Senior Design Project
T307
16 October 2020
Concept Generation

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SECTION I: Phases of Concept Generation

1.1: External Search

The external search involved reaching out to the customer, advisor, and Keysight technical advisor to obtain any previous information that helped with the generation of the concepts. For example, a suggested software defined radio (SDR) from the customer was the Hack RF One and to use a software called GNU Radio. This suggestion not only served as concepts on their own, but sparked ideas of research for more SDRs with similar capabilities such as the Adalm Pluto SDR, that also supports the GNU Radio software as well as programming languages like Matlab and C++.

An approach like “crap shoot” where random concepts are generated via the team’s capacity, originality, and creativity was also used to establish the columns of the table. In addition, a force analogy of comparing attributes to systems that are not the same allowed for extra concepts to be generated.

1.2: Internal Search

The internal search involved doing research without the aid of the customer, advisor, or technical advisor’s input. Searching forums and the internet for similarly designed projects using the SDRs helped to generate concepts such as using the general-purpose input or output pins on the SDR to trigger its analog to digital converter so that it only starts processing data when the pin is active low or high.

1.2.1: Morphological Chart

The morphological chart was used to generate more ideas via functions or sub-functions of the system. The red selections were obtained via the most feasible and logical path to implementation, but any of the paths can be selected for a concept.

Figure I: Morphological Chart I

MORPHOLOGICAL CHART 1.			
Attenuation	On SDR	On Bi-dicoupler	On Box cable to SDR
Trigger	Digital interpeter circuit	Soldered connection	Input connection
Interface	Keyboard	Switches	Buttons
Software	SDRuno	Simulink	SDRangel
Display	PC monitor	In lab monitor devices	CRT

Figure 1: Morphological Chart I elements contained in this figure

Figure II: Morphological Chart II

MORPHOLOGICAL CHART 2.			
Number of SDR	One (two receiver ports)	Two (one receiver port)	Two (two receiver ports)
SDR	Adalm PLuto	Hack RF One	SDRplay DUO
Power	Battery	DC POWER	USB POWER
Storage	Internal SDR memory	External (PC Hard Drive)	Cloud
Trigger implementation	ADC control (DMA recording)	Tagged Sink Block	Separate circuit PCB design

Figure 2: Morphological Chart I elements contained in this figure

1.2.2: Biomimicry

The concepts generated through the use of biomimicry had to be derived from “outside-the-box” ideas since the prototype is essentially a box itself. Using such an unconventional approach to a stagnant object, the first ideas included reasoning for the shell. Then the actual construction, shape, and design were considered. Lastly, the materials, appearance, and performance were considered. After analyzing all these possibilities, animals or biological entities that carry these characteristics were able to be compared.

The outer shell was compared to such as a turtle, snail, or crab. The material shell itself was conceptualized as compostable or biodegradable material; while maintaining a solid construction like a rock. The shape was compared to the effective use of space like a beehive, and the internal components were thought of as layers like soil in case they are stackable. Added concepts included see through design like a jellyfish, internal thermal control like observed in weather, sealed and inaccessible to the user like a cocoon, and lastly silent components and performance like a predator or a cat.

