

Final Project Proposal:
Quade, Temperature Sensor, Wi-Fi ESP8266, Buzzer, LCD
[Name of the project to be determined soon]

I. Project Overview

The Internet-of-Things (IoT) is the notion of all devices and products being connected to the Internet, rather than only computers and mobile devices, as has been the case until the recent past. The IoT is already booming, and its adoption will only accelerate in coming years. At the same time, the world continues to go wireless. Wired Internet and telephone connections are becoming rarer with each passing year, and consumers expect and demand wireless communications more and more. One critical enabling technology for the IoT is wireless communications: IP-cameras, printers, kitchen appliances, and more deliver greater flexibility in their design when they do not need a wired connection to access the Internet. In this project, we propose to build on top of the class project Quade (Quadruped) a highly integrated Wi-Fi SoC solution to meet continuous demands for efficient power usage, and reliable performance on the Internet of Things industry by using the Wi-Fi Development Tools (802.11) Wi-Fi Module ESP8266WRL-13678. A temperature sensor and low voltage buzzer is also deployed on the Quade, and with a remote interaction capability.

II. Project Scope

The MSP432P401R launchpad is an easy to use evaluation module board. It contains everything needed to start developing on the MSP432 including on-board emulation for programming, debugging, and energy measurements (TI slau597a, p.3). The MSP432P401x devices are part of the Simple Link microcontroller (MCU) platform simplified by access to the 40-pin headers and a wide variety of BoosterPack plugin modules that enable technologies such as wireless connectivity, which consists of Wi-Fi, Bluetooth low energy, Sub-1GHz and host MCUs (TI MSP432P401r, p. 2). The SimpleLink MSP432P401x MCU are optimized wireless host MCUs with an integrated 16-bit precision ADC, delivering ultra-low-power performance including 80 μ A/MHz in active power. As an optimized wireless host MCU, MSP432P401x will allow us to add high precision analog to applications based on SimpleLink wireless connectivity (TI MSP432P401r, p. 2). Using the Code Composer Studio environment, the in-class project Quade will be used. On top of Quade, a temperature sensor, a low voltage buzzer, and an LCD1602 will be deployed to respectively capture the temperature and plot in real time, to emit a noise when the

temperature goes below some threshold, and to display some information on the LCD. Finally, the complete and self-contained Wi-Fi networking capabilities, ESP8266 with a full TCP/IP stack, will be deployed on the Quad through the I2C interfaces. The ESP8266 will be wirelessly performed as the “slave” to a host computer. Lastly, a particular focus will be made on the 802.11 Wi-Fi Module ESP8266 to analyze its pros and cons, any imperfection of the radio such as carrier leakage, I/Q phase matching, or baseband nonlinearities. ESP8266 has a 32-bit processor with a single core processor that runs at 80MHz (Espressif ESP8266EX Datasheet, p.17).

