM_init(void);
Parameters (in)	void
Return	u8_pwmErrorType: PWM_ERROR_OK / PWM_ERROR_NOT_OK
Description	This Function Initialize PWM module

- PWM_start

Service name	PWM_start
Syntax	u8_pwmErrorType PWM_start (uint8_t u8_duty , uint8_t u8_cycle , en_motor_dir_t u8_motor_dir);
Parameters (in)	void
Return	u8_pwmErrorType: PWM_ERROR_OK / PWM_ERROR_NOT_OK
Description	This Function starts the PWM module with a specific duty cycle and operation cycle in ms

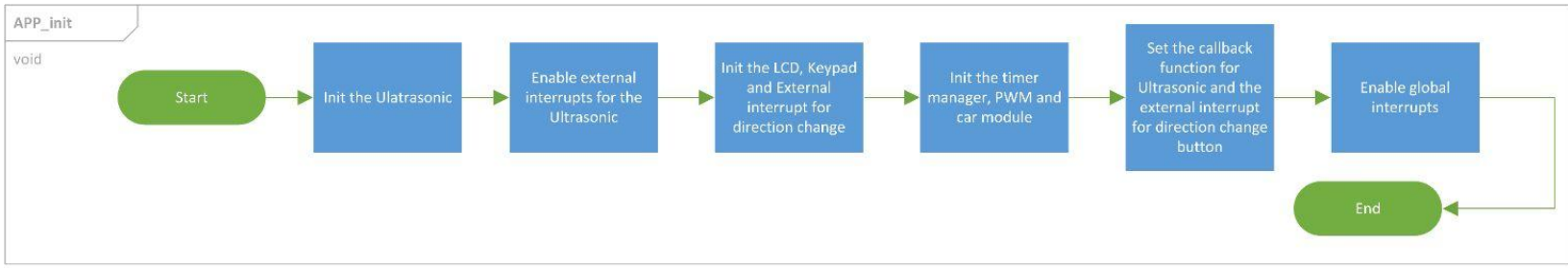
- PWM_stop

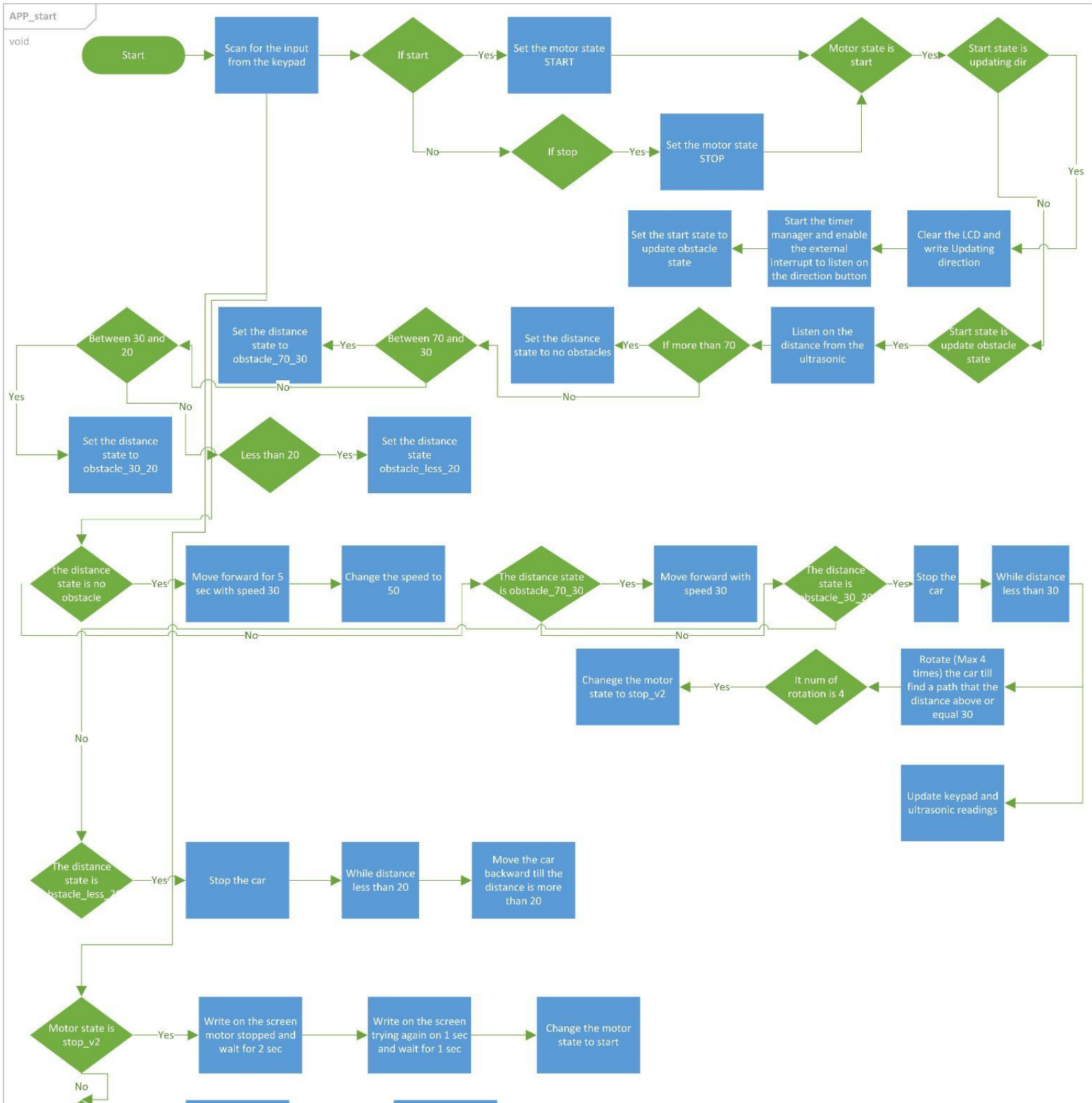
Service name	PWM_stop
Syntax	u8_pwmErrorType PWM_stop(void);
Parameters (in)	void
Return	u8_pwmErrorType: PWM_ERROR_OK / PWM_ERROR_NOT_OK
Description	This Function stops PWM module