Figure III: Biomimicry

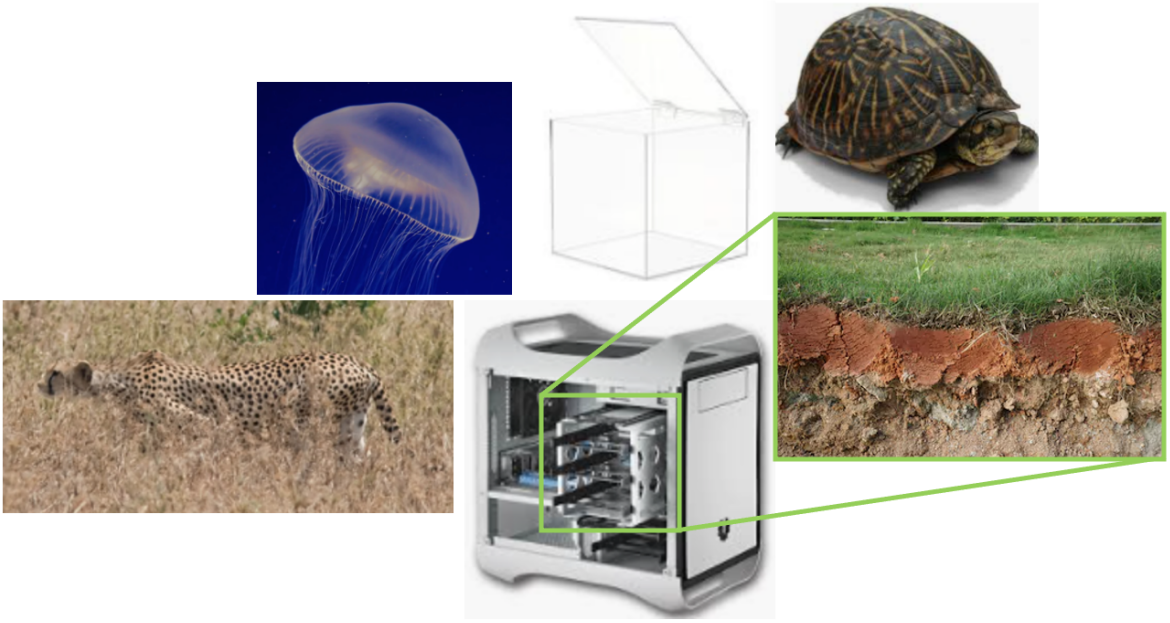

Figure 3: Biomimicry Concepts contained in this figure

1.2.3: Anti-Problem

The anti-problem method was used to come up with a few concepts. Some of these anti-problem concepts helped to generate ideas that work to make the user's experience more difficult than if they used their current equipment. This approach also sparked ideas that were not previously thought of i.e. having any wireless connections would pose an immediate problem whilst working in a magnetic field as the antenna components will be affected.

