Florida Light and Power

Image Recognition for Pad Mounted Equipment

Concept Generation

Senior Design – Team 304:

Kent Logue

Jordan Wilkerson

Sam Hammermaster

Erin Murphy

Gage Irwin

Date:

October 20th, 2021

1. **Concept Generation Process**
    a. The brainstorming process began separately. The team thought that more ideas could be generated if there was no interruption and ideas were free-flowing. The downside to this approach is duplicate ideas. Once the team got together to discuss, the duplicate ideas were immediately condensed. Then, major function criteria were decided upon for the software and hardware. The team chose the categories to be a power source, binary input, attachment method, signal type, and material for hardware and input type, computer language, deep learning framework, cloud platform, annotation, algorithm, user interface, and data storage for software. For each category, there were on average 10 concepts generated for 100 sub concepts. From those 100 sub-concepts, the team then generated 100 concepts that incorporated aspects of the sub-concepts. Those concepts were then voted on to find 5 medium fidelity and 3 high fidelity concepts.
2. **Biomimicry**
    a. For the biomimicry process, the team decided to try to mimic the functionality of a tree. This chart shows the tree feature on the left and the corresponding idea on the right.

Tree Function	Associated Function
Growth	Something extends up or out when powered
Branches	Heat/lack of heat moves outwards from a central point
Roots	Output is under the transformer
Seeds	Emit some sort of color or light outside of the transformer
Wood	Use a non-conductive material that won’t passively get too hot

	from the transformer
Water	Heat/cool a reservoir of liquid
Bark	Heat/cool the surface of a transformer
Squirrel living in the tree	Put a small child inside of the transformer to come out whenever the light inside turns on

3. **Forced Analogy**
    a. The forced analogy we chose to do was to an aircraft carrier. Below shows the functions of the aircraft carrier and their corresponding forced analogy.

Aircraft Carrier Function	Forced Analogy
Holds Airplanes	The drone can land on the transformer to receive binary input
Has a full staff onboard	Multiple options to flag drone in case one fails
Floats	Everything is watertight to make sure integrity is complete
Moves through the ocean	A mechanical solution that moves back and forth along the transformer
Equipped with weaponry	Heater / Cooler applies the effect to different parts of the transformer
Associated with a countries military	The transformer has a flag that can pop up

4. Morphological Chart

Morphological Chart					
Functions	Option 1	Option 2	Option 3	Option 4	Option 5
Power Source	Transformer	Battery	Solar		
Attachment Method	Nut & Bolt	Rivet	Polyurethane Sealant		
Signal Type	Heater	Cooler	Single Color LED	Multi Color LED	3-D
Material	Stainless Steel	Aluminum	Steel		
Input type	Images	Videos	RGB	Infrared	
Computer Languages	MATLAB	Python	Javascript	C++	
Training Platform	Amazon SageMaker	Google Collab	Azure AI	Run Locally	
Algorithm	YOLOv4	YOLOv5	R-CNN	Fast R-CNN	

High Fidelity Concepts

1. Transformer-powered plastic LED attached using a polyurethane sealant. Corresponding image recognition system that takes in RGB video uses trained YOLOv5 to make detections.
2. Stainless steel external device that cools with transformer power and is attached with rivets. Computer vision system analyzes infrared videos using YOLOv5.

3. Stainless steel mechanical flap that opens up with transformer power and is attached with rivets. Computer vision system analyzes RGB videos using YOLOv5.

Medium Fidelity Concepts

1. Cool the transformer lid with an internal device and detect the cooled lid with infrared video input using YOLOv5.
2. Mount an external LED using a stainless steel device attached using rivets and power by the transformer.
3. External cooled rod made of stainless steel (or same metal as transformer) and infrared video input with YOLOv5 algorithm.
4. Side rod of stainless steel powered by transformer. When fault is detected it is raised and RGB video is captured to be processed.
5. Strips of stainless steel wrap around edges and are cooled by the transformer. Infrared video is captured and beacon is detected with YOLOv5.