III. Functional Block Diagram

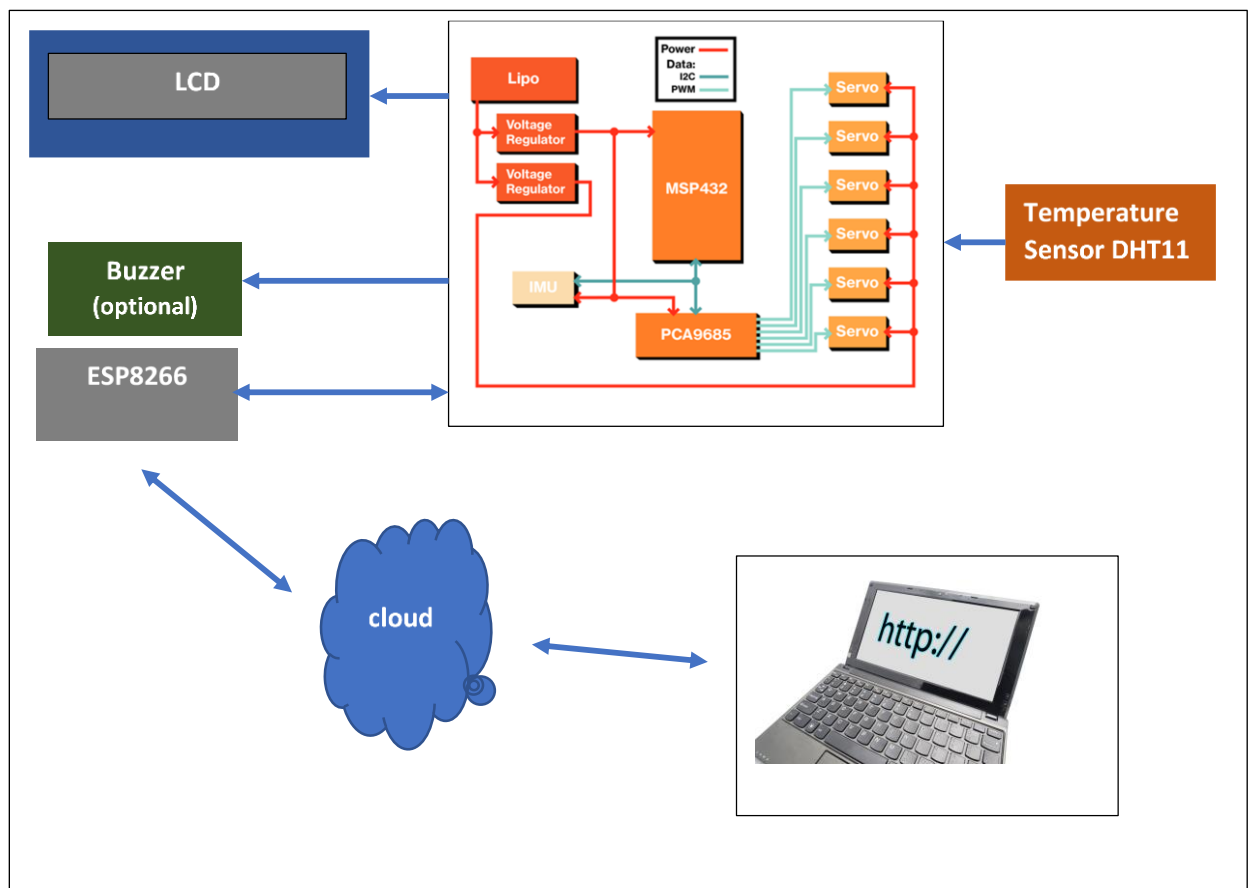
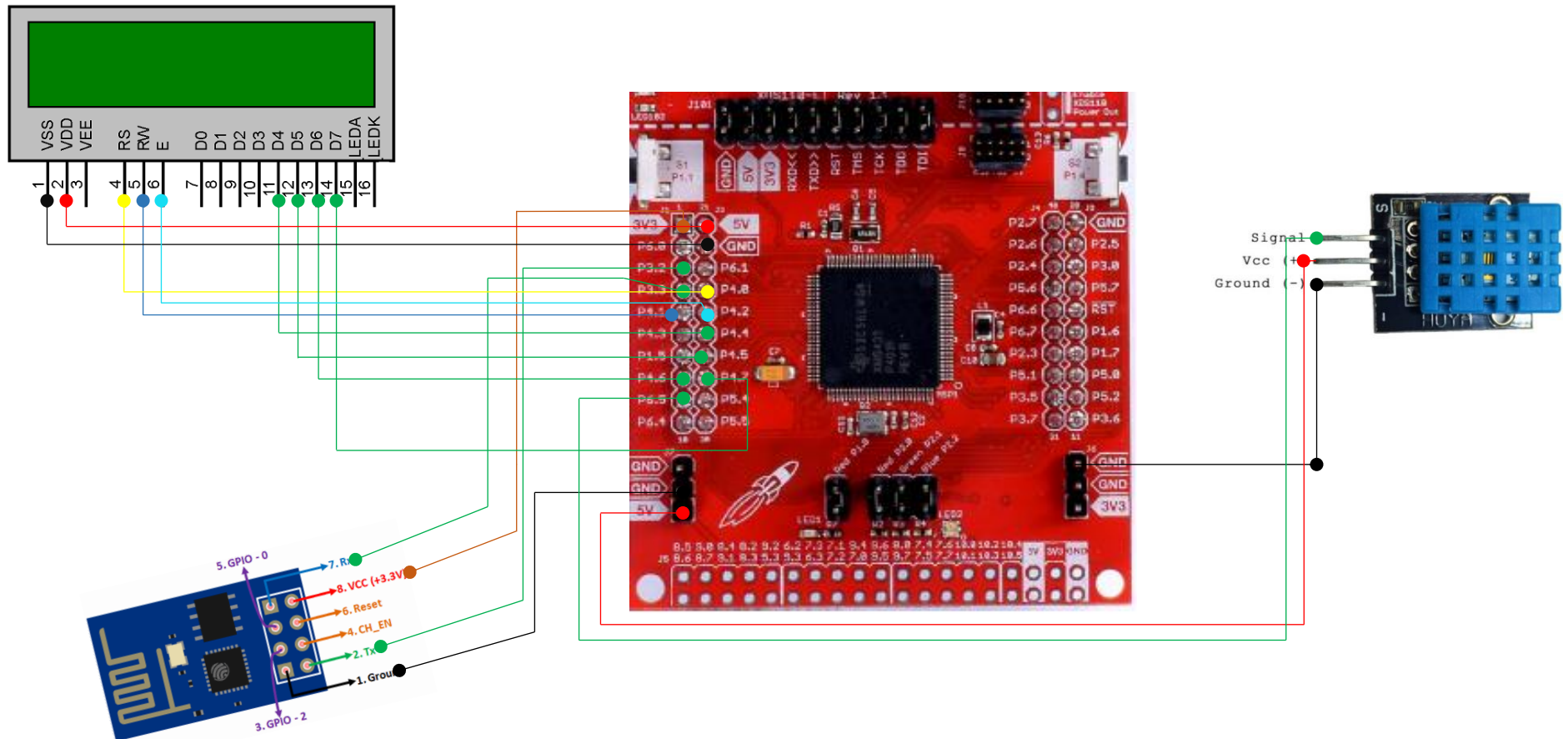