Figure IV: Anti-Problem I

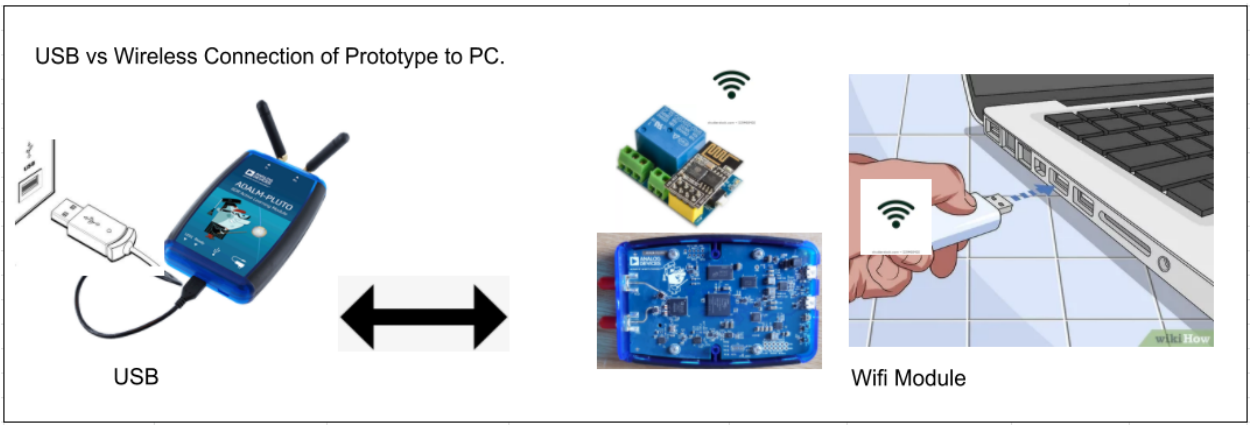

Figure 4: Anti-Problem I contained in this figure

Figure V: Anti-Problem II

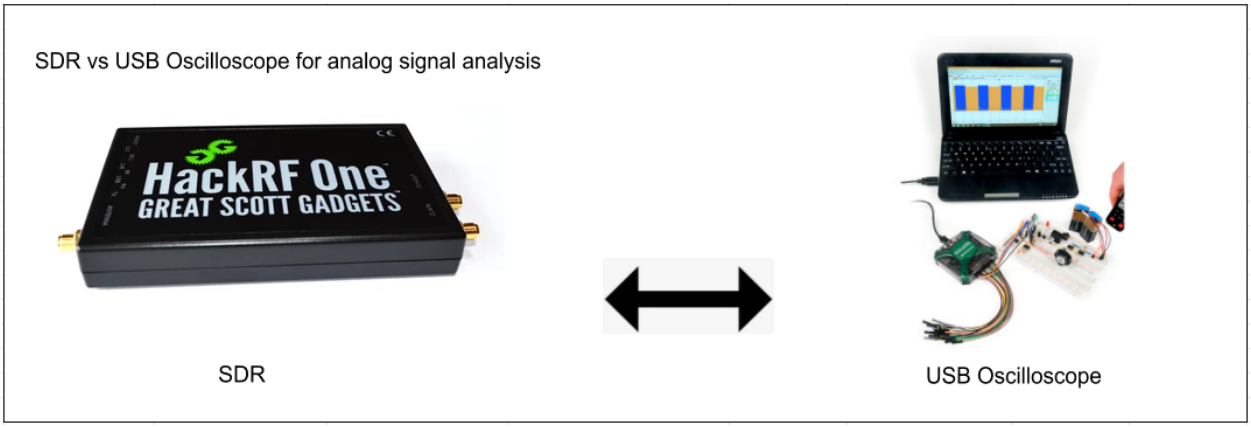

Figure 5: Anti-Problem II contained in this figure

Figure VI: Anti-Problem III

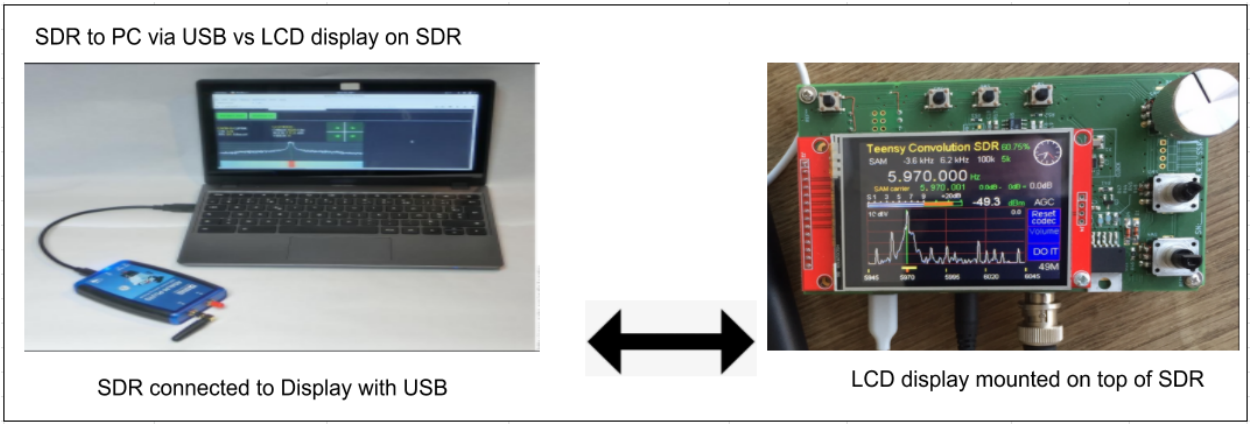

Figure 6: Anti-Problem III contained in this figure

1.3: Systematically Generated Concepts

The systematically generated concepts were created by looking at the different functions that our prototype must perform and breaking down the components and ways they can be performed. For example, for the PC or Display module we would need a PC running an operating system that supports the SDR and its software. Additionally, a display is needed as well as interface for the user to interact with.

SECTION II: Concept Table(s)

Table I: All Concepts I

Number of SDR	SDR	Attenuation	Trigger	Trigger implementation	Connection	Display	Software	Language	Power
One (two receiver ports)	Adalm PLuto	On SDR	Digital interpeter circuit	ADC control (DMA recording)	USB	PC monitor	Ubuntu	libiio	Battery
Two (one receiver port)	Hack RF One	On Bi-dicoupler	Soldered connection	Tagged Sink Block	Ethernet	In lab monitor devices	Windows 10	C	AC Power
Two (two receiver ports)	SDRplay DUO	On Box cable to SDR	Input connection	GPIO digital connection on SDR	Coax	Plasma	Linux	C++	DC Power
	SDRplay RSP2pro			Separate circuit PCB design	RCA	CRT	Viirtual Machine on Linux	C#	USB Power
				Trigger from the PC via USB	VGA		RTL-SDR	Linux Scripts	Outlet
					HDMI		Airspy	Python	surge protector
					DisplayPort		SDRangel	MATLAB	
							SDRSharp		
							GNU Radio		
							SDRuno		
							Simulink		

Table 1: All Concepts Part 1 contained in this table

Table I: All Concepts II

Storage	Interface	Prototype Box Material	Prototype Box Shape	Prototype Box Design	Prototype Box Size	Biomimicry	Anti Problem
Internal SDR memory	Keyboard	Metals	Cylindrical	Compact (space effective)	Shoe box	Outer Shell Protection of Internal Components (like a turtle, snail, crab)	Wireless Connection to PC
External (PC Hard Drive)	Touch	ABS Plastic (3D Printing)	Cubical	Self contained	Small gift box	compostable shell (recyclable material)	USB oscilloscope
Flash Drive	None (run and start)	Cardboard	Heptagonal	Open and accessible	Tight fit box (fit to the sdr's size)	biodegradable shell (organic materials)	On board display
CD	Mouse	Silicone	Hexagon	Closed and accessible (not compact)	Medium box	solid construction that can be thrown around (like a rock)	
Cloud	Knobs	Wood	Hybrid	Attractive Design	Large box	Hexagon shape (like a beehive)	
	Switches	Glass	Non-geometric	Unappealing Design		Layered Design (like soil)	
	Buttons	Resin	Triangular			Clear See-through design (like a jellyfish)	
						Internal thermal control (weather)	
						Sealed/cannot be opened (like a cocoon)	
						Silent Performance/Components (like a predator)	

