PROJECT REPORT
ON

Emergency Accident Locater (EAL) using GSM Module

Submitted in partial fulfillment for the awardof **Post Graduate Diploma in EMBEDDED SYSTEMS AND DESIGN** From C-DAC, ACTS (Pune)

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CERTIFICATE

TO WHOMSOEVER IT MAY CONCERN

This is to certify that

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Have successfully completed their project on

Emergency Accident Locater (EAL) using GSM Module

Under the guidance of
Mr. Tarun Bharani

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ACKNOWLEDGEMENT

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Abstract

The project implements the idea of locating an accidental vehicle. Use of GSM Module, GPS Module will help in locating the coordinates of the accident. Furthermore, the coordinates would automatically be shared with the nearest hospitals or police station, or relatives. This auto-smart feature would result in prompt action towards the catastrophic situation. Hence, saving human lives.

Chapter 2

Literature Survey

2.1 ARM Cortex M4 Architecture:-

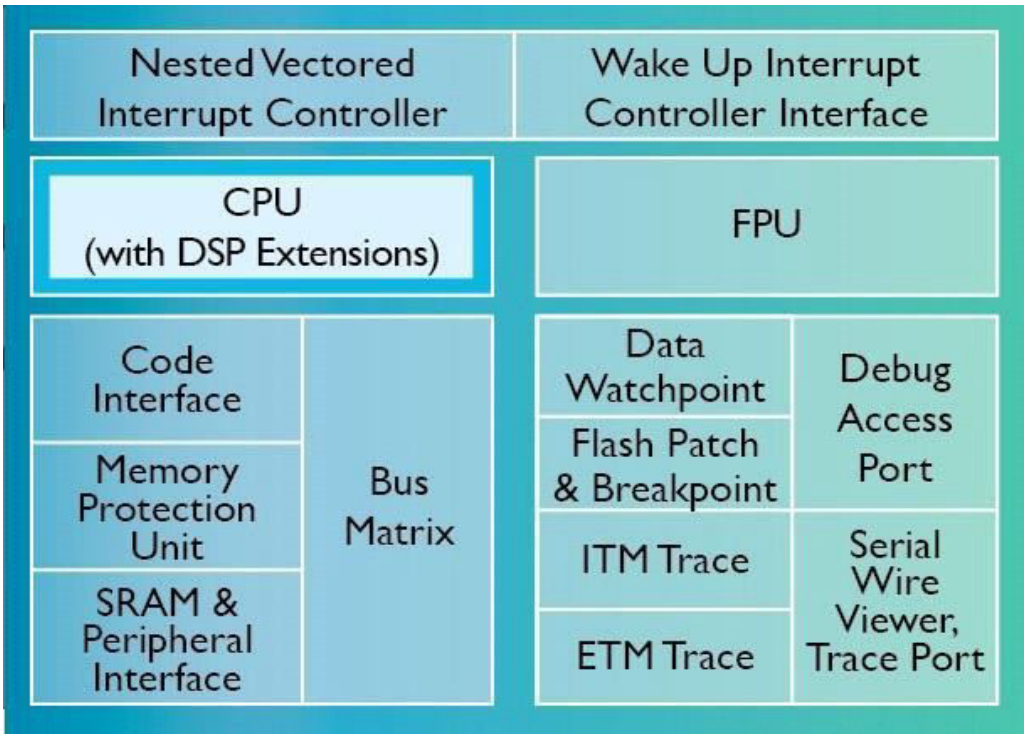

Figure 2.1 ARM Cortex M4 Architecture

The ARM® Cortex®-M4 processor is a high performance embedded processor with DSP instructions developed to address digital signal control markets that demand an efficient, easy-to-use blend of control and signal processing capabilities. The processor is highly configurable enabling a wide range of implementations from those requiring floating point operations, memory

protection and powerful trace technology to cost sensitive devices requiring minimal area.