Figure 1: Functional Diagram

In Fig. 1, the LCD, buzzer, ESP8266 and the temperature sensor will be mounted on the Quade.

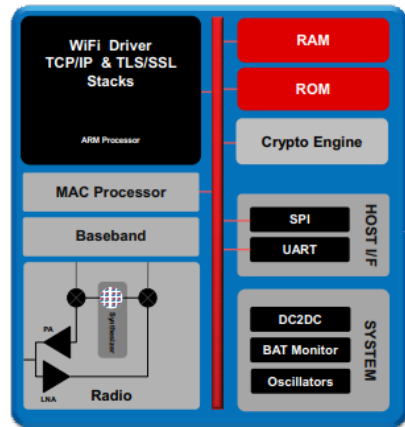
IV. Wiring Diagram



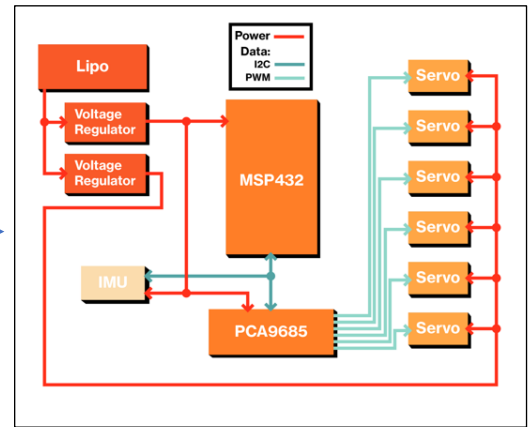
Note: after programming the above peripherals, I never got the ESP8266 connectivity to work properly. As stated previously, the main goal of this project is to emphasis on IoT. Therefore, I changed the hardware configuration to adapt the needs. In a first step, I paired the Wi-Fi CC3100 Boost with the MSP432 to enable flashing, RF performance evaluation and MCU software development using SimpleLink Studio on a PC.