3.4 : App APIs

3.4.1 : APP API :

3.3.9.1 : Flowcharts:


APP_init
void
Start
Init the Ulatrasonic
Enable external interrupts for the Ultrasonic
Init the LCD, Keypad and External interrupt for direction change
Init the timer manager, PWM and car module
Set the callback function for Ultrasonic and the external interrupt for direction change button
Enable global interrupts
End


APP_start
void
Start
Scan for the input from the keypad
If start
Yes
Set the motor state START
Motor state is start
Yes
Start state is updating dir
Yes
No
No
If stop
Yes
Set the motor state STOP
Clear the LCD and write Updating direction
Start the timer manager and enable the external interrupt to listen on the direction button
Set the start state to update obstacle state
Start state is update obstacle state
Yes
Listen on the distance from the ultrasonic
If more than 70
Yes
Set the distance state to no obstacles
No
Between 70 and 30
Yes
Set the distance state to obstacle_70_30
No
Between 30 and 20
Yes
Set the distance state to obstacle_30_20
No
Less than 20
Yes
Set the distance state obstacle_less_20
the distance state is no obstacle
Yes
Move forward for 5 sec with speed 30
Change the speed to 50
No
The distance state is obstacle_70_30
Yes
Move forward with speed 30
The distance state is obstacle_30_20
Yes
Stop the car
While distance less than 30
No
Rotate (Max 4 times) the car till find a path that the distance above or equal 30
It num of rotation is 4
Yes
Chanege the motor state to stop_v2
Update keypad and ultrasonic readings
No
The distance state is obstacle_less_20
Yes
Stop the car
While distance less than 20
Move the car backward till the distance is more than 20
Motor state is stop_v2
Yes
Write on the screen motor stopped and wait for 2 sec
Write on the screen trying again on 1 sec and wait for 1 sec
Change the motor state to start
No

3.4.1.3 : Services affecting the hardware unit

- APP_vidStart

Service name	APP_vidStart
Syntax	void APP_vidStart(void);
Description	This Function Start the Application.
Available via	app.h

- APP_vidInit

Service name	APP_vidInit
Syntax	void APP_vidInit(void);
Description	This Function Initialize used Modules
Available via	app.h