KeyBenefits

- Gain the advantages of a microcontroller with integrated DSP, SIMD, andMAC instructions that simplify overall system design, software development anddebug

- Accelerate single precision floating point math operations up to 10x over the equivalent integer software library with the optional floating point unit(FPU)

- Develop solutions for a large variety of markets with a full-featured ARMv7M instruction set that has been proven across a broad set of embeddedapplications

- Achieve exceptional 32-bit performance with low dynamic power, delivering leading system energy efficiency due to integrated software controlled sleep modes, extensive clock gating and optional stateretention.

2.2 GSM/GPRS Module

Designed for global market, SIM800A is a Dual-band GSM/GPRS module that works on frequencies EGSM
900MHz and DCS 1800MHz . SIM800A features GPRS multi-slot class 12/ class 10 (optional) and supports the
GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.
With a tiny configuration of 24*24*3mm, SIM800A can meet almost all the space requirements in users' applications, such as smart phone, PDA and other mobile devices.
SIM800A is a SMT package with 68 pads, and provides hardware interfaces as below:

- One full function UART port
- One USB port for debugging and firmware upgrading
- Audio channel which includes a microphone input and a receiver output
- One SIM card interface
- Support up to 4*5 Keypads
- One display interface
- One I2C master interface for peripheral management
- Programmable general purpose input and output
- Two PWM output
- One ADC input
- Bluetooth antenna interface
- GSM antenna interface
-

SIM800A is designed with power saving technique so that the current consumption is as low as 0.55mA in sleep
mode.

SIM800A integrates TCP/IP protocol and extended TCP/IP AT commands which are very useful for data transfer

applications.

Table 1: SIM800A key features

Features	***Implementation***
Power supply	3.4V ~ 4.4V
Power saving	Typical power consumption in sleep mode is 0.55mA (AT+CFUN=0)
Frequency bands	• SIM800A Dual-band: EGSM 900,DCS 1800 • SIM800A can search the 4 frequency bands automatically. The frequency bands also can be set by AT command "AT+CBAND". For details, please refer to document [1] • Compliant to GSM Phase 2/2+
Transmitting power	• Class 4 (2W) at EGSM 900 • Class 1 (1W) at DCS 1800
GPRS connectivity	• GPRS multi-slot class 12 (default) • GPRS multi-slot class 1~12(option)
Temperature range	• Operation temperature: -40°C ~ +85°C • Storage temperature -45°C ~ +90°C
Data GPRS	• GPRS data downlink transfer: max. 85.6 kbps • GPRS data uplink transfer: max. 85.6 kbps • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • Integrate the TCP/IP protocol. • Support Packet Broadcast Control Channel (PBCCH)
USSD	Unstructured Supplementary Services Data (USSD) support
SMS	• MT, MO, CB, Text and PDU mode

	• SMS storage: SIM card
FAX	Group 3 Class 1
SIM interface	Support SIM card: 1.8V, 3V
External antenna	Antenna pad
Audio features	Speech codec modes: • Half Rate (ETS 06.20) • Full Rate (ETS 06.10) • Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) • Adaptive multi rate (AMR) • Echo Cancellation • Noise Suppression
Serial port and USB	Serial port: • Full modem serial port • Can be used for AT commands or data stream • Support RTS/CTS hardware handshake • Comply with GSM 07.10 Multiplexer Protocol • Support auto baud detect from 1200 bps to 115200bps USB: • For debugging and upgrading firmware
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC.
SIM application toolkit	GSM 11.14 Release 99
Real time clock	Support RTC
Physical characteristics	Size: 24*24*3mm Weight: 3.1g
Firmware upgrading	Upgrade firmware via USB port

Operating Modes

The table below summarizes the various operating modes of SIM800A.