Initial Concept Generation

Appendix - 100 Concepts

Concept Idea	Concept Description
1	Transformer powered single color LED that is attached with polyurethane sealant and uses a plastic-type enclosure. Then videos are fed into a Python program using the YOLOv5 algorithm which was trained on Google AI.
2	Transformer-powered heater that heats the surface of the transformer, and a corresponding image recognition system built using MATLAB and YOLOv5 trained locally.
3	Transformer powered cooler, made using stainless steel, attached using rivets. The drone will capture the coolers output signal using imaging, utilizing an R-CNN made algorithm to decipher the output.
4	Transformer powered Multi-Color LED attached via nuts and bolts made out of stainless steel where the drone will detect with images, that will send be read using YOLOv4
5	Transformer powered antenna that rises after a fault, and a corresponding image recognition system built using MATLAB and YOLOv5 trained locally.

6	Solar-powered single color LED that is attached with Polyurethane sealant and uses a Steel-type enclosure. Then images are fed into a C++ program using the Fast R-CNN algorithm which was trained on Amazon SageMaker.
7	Transformer powered heater that heats an aluminum rod that protrudes through the transformer, and a corresponding image recognition system built using MATLAB and YOLOv5 trained on Google Colab.
8	Transformer powered cooler, made using aluminum, attached using nuts and bolts. The drone will capture the cooler's output signal using videos, utilizing a Yolov4 made algorithm to decipher the output.
9	Battery-powered Multi Color LED beacon that will attach using rivets, the device made out of aluminum and the drone will take in videos being read on YOLOv5
10	Battery-powered device that opens into a larger shape with a video detection system using Python and YOLOv5 trained on Google Colab.
11	Transformer powered single color LED that is attached with Polyurethane sealant and uses a Steel-type enclosure. Then videos are fed into a Javascript program using the YOLOv4 algorithm which was trained on IBM Watson.
12	Transformer-powered heater that heats a steel rod on the inside of the transformer, and a corresponding image recognition system built using Python and YOLOv5 trained on Amazon SageMaker.
13	Battery-powered cooler, made using steel, attached using rivets. The drone will capture the cooler's output signal using images, utilizing a Yolov4 made algorithm to decipher the output.
14	Solar-powered multi-colored LED attached via polyurethane metal sealant made out of steel, the drone will take in images and read them with the YOLOv4 algorithm
15	Solar-powered flap that opens after a fault to display color block. Image recognition system using C++ and R-CNN trained on Azure.
16	Transformer powered single color LED that is attached with Nuts & bolts and uses a Steel-type enclosure. Then RGB is fed into a Python program using the YOLOv5 algorithm which was trained on IBM Watson.
17	A heat lamp that is inside the transformer that faces outwards, and a corresponding image recognition system built using Python and YOLOv5 trained locally.
18	Battery-powered cooler, made using steel, attached using rivets. The drone will capture the cooler's output signal using images, utilizing a Yolov5 made algorithm to decipher the output.
19	Transformer powered multi-color LED attached using a polyurethane sealant

	the beacon will be made from aluminum and the drone will take in videos
20	Transformer powered incandescent lightbulb with a video recognition system using Javascript and Fast R-CNN trained locally.
21	Battery powered single color LED that is attached with Polyurethane sealant and uses a Stainless steel type enclosure. Then images are fed into a C++ program using the YOLOv5 algorithm which was trained on Azure AI.
22	The output signal turns on a heat lamp that is mounted on the outside of the transformer, and a corresponding image recognition system built using C++ and YOLOv4 trained on IBM Watson.
23	Battery-powered cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using images, utilizing a Fast R-CNN made algorithm to decipher the output.
24	A device that alternates the color of LED to create a disco ball effect made out of steel, the drone would receive videos of the device and use YOLO to determine if the disco is going
25	A battery-powered antenna that rises a certain height with an RGB image recognition system trained on Python and YOLOv5 using Amazon SageMaker.
26	Transformer powered single color LED that is attached with Rivets and uses a Steel-type enclosure. Then images are fed into a C++ program using the R-CNN algorithm which was trained on Google AI.
27	The output signal heats a stainless steel strip that goes across the edge of the transformer, and a corresponding image recognition system built using Python and YOLOv5 trained locally.
28	Solar-powered cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using images, utilizing a Fast R-CNN made algorithm to decipher the output.
29	Multi color LED that will attach via rivets made out of stainless steel, the bulb would heat up and the drone would take in infrared imaging to determine if the bulb is on
30	Solar-powered flare gun with video recognition system that uses Javascript and R-CNN trained locally.
31	Battery-powered single color LED that is attached with Polyurethane sealant and uses a Plastic-type enclosure. Then videos are fed into a C++ program using the YOLOv4 algorithm which was trained on Google AI.
32	A reservoir of liquid that is held on the top of the transformer is heated until boiling point is reached and water vapor has started to rise, and a corresponding image recognition system is built using C++ and YOLOv5 trained on Google AI.