Modified and Adopted Functional Block and Wiring Diagram

a) Functional Block Diagram



Block Diagram: CC3100 hardware overview



MSP432 hardware overview

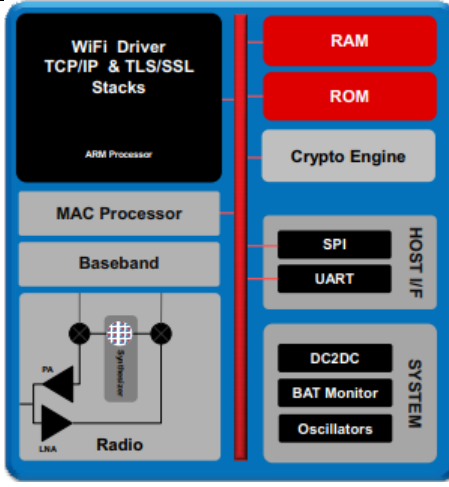
b) Wiring Diagram

.....needs setup picture.....


The CC3100 BOOST Connected to the MSP432

Deep Dive Into CC3100 Boost

CC3100 Boost has the following features: Internet on a chip Wi-Fi, Network processor, Embedded TCP/IP stack for systems using external low-cost MCU.



The CC3100 hardware overview



P1	P3
VCC(3.3V)	+5V
UNUSED	GND
UART1_TX	NC
UART1_RX	NC
nHIB	NC
UNUSED	NC
SPI_CLK	NC
UNUSED	NC
UNUSED	NC
UNUSED	NC

P4	P2
NC	GND
NC	IRQ
NC	SPI_CS
UART1_CTS	NC
UART1_RTS	nRESET
NC	SPI_MOSI
NWP_LOG_TX	SPI_MISO
WLAN_LOG_TX	NC
NC	NC
NC	NC

The signal assignment on the 2x20 pin connector is shown. The convention of J1..J4 is replaced with P1...P4 to avoid confusion with the actual board reference.

Pin No	Signal Name	Direction	Pin No	Signal Name	Direction
P1.1	VCC (3.3 V)	IN	P2.1	GND	IN
P1.2	UNUSED	NA	P2.2	IRQ	OUT
P1.3	UART1_TX	OUT	P2.3	SPI_CS	IN
P1.4	UART1_RX	IN	P2.4	UNUSED	NA
P1.5	nHIB	IN	P2.5	nRESET	IN
P1.6	UNUSED	NA	P2.6	SPI_MOSI	IN
P1.7	SPI_CLK	IN	P2.7	SPI_MISO	OUT
P1.8	UNUSED	NA	P2.8	UNUSED	NA
P1.9	UNUSED	NA	P2.9	UNUSED	NA
P1.10	UNUSED	NA	P2.10	UNUSED	NA

Outer Row Connectors

Pin No	Signal Name	Direction	Pin No	Signal Name	Direction
P3.1	+5 V	IN	P4.1	UNUSED	OUT
P3.2	GND	IN	P4.2	UNUSED	OUT
P3.3	UNUSED	NA	P4.3	UNUSED	NA
P3.4	UNUSED	NA	P4.4	UART1_CTS	IN
P3.5	UNUSED	NA	P4.5	UART1_RTS	OUT
P3.6	UNUSED	NA	P4.6	UNUSED	NA
P3.7	UNUSED	NA	P4.7	NWP_LOG_TX	OUT
P3.8	UNUSED	NA	P4.8	WLAN_LOG_TX	OUT
P3.9	UNUSED	NA	P4.9	UNUSED	IN
P3.10	UNUSED	NA	P4.10	UNUSED	OUT

Inner Row Connectors

NOTE: All signals are 3.3 V CMOS 400mA logic levels and are referred w.r.t. CC3100 IC. For example, UART1_TX is an output from the CC3100. For the SPI lines, the CC3100 always acts like a slave (TI, p.9).