Table 2: Overview of operating modes

Mode	Function	
Normal operation	GSM/GPRS SLEEP	Module will automatically go into sleep mode when the sleep mode is enabled and there is no on air or hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will reduce to the minimal level, and the module can still receive paging message and SMS.
	GSM IDLE	Software is active. Module has been registered to the GSM network and is ready to communicate.
	GSM TALK	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, antenna
	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration.
	GPRS DATA	There is GPRS data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level), uplink/downlink data rates and GPRS configuration (e.g. used multi-slot settings).
Power off	Normal power off by sending the AT command “AT+CPOWD=1” or using the PWRKEY. The power	

	management unit shuts down the power supply for the baseband part of the module, and only the power supply for the RTC is remained. Software is not active. The serial port is not accessible. Power supply (connected to VBAT) remains applied
Minimum functionality mode	AT command “AT+CFUN” can be used to set the module to a minimum functionality mode. In this mode, the RF function and SIM card function can be disabled, but the serial port is still accessible. The power consumption in this mode is lower than normal mode.

SIM800A Functional Diagram

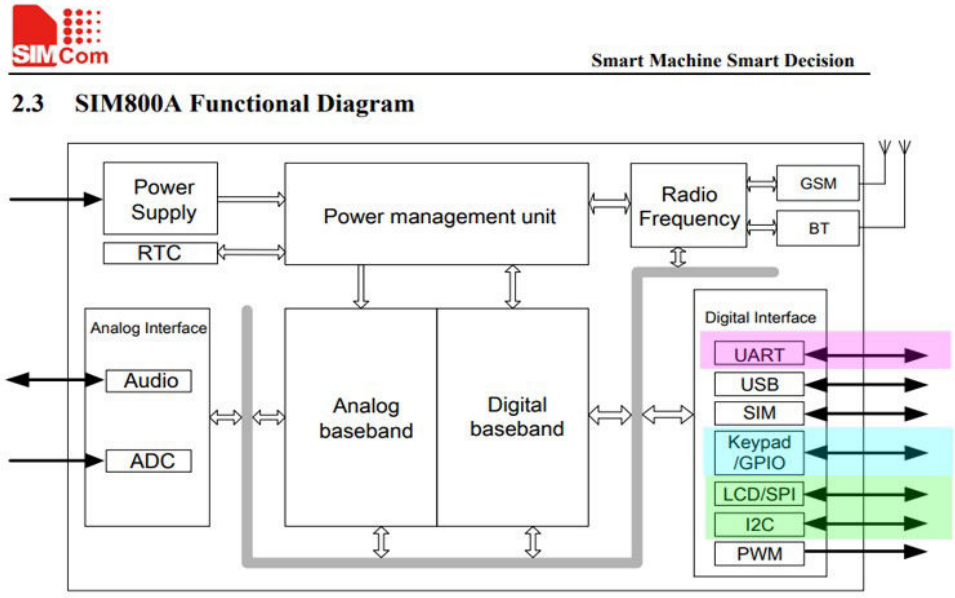

Figure 1: SIM800A functional diagram

Chapter 3

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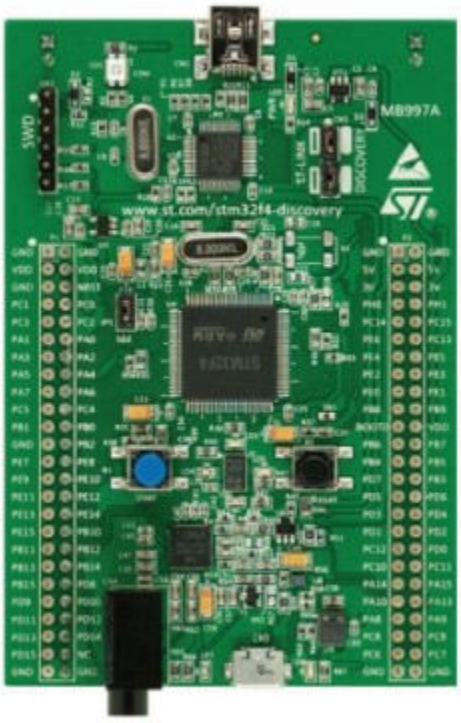
Requirements