33	Solar powered cooler, made using steel, attached using polyurethane sealant. The drone will capture the cooler's output signal using images, utilizing a Fast R-CNN made algorithm to decipher the output.
34	Solar-powered multi-color LED that will attach with nuts and bolts made out of stainless steel, The drone will then take in images and use python to use R-CNN to read images
35	Transformer powered smoke signal with a computer vision system that takes video input, is written in C++, and uses the YOLOv4 algorithm trained on Google AI.
36	Solar-powered single color LED that is attached with Polyurethane sealant and uses a Plastic-type enclosure. Then videos are fed into a MATLAB program using the YOLOv4 algorithm which was trained on Amazon SageMaker.
37	The output signal is connected to a gas line that sparks when a signal is received so a flame shoots out of the transformer, and a corresponding image recognition system is built using Python and R-CNN trained on Google AI.
38	Transformer powered cooler, made using stainless steel, attached using polyurethane sealant. The drone will capture the cooler's output signal using RGB, utilizing a Yolov5 made algorithm to decipher the output.
39	Battery-powered multi-color LED beacon that will attach via polyurethane metal sealant made out of steel with a drone that takes in videos using javascript to run Fast R-CNN
40	A battery-powered 3D lever that rises after a fault and a computer vision system with an image input, written in Python, using Fast R-CNN and Azure.
41	Battery-powered single color LED that is attached with Rivets and uses a Plastic-type enclosure. Then infrared is fed into a Javascript program using the YOLOv5 algorithm which was trained on Amazon SageMaker.
42	The transformer powers a heat source so extreme that the entire transformer melts, and a corresponding image recognition system is built using MATLAB and YOLOv5 trained locally.
43	Transformer powered cooler, made using aluminum, attached using polyurethane sealant. The drone will capture the cooler's output signal using imaging, utilizing a Fast R-CNN made algorithm to decipher the output.
44	Transformer powered multi-color LED that will flash and the drone will receive videos and process them using YOLOv5
45	An antenna that rises with solar power and an image recognition system written in MATLAB with YOLOv5 trained on IBM Watson's platform.
46	Battery-powered single color LED that is attached with Nuts & bolts and uses a Plastic-type enclosure. Then RGB is fed into a C++ program using the

	YOLOv4 algorithm which was trained on IBM Watson.
47	A copper ring is heated internally around the lid of the transformer, and a corresponding image recognition system is built using Azure AI and YOLOv5 trained locally.
48	Solar powered cooler, made using aluminum, attached using polyurethane sealant. The drone will capture the cooler's output signal using videos, utilizing a Yolov4 made algorithm to decipher the output.
49	The flap that opens to expose distinct color with transformer power and computer vision system that takes video input and trains Fast R-CNN on Google Colab
50	Transformer powered single color LED that is attached with Polyurethane sealant and uses a Steel-type enclosure. Then infrared is fed into a Javascript program using the Fast R-CNN algorithm which was trained on local hardware.
51	A bronze statue of Apollo is mounted to the top of the transformer and heated from the attachment on the feet, and a corresponding image recognition system is built using Python and YOLOv5 trained on Amazon SageMaker.
52	Solar-powered cooler, made using aluminum, attached using polyurethane sealant. The drone will capture the cooler's output signal using RGB, utilizing a Yolov4 made algorithm to decipher the output.
53	Fire powered by a battery attached with a rivet in a steel device with a corresponding image recognition system using Python, YOLOv4, and trained locally.
54	Battery-powered single color LED that is attached with Polyurethane sealant and uses a Steel-type enclosure. Then videos are fed into a C++ program using the YOLOv5 algorithm which was trained on local hardware.
55	The four corners of the transformer are all heated using aluminum, and a corresponding image recognition system is built using MATLAB and R-CNN trained locally.
56	Battery-powered cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using RGB, utilizing a Fast R-CNN made algorithm to decipher the output.
57	An aluminum antenna that rises with solar power and a computer vision system using C++, Amazon SageMaker, and R-CNN
58	Battery-powered single color LED that is attached with Nuts & bolts and uses a Steel-type enclosure. Then images are fed into a Javascript program using the Fast R-CNN algorithm which was trained on local hardware.
59	Plastic on the outside of the transformer is melted via an aluminum rod protruding from the transformer, and a corresponding image recognition