SimpleLink™ Wi-Fi® CC3100 Solution

Features/Benefits

- **Supported protocols and roles** – 802.11 b/g/n, Station, Access Point, and Wi-Fi Direct with fully integrated radio, baseband, and MAC
- **Wi-Fi network processor** – on-chip WLAN and TCP/IP stack, industry standard API. No previous Wi-Fi experience needed
- **Embedded Crypto engine** – 256-bit encryption, SSL/TLS, personal and enterprise security, allows fast secure connection
- **Low power** – low power radio with advanced low power modes enabling battery powered Wi-Fi (2AA over a year)

Design Kits & EVMs



CC3100 BoosterPack + EMU board – CC3100BOOST-CC31XXEMUBOOST



CC3100 BoosterPack with MSP430F5529 LP

CC3100BOOST-CC31XXEMUBOOST-EXP430F5529LP

Note: CC31XXEMUBOOST must be purchased to flash CC3100BOOST plus other functions

Dev Tools & Software

- **Flexible Provisioning** - AP mode, WPS, SmartConfig™, + 1
- **Uniflash, RF Performance Tool, PLT**
- **CC3100 SDK Download** – Driver, 30+ sample apps
- **SimpleLink™ Studio for CC3100** – MCU dev on PC

CC3100 Network Processor

Temperatures: -40 °C to 85 °C

Wi-Fi Network Processor + Crypto Engine	Protocol	Power & Clocking
	IPv4 TCP/IP Stack	DC2DC
	SSL 3.0	BAT Monitor
	TLS 1.2	Hibernate RTC
		Oscillators
Radio	Data Protection	Packages
2.4 GHz	DES	64-pin 9x9mm QFN
Wi-Fi 802.11 b/g/n	DES3	17.5 x 20.5mm Module
STA, AP, Wi-Fi Direct	AES256	
WPA2 Personal	MD5	
WPA2 Enterprise	SHA2	
WPS2	RSA	
802.1x	ECC	
EAP		
	Interfaces	Memory
	SPI (Host I/F)	Embedded ROM
	UART (Host I/F)	Host Memory Footprint
		10 KB (Flash)
		2 KB (RAM)

Target Applications

- **Home Automation** – lighting, access control
- **Home Appliance** – washer & dryer, refrigerator
- **Safety and Security** – wireless camera, video surveillance
- **Smart Energy** – smart meter, thermostat control, smart plug
- **Industrial M2M Communication** – web interface industrial control
- **Wireless audio streaming** – speakers, remote controls, sound bars



Attempt Design 1 Pins Mapping

MSP432 Microcontroller and LCD1602 pins connection description

MSP432 Microcontroller	LCD1602	Description
GND	GND	Ground (-)
VCC (+5)	VCC (+5)	Source (+)
P4.0	RS	Register Select
P4.1	R/W	Read/Write
P4.2	EN	Enable
P4.4	D4	Data 4
P4.5	D5	Data 5
P4.6	D6	Data 6
P4.7	D7	Data 7

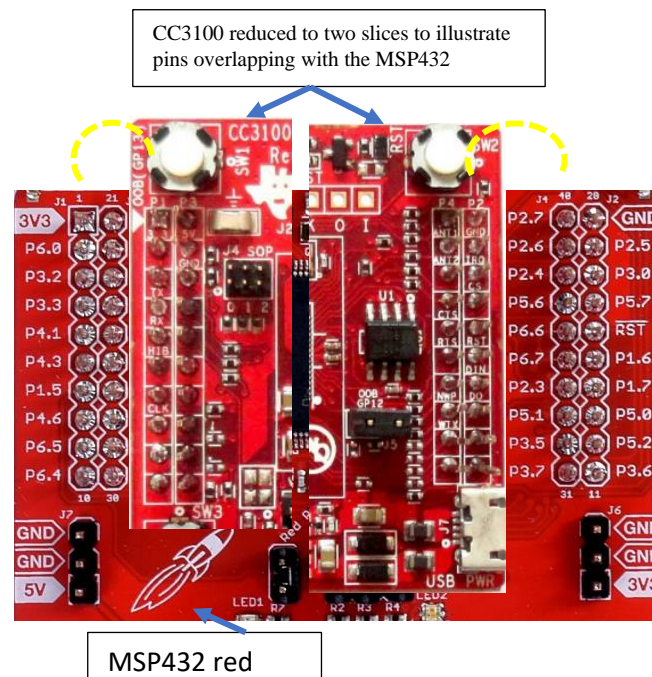
MSP432 Microcontroller and ESP8266 pins connection description