3.1 HardwareRequirements

3.1.1 STM32F407 DiscoveryBoard

The STM32F4DISCOVERY Discovery kit leverages the capabilities of the STM32F407 high-performance microcontrollers, to allow users to develop audio applications easily. It includes an ST-LINK/V2-A embedded debug tool, one ST-MEMS digital accelerometer, one digital microphone, one audio DAC with integrated class D speaker driver, LEDs, push-buttons, and a USB OTG Micro-AB connector.



KEY FEATURES

- STM32F407VGT6 microcontroller featuring 32-bit Arm® Cortex®-M4 with FPU core, 1-Mbyte Flash memory and 192-Kbyte RAM in an LQFP100 package
- USB OTG FS
- ST MEMS 3-axis accelerometer
- ST-MEMS audio sensor omni-directional digital microphone
- Audio DAC with integrated class D speaker driver
- User and reset push-buttons
- Eight LEDs:
    - LD1 (red/green) for USB communication
    - LD2 (red) for 3.3 V power on
    - Four user LEDs, LD3 (orange), LD4 (green), LD5 (red) and LD6 (blue)
    - Two USB OTG LEDs, LD7 (green) VBUS and LD8 (red) over-current

Board connectors:

- USB with Micro-AB
- Stereo headphone output jack
- 2.54 mm pitch extension header for all LQFP100 I/Os for quick connection to prototyping board and easy probing

- Flexible power-supply options: ST-LINK, USB VBUS, or external sources
-
- External application power supply: 3 V and 5 V
-
- Comprehensive free software including a variety of examples, part of STM32CubeF4 MCU Package, or STSW-STM32068 for using legacy standard libraries
-
- On-board ST-LINK/V2-A debugger/programmer with USB re-enumeration capability: mass storage, Virtual COM port, and debug port

-
- Support of a wide choice of Integrated Development Environments (IDEs) including IAR Embedded Workbench®, MDK-ARM, and STM32CubeIDE

3.1.2 HC-SR04 Ultrasonic Sensor

The HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver.

Ultrasonic Sensor Pin Configuration

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

HC-SR04 Sensor Features

- •Operating voltage: +5V
- •Theoretical Measuring Distance: 2cm to 450cm
- •Practical Measuring Distance: 2cm to 80cm
- •Accuracy: 3mm
- •Measuring angle covered: <15°
- •Operating Current: <15mA
- •Operating Frequency: 40Hz