Table 2: All Concepts Part 2 contained in this table

Table III: Medium Fidelity Concepts

Column1	Column2	Column3	Column4	Column5	Column6	Column7
Number	Concept					
1	Trigger Module	Trigger	Trigger Implementation			
		Digital Interpreter Circuit	ADC control (DMA recording)			
2	PC Module	Software	Language	Display	Connection	Power
		Windows	MATLAB	PC Monitor	HDMI	DC Power
3	SDR Module 1	Number of SDRs	SDR	Attentuation	Connection	Power
		Two (one receiver port)	Hack RF One	On SDR	USB	USB Power
			Adalm Pluto	On Bidirectional Coupler	Ethernet	AC Power
						Battery
4	SDR Module 2	Number of SDRs	SDR	Display	Storage	Anti Problem
		One	Hack RF One	PC monitor	Internal SDR memory	Wireless Connection to PC
			Adalm Pluto	In lab monitor devices	External (PC Hard Drive)	USB oscilloscope
					Cloud	On board display
5	Box Module	Prototype Box Material	Prototype Box Shape	Prototype Box Design	Prototype Box Size	Component Layout
		Plastic	Cubical	Open and accessible	Tight Fit (fit to the sdr's size)	Layered (like soil)

Table 3: Medium Fidelity Concepts contained in this table

Table IV: High Fidelity Concepts

Number	Concept	Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9
1	Prototype 1	Number of SDR	SDR	Attenuation	Trigger	Trigger implementation	Connection to PC	Display	Software	Language
		Two (one receiver port)	Adalm PLuto	On SDR	Digital interpeter circuit	ADC control (DMA recording)	USB 3.0	PC monitor	Windows 10	MATLAB
							VGA		Simulink	Python
2	Prototype 2	Number of SDR	SDR	Attenuation	Trigger	Trigger implementation	Connection to PC	Display	Software	Language
		Two (one receiver port)	SDRplay DUO	On Bi-dicoupler	Soldered connection	Separate circuit PCB design	USB 3.0	Plasma TV Screen	Virtual Machine on Linux	C
							HDMI		SDRuno	
3	Prototype 3	Number of SDR	SDR	Attenuation	Trigger	Trigger implementation	Connection to PC	Display	Software	Language
		One (two receiver ports)	Hack RF One	On Box cable to SDR	Input connection	Tagged Sink Block	Ethernet	CRT	SDRangel	Linux Scripts
							USB		Simulink	

Table 4: High Fidelity Concepts contained in this table

Table V: High Fidelity Concepts (Cont…)

Column10	Column11	Column12	Column13	Column14	Column15	Column16	Column17	Column18
Power	Storage	Interface	Prototype Box Material	Prototype Box Shape	Prototype Box Design	Prototype Box Size (LxWxH)	Biomimicry	Anti Problem
DC Power	External (PC Hard Drive)	Keyboard	Metals	Cubical	Open and accessible (Like a package)	Medium (10x8x4 inches)	Clear See-through design (like a jellyfish)	Wireless Connection to PC
							Silent Performance/ Components (like a cat)	
Power	Storage	Interface	Prototype Box Material	Prototype Box Shape	Prototype Box Design	Prototype Box Size (LxWxH)	Biomimicry	Anti Problem
AC Power	Internal SDR memory	Keyboard	ABS Plastic (3D Printing)	Triangular (two inputs, one output to PC)	Closed and accessible (Like a shoe box)	Small (6x3x3 inches)	Sealed/cannot be opened (like a cocoon)	USB oscilloscope
		Mouse					solid construction that can be thrown around (like a rock)	
Power	Storage	Interface	Prototype Box Material	Prototype Box Shape	Prototype Box Design	Prototype Box Size (LxWxH)	Biomimicry	Anti Problem
USB Power	Flash Drive	Switches	Wood	Hexagon	Compact (space effective)	Tight fit box (fit to the sdr's size)	Hexagon shape (like a beehive)	On board display
		Buttons					Layered Design (like soil)	

Table 5: High Fidelity Concepts (Cont…) contained in this table

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