	system is built using Python and YOLOv5 trained on IBM Watson.
60	Battery-powered cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using infrared imaging, utilizing a Yolov4 made algorithm to decipher the output.
61	Stainless steel 3D lever connected with nuts & bolts and a system that takes in images and uses YOLOv5 trained on Google Colab
62	Battery-powered single color LED that is attached with Nuts & bolts and uses a Steel-type enclosure. Then images are fed into a Javascript program using the Fast R-CNN algorithm which was trained on local hardware.
63	Plastic on the outside of the transformer is melted via an aluminum rod protruding from the transformer, and a corresponding image recognition system built using Python and YOLOv5 trained on IBM Watson.
64	Battery-powered cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using infrared imaging, utilizing a Yolov4 made algorithm to decipher the output.
65	Stainless steel 3D lever connected with nuts & bolts and a system that takes in images and uses YOLOv5 trained on Google Colab
66	Transformer powered single color LED that is attached with Rivets and uses a Steel-type enclosure. Then RGB is fed into a MATLAB program using the R-CNN algorithm which was trained on IBM Watson.
67	The transformer powers a microwave that is mounted to the outside, and a corresponding image recognition system built using MATLAB and YOLOv5 trained locally.
68	Transformer powered cooler, made using steel, attached using rivets. The drone will capture the cooler's output signal using RGB, utilizing a Fast R-CNN made algorithm to decipher the output.
69	Aluminum flare gun powered by the battery and connected with a rivet, with image recognition system using Javascript, Fast R-CNN, and Azure.
70	Solar-powered single color LED that is attached with Nuts & bolts and uses an Aluminum type enclosure. Then infrared is fed into a Python program using the R-CNN algorithm which was trained on Amazon SageMaker.
71	A second transformer is powered by the original transformer that emits passive heat due to that power, and a corresponding image recognition system is built using HTML and manual labor trained by the CIA.
72	Battery-powered internal cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using RGB, utilizing a Fast R-CNN made algorithm to decipher the output.
73	Steel flap that opens to display color with solar power and image recognition

	using C++ language and YOLOv5 trained locally.
74	Solar-powered single color LED that is attached with Polyurethane sealant and uses a Plastic-type enclosure. Then videos are fed into a MATLAB program using the R-CNN algorithm which was trained on local hardware.
75	Transformer powered heater that heats an aluminum rod that protrudes through the transformer, and a corresponding image recognition system built using C++ and YOLOv5 trained locally.
76	Solar-powered internal cooler, made using steel, attached using nuts and bolts. The drone will capture the cooler's output signal using images, utilizing a Fast R-CNN made algorithm to decipher the output.
77	Steel device attached with polyurethane sealant that opens to larger shape with solar power and video recognition using YOLOv4 trained locally
78	Transformer powered single color LED that is attached with Rivets and uses a Plastic-type enclosure. Then images are fed into a Javascript program using the YOLOv4 algorithm which was trained on IBM Watson.
79	Transformer-powered heater that heats an aluminum rod that protrudes through the transformer, and a corresponding image recognition system built using Python and R-CNN trained locally.
80	Transformer powered internal cooler, made using stainless steel, attached using polyurethane sealant. The drone will capture the coolers output signal using imaging, utilizing a R-CNN made algorithm to decipher the output.
81	Steel antenna that rises when powered by the transformer and is attached with rivets with an image recognition system that can measure the height of antenna growth trained on Amazon Sagemaker
82	Transformer powered single color LED that is attached with Rivets and uses a Stainless steel type enclosure. Then images are fed into a Python program using the YOLOv5 algorithm which was trained on Google AI.
83	Transformer powered heater that heats an aluminum rod that protrudes through the transformer, and a corresponding image recognition system built using MATLAB and YOLOv4 trained on R-CNN.
84	Solar-powered internal cooler, made using aluminum, attached using polyurethane sealant. The drone will capture the cooler's output signal using RGB, utilizing a Yolov4 made algorithm to decipher the output.
85	Aluminum flap that opens after receiving battery power, attached with nuts and bolts, and a video recognition system trained on Google Colab using YOLOv5.
86	Transformer powered single color LED that is attached with Nuts & bolts and uses a Plastic-type enclosure. Then videos are fed into a Javascript program using the YOLOv4 algorithm which was trained on Google AI.