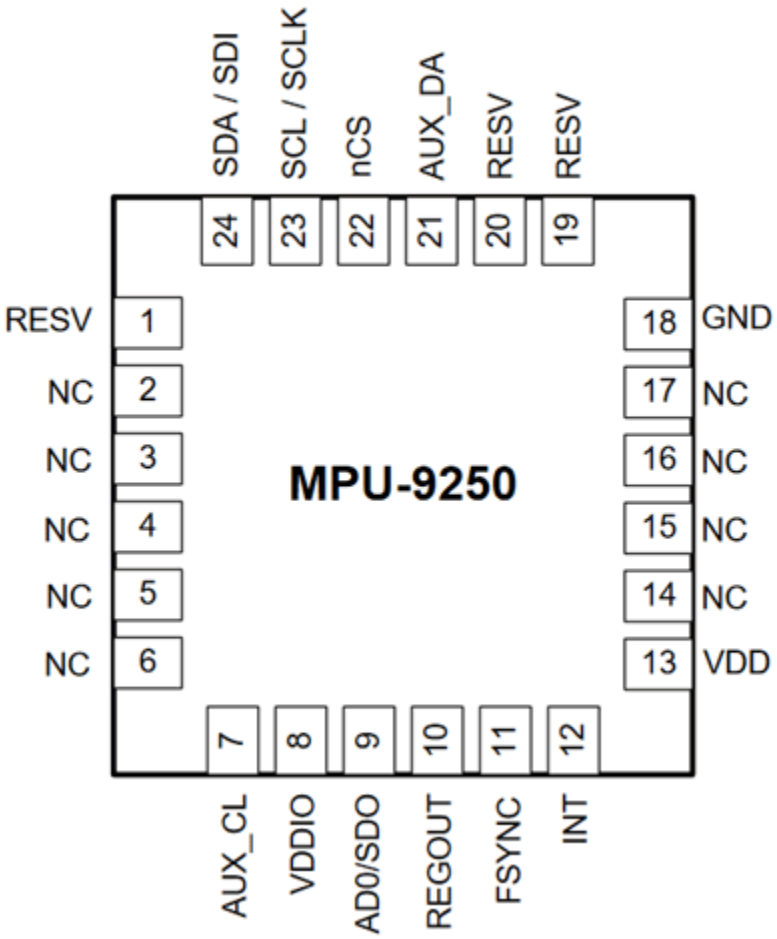
3.1.3 MPU-9250

MPU-9250 is a multi-chip module (MCM) consisting of two dies integrated into a single QFN package. One die houses the 3-Axis gyroscope and the 3-Axis accelerometer. The other die houses the AK8963 3-Axis magnetometer from Asahi Kasei Microdevices Corporation. Hence, the MPU-9250 is a 9-axis motion tracking device that combines a 3-axis gyroscope, 3-axis accelerometer, 3-axis magnetometer, and a Digital Motion Processor.

Its dedicated I2C sensor bus, the MPU-9250directly provides complete 9-axis Motion Fusion output. For requiring faster communications, the sensor and interrupt registers may be read using SPI as well.

Pin Description of MPU9250

Pin Number	Pin Name	Descriptions
1	RESV	Reserved. Connect to VDDIO.
7	AUX_CL	I2C Master serial clock, for connecting to external sensors
8	VDDIO	Digital I/O supply voltage
9	AD0 /SDO	I2C Slave Address LSB (AD0); SPI serial data output (SDO)
10	REGOUT	Regulator filter capacitor connection
11	FSYNC	Frame synchronization digital input. Connect to GND if unused
12	INT	Interrupt digital output (totem pole or open-drain)
13	VDD	Power supply voltage and Digital I/O supply voltage
18	GND	Power supply ground
19	RESV	Reserved. Do not connect
20	RESV	Reserved. Connect to GND
21	AUX_DA	I2C master serial data, for connecting to external sensors
22	NCS	Chip select (SPI mode only)
23	SCL / SCLK	I2C serial clock (SCL); SPI serial clock (SCLK)
24	SDA / SDI	I2C serial data (SDA); SPI serial data input (SDI)
2-6, 14-17	NC	Not internally connected. May be used for PCB trace routing.



Features and Specification of MPU9250 9-axis Digital Motion Processor

1. 3-axis Gyroscope Features

•Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full-scale range of ±250, ±500, ±1000, and ±2000°/secand integrated 16-bit ADCs

•Digitally-programmable low-pass filter

•Gyroscope operating current: 3.2mA

•Sleep mode current: 8µA

•Factory calibrated sensitivity scale factor

•Self-test

2. 3-axis Accelerometer Features

•Digital-output triple-axis accelerometer with a programmable full-scale range of ±2g, ±4g, ±8gand ±16gand integrated 16-bit ADCs

•Accelerometer normal operating current: 450μA

•Low power accelerometer mode current: 8.4μA at 0.98Hz, 19.8μA at 31.25Hz

•Sleep mode current: 8μA

•User-programmable interrupts

•Wake-on-motion interrupt for low power operation of applications processor

•Self-test

3. 3-axis Magnetometer Features

•3-axis silicon monolithic Hall-effect magnetic sensor with magnetic concentrator

•Wide dynamic measurement range and high resolution with lower current consumption.