MSP432 Microcontroller	ESP8266	Description
GND	GND	Ground (-)
3V3	3V3	Source (+)
P3.2	TxD	Transmit Data
P3.3	RxD	Receive Data

MSP432 Microcontroller and DHT11 pins connection description

MSP432 Microcontroller	DHT11	Description
GND	GND	Ground (-)
VCC(+5)	VCC (+5)	Source (+)
P6.5	DOUT	Transmit Data

Final Design Pins Mapping: CC3100 – MSP432

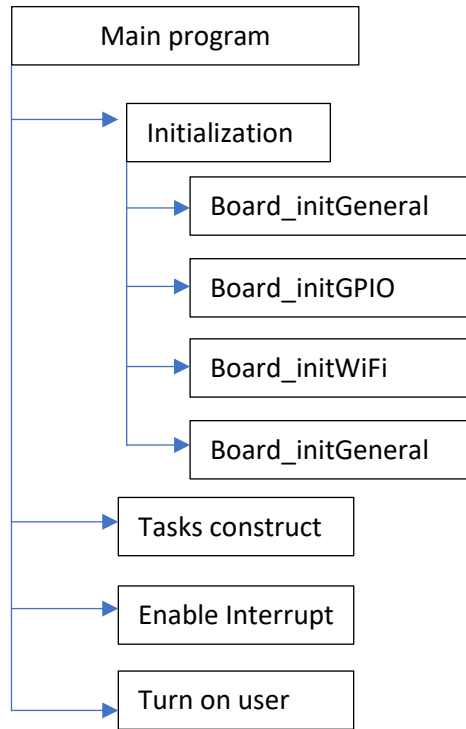


CC3100 inner side female overlaps with MSP432 front side male pins as illustrated

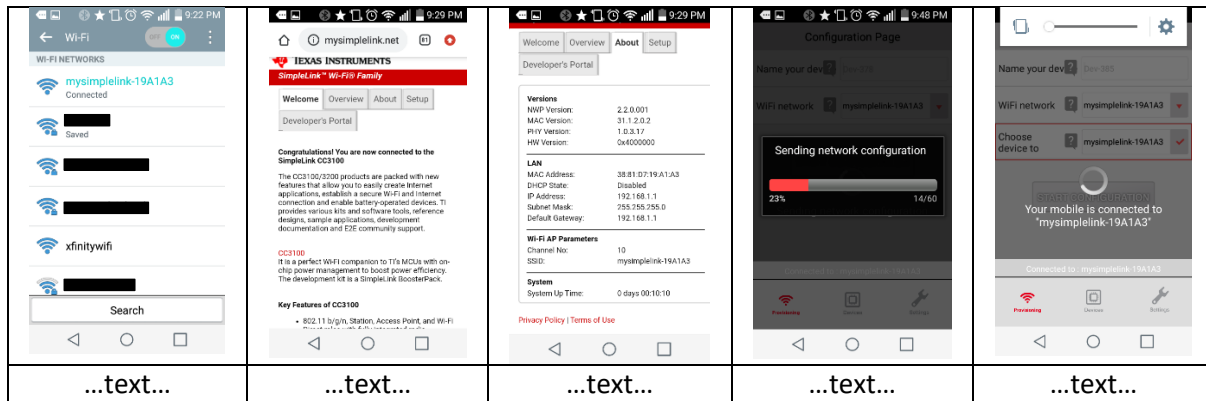
Align the pin1 of the boards together using the triangle marking on the “PCB”. An incorrect connection can destroy the boards permanently. Ensure that none of the header pins are bent before connecting the two boards. Jumper settings on the CC3100BOOST.