•Output data resolution of 14 bit (0.6μT/LSB)

•Full-scale measurement range is ±4800μT

•Magnetometer normal operating current: 280μA at 8Hz repetition rate

•Self-test function with the internal magnetic source to confirm magnetic sensor operation on end products

4. Additional Features

•Auxiliarymaster I2C bus for reading data from external sensors(e.g. pressure sensor)

•Digital-output temperature sensor

•VDD supply voltage range of 2.4–3.6V

•VDDIO reference voltage for auxiliary I2C devices

•Smallest and thinnest QFNpackage for portable devices:3x3x1mm

•Minimal Cross-axis sensitivity between the accelerometer, gyroscope and magnetometer axes

•512byte FIFO buffer enables the applications processor to read the data in bursts

•10,000gshock tolerant

•400kHz Fast Mode I2C for communicating with all registers

•1MHz SPI serial interface for communicating with all registers

•20MHz SPI serial interface for reading sensor and interrupt registers

•MEMS structure hermetically sealed and bonded at the wafer level

3.1.4 SIM800A Quad Band GSM/GPRS Module

The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to the Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800A modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manager of the USB to Serial Adapter.
Then you can open Putty or any other terminal software and open a connection to that COM port at 9600 baud rate, which is the default baud rate of this modem. Once a serial connection is open through the computer or your microcontroller you can start sending the AT commands. When you send AT commands for example "ATr" you should receive back a reply from the SIM800A modem saying "OK" or other response depending on the command sent.

Application :

1.Remote Data Monitor and Control.

2.Water, gas, and oil flow metering.

3.AMR (automatic meter reading).

4.Power station monitoring and control.

5.Remote POS (point of sale) terminals.

6.Traffic signals monitor and control.

7.Fleet management.

8.Power distribution network supervision.

9.Central heating system supervision.

10.The weather station data transmission.

11.Hydro-logic data acquisition.

12.Vending machine.

13.Traffic info guidance.

14.Parking meter and Taxi Monitor.

15.Telecom equipment supervision (Mobile base station, microwave or optical\ relay station).

Features :

1.Quad-band 850/900/1800/1900MHz.

2.GPRS class 2/10.

3.Control via AT commands (3GPP TS 27.007, 27.005 and SIMCOM enhanced AT command set).

4.High-Quality Product (Not hobby grade).

5.5V interface for direct communication with MCU kit.

6.Configurable baud rate.

7.Built-in SIM Cardholder.

8.Built-in Network Status LED.

9.Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS.

10.Low power.

3.2 Software Requirements

3.2.1 STM32CubeIDE

STM32CubeIDE is an advanced C/C++ development platform with peripheral configuration, code generation, code compilation, and debug features for STM32 microcontrollers and microprocessors. It is based on the Eclipse®/CDT framework and GCC toolchain for the development, and GDB for the debugging. It allows the integration of the hundreds of existing plugins that complete the features of the Eclipse®IDE.

STM32CubeIDE integrates STM32 configuration and project creation functionalities from STM32CubeMX to offer all-in-one tool experience and save installation and development time. After the selection of an empty STM32 MCU or MPU, or preconfigured microcontroller or microprocessor from the selection of a board or the selection of an example, the project is created and initialization code generated. At any time during the development, the user can return to the initialization and configuration of the peripherals or middleware and regenerate the initialization code with no impact on the user code. STM32CubeIDE includes build and stack analyzers that provide the user with useful information about project status and memory requirements. STM32CubeIDE also includes standard and advanced debugging features including views of CPU core registers, memories, and peripheral registers, as well as live variable watch, Serial Wire Viewer interface, or fault analyzer.

KEY FEATURES

Integration of services from STM32CubeMX:

- STM32 microcontroller, microprocessor, development platform and example project selection
- Pinout, clock, peripheral, and middleware configuration
- Project creation and generation of the initialization code
- Software and middleware completed with enhanced STM32Cube Expansion Packages

Based on Eclipse®/CDT, with support of Eclipse® add-ons, GNU C/C++ for Arm® toolchain and GDB debugger.