I. Software Diagram

(...in progress... Update is made as the implementation goes. A final diagram will be provided as soon as the implementation is finalized)



Execution Outcome



II. Project Requirement

(...in progress... Update is made as the implementation goes)

This project embedded many subsystems that interact with each other. The following will be required to make the project successful:

- Buzzer: an alarm is triggered when a defined particular action is true [defined actions are still in progress]. The buzzer is physically connected to the Quad to some pins illustrated on the wiring diagram. A program module is required to act upon a given action from the Quad.
- LCD1602: it will display a set of state that we are still defining
- ESP8266: this radio connection is shown on the wiring diagram and operates on the 2.4GHz transceiver band with high speed clock generators and crystal oscillator. The ESP8266 supports the frequency channels 2447MHz, 2452MHz, 2457MHz, and 2462MHz (Espressif ESP8266EX Datasheet, p.17). A program module is required to allow an interaction between Quad – ESP8266 – Remote user actions.
- Temperature Sensor (undecided, but DHT11 is likely to be used): the sensor is connected to some pins illustrated on the wiring diagram. It measures the temperature and humidity of the field. Data can be displayed on the LCD or transmitted to the remote user via ESP8266 for further processing.
- Quad system: [description in progress]
- CC3100: The CC3100 device is the industry's first Wi-Fi CERTIFIED chip used in the wireless networking solution. The CC3100 device is part of the new SimpleLink Wi-Fi family that dramatically simplifies the implementation of Internet connectivity. The CC3100 device integrates all protocols for Wi-Fi and Internet, which greatly minimizes host MCU software requirements. With built-in security protocols, the CC3100 solution provides a robust and simple security experience (TI CC3100, p. 2).

(text needs update)

III. Proposed Timeline

October 2020													November 2020								
19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
Assemble Quad & Testing																					
		Assemble Quad - LCD																			
			Quad - LCD - Sensor																		
				Quad-LCD-Sensor-ESP8266																	
													test HTTP Server								
													Field & Protocols Test								
															Overall Test						
																Final report					

(...Grant chart **in progress**...)

Note on 10-20-2020: regardless of quade program, the MSP432 will be used to program the LCD, DHT11, and ESP8266 to gain time.

Note on 10-20-2020: beginning implementation MSP – LCD – DHT11 on 10-21-2020. Goal: get it done by 10-22-2020.

Note on 10-26-2020: implementation of MSP432-LCD-ESP8266-DHT11 in progress. CC3100 may be added and to remove ESP8266.

IV. Bill of Materials

(...in progress...giving the orientation, we might add or remove some components)

Device	Description	Cost	Observation	URL
ESP8266	Wi-Fi Module		In class Kit project	https://www.mouser.com/ProductDetail/SparkFun/WRL-13678?qs=WYAArYrbSnZdmwzIRTs1Tw%3D%3D&gclid=EAIaIQobChM19ITJqdTA6gIVE9bACh38gwhOEAAQYAIAABegKgZvD_BwE
LCD1602	To display customized information	\$9.90	The connection to MSP432 and ESP8266 requires some resistors	https://www.mouser.com/Search/Refine?Ntk=P_MarCom&Ntt=139536055
DHT11	Temperature and humidity sensor	\$5.00	The connection to MSP432, ESP8266, and LCD requires some resistors.	https://www.adafruit.com/product/386
Quad	Quadruped robot using MSP432 and additional supports	\$95.00	In-class Kit project	
Miscellaneous	Additional cost	\$10.00		
TOTAL COST		\$129.9		

V. Trade Study

(...in progress...)

VI. Theoretical Analysis

(...in progress...)

VII. Version Control Repository Set Up

A new repository has been created on the trunk evso9816.

The address is: <https://github.com/evso9816/Embeddedd-App-ECE2440>

All update can be found at this repository.

References

(...in progress...)

TI CC3100 SimpleLink™ Wi-Fi® and IoT Solution BoosterPack Hardware, can be found at:
https://www.ti.com/lit/ds/swas031d/swas031d.pdf?ts=1604303858023&ref_url=https%253A%252F%252Fwww.google.com%252F

MSP432P401R SimpleLink™ Microcontroller LaunchPad™ Development Kit (MSP-EXP432P401R), can be found at:
https://components101.com/sites/default/files/component_datasheet/MSP432%20User%20Manual.pdf