Additional advanced debug features including:

- CPU core, peripheral register, and memory views
- Live variable watch view
- System analysis and real-time tracing (SWV)
- CPU fault analysis tool
- FreeRTOS™-aware debug suport

Support of ST-LINK (STMicroelectronics) and J-Link (SEGGER) debug probes
Import project from Atollic® TrueSTUDIO® and AC6 System Workbench for STM32 (SW4STM32)

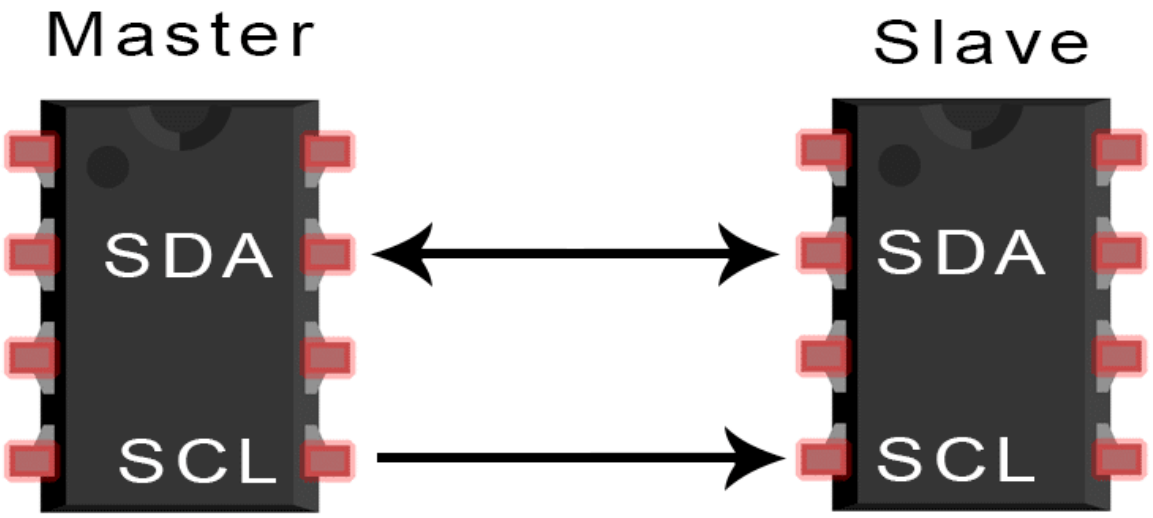
4 Communication Protocol

4.1 I2C Protocol

I2C combines the best features of SPI and UARTs. With I2C, you can connect multiple slaves to a single master (like SPI) and you can have multiple masters controlling single, or multiple slaves. This is really useful when you want to have

more than one microcontroller logging data to a single memory card or displaying text to a single LCD.

Like UART communication, I2C only uses two wires to transmit data between devices:



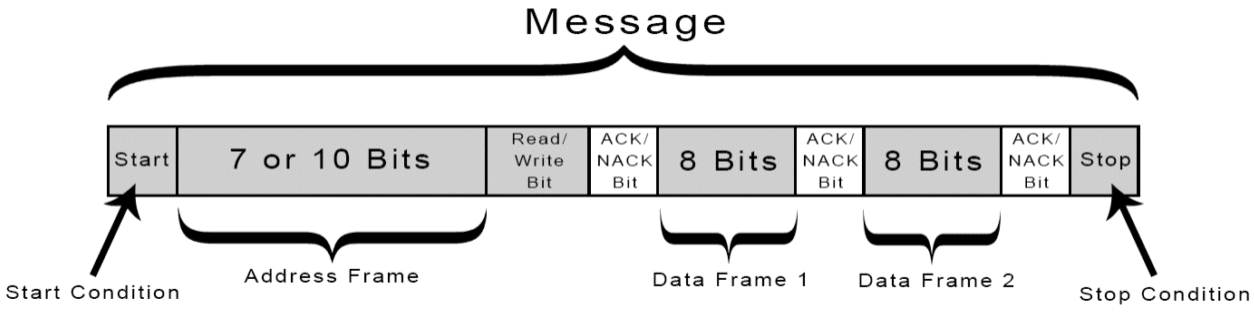
SDA (Serial Data) – The line for the master and slave to send and receive data.
SCL (Serial Clock) – The line that carries the clock signal.

Like SPI, I2C is synchronous, so the output of bits is synchronized to the sampling of bits by a clock signal shared between the master and the slave. The clock signal is always controlled by the master.

Wires Used	2
Maximum Speed	Standard mode= 100 kbps
	Fast mode= 400 kbps
	High speed mode= 3.4 Mbps
	Ultra fast mode= 5 Mbps
Synchronous or Asynchronous?	Synchronous
Serial or Parallel?	Serial
Max # of Masters	Unlimited
Max # of Slaves	1008

HOW I2C WORKS

With I2C, data is transferred in *messages.* Messages are broken up into *frames* of data. Each message has an address frame that contains the binary address of the slave, and one or more data frames that contain the data being transmitted. The message also includes start and stop conditions, read/write bits, and ACK/NACK bits between each data frame:



Start Condition: The SDA line switches from a high voltage level to a low voltage level *before* the SCL line switches from high to low.

Stop Condition: The SDA line switches from a low voltage level to a high voltage level *after* the SCL line switches from low to high.

Address Frame: A 7 or 10 bit sequence unique to each slave that identifies the slave when the master wants to talk to it.

Read/Write Bit: A single bit specifying whether the master is sending data to the slave (low voltage level) or requesting data from it (high voltage level).

ACK/NACK Bit: Each frame in a message is followed by an acknowledge/no-acknowledge bit. If an address frame or data frame was successfully received, an ACK bit is returned to the sender from the receiving device.

ADDRESSING

I2C doesn't have slave select lines like SPI, so it needs another way to let the slave know that data is being sent to it, and not another slave. It does this by *addressing*. The address frame is always the first frame after the start bit in a new message.

The master sends the address of the slave it wants to communicate with to every slave connected to it. Each slave then compares the address sent from the master to its own address. If the address matches, it sends a low voltage ACK bit back to the master. If the address doesn't match, the slave does nothing and the SDA line remains high.

READ/WRITE BIT

The address frame includes a single bit at the end that informs the slave whether the master wants to write data to it or receive data from it. If the master wants to send data to the slave, the read/write bit is a low voltage level. If the master is requesting data from the slave, the bit is a high voltage level.

THE DATA FRAME

After the master detects the ACK bit from the slave, the first data frame is ready to be sent.

The data frame is always 8 bits long, and sent with the most significant bit first. Each data frame is immediately followed by an ACK/NACK bit to verify that the frame has been received successfully. The ACK bit must be received by either the master or the slave (depending on who is sending the data) before the next data frame can be sent.

After all of the data frames have been sent, the master can send a stop condition to the slave to halt the transmission. The stop condition is a voltage transition from low to high on the SDA line after a low to high transition on the SCL line, with the SCL line remaining high.

5 Conclusion and Future Scope

In our project, we are taking inputs from Ultrasonic sensor and Gyroscope Sensor which is sent using GPIO amd I2C protocol respectively to STM32F4 Discovery board where it analyzes the input from sensors and produce the output as required. CAN transceivers MCP2551 is used for communicating between two STM32F4 discovery boards. STM32CUBEIDE is used for programming.

Further extension to the project could be possible by using two individual development boards and using both boards as Transmitter and Receiver units.

These two Tx and Rx units is to be interfaced with the help of CAN protocol.

CAN protocol will be used to implement Automatic Emergency Braking.

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