87	Battery powered internal cooler, made using steel, attached using rivets. The drone will capture the cooler's output signal using images, utilizing a Yolov4 made algorithm to decipher the output.
88	Battery powered single color LED that is attached with Rivets and uses a Stainless steel type enclosure. Then infrared is fed into a MATLAB program using the YOLOv5 algorithm which was trained on local hardware.
89	Transformer powered internal cooler, made using aluminum, attached using polyurethane sealant. The drone will capture the cooler's output signal using imaging, utilizing a Fast R-CNN made algorithm to decipher the output.
90	Battery powered single color LED that is attached with Polyurethane sealant and uses a Plastic type enclosure. Then infrared is fed into a MATLAB program using the YOLOv4 algorithm which was trained on local hardware.
91	Transformer powered single color LED that is attached with Polyurethane sealant and uses an Aluminum type enclosure. Then videos are fed into a Javascript program using the R-CNN algorithm which was trained on Azure AI.
92	Solar-powered single color LED that is attached with Rivets and uses a Stainless steel type enclosure. Then infrared is fed into a C++ program using the YOLOv4 algorithm which was trained on Azure AI.
93	Transformer powered single color LED that is attached with Polyurethane sealant and uses a Stainless steel type enclosure. Then RGB is fed into a Python program using the YOLOv4 algorithm which was trained on Google AI.
94	Solar-powered single color LED that is attached with Rivets and uses a Plastic-type enclosure. Then RGB is fed into a Python program using the YOLOv4 algorithm which was trained on local hardware.
95	Transformer powers a heater that incubates a pigeon egg. Once the pigeon hatches, the pigeon is given time to mature and taught how to fly by its mother. The pigeon is also forced to watch films of other pigeons flying into drones to teach it how to attack drones. Once it is ready, it is released from the transformer to fly into the nearest drone. FPL will be able to see the last location of the drone before it got demolished by a pigeon. The closest transformer is therefore probably the one that had the initial issue.
96	Battery-powered cooler, made using aluminum, attached using polyurethane. The drone will capture the cooler's output signal using RGB, utilizing a Fast R-CNN made algorithm to decipher the output.
97	The transformer has a landing platform for the drone that uploads a binary signal of either working or not working to the drone.
98	Transformer powered extending rod with a flag that is attached with polyurethane sealant and uses a stainless steel enclosure. Then videos are fed into a Python program using the YOLOv5 algorithm which was trained on Google AI.

99	Solar-powered cooler, made using stainless steel, attached using nuts and bolts. The drone will capture the cooler's output signal using RGB, utilizing a Fast R-CNN made algorithm to decipher the output.
100	The transformer is equipped with motion-sensing turrets that shoot the drone out of the sky. The last known location of the drone is where the issue is occurring.

100 sub function concepts:

Hardware				
Power Source	**Binary Input**	**Attachment Method**	**Signal Type**	**Material**
Transformer	Power	Nuts & bolts	Heater (internal)	Stainless steel
Battery	RF	Rivet	Cooler (internal)	Aluminum
Solar	±5V (not power)	Polyurethane sealant	Antenna	Titanium
		Weld	Single Color LED	Brass
		Magnets	Multi Color LED	Steel
		Duct Tape	Incandescent Lightbulb	Bronze
			3D Lever	Plastic
			Flap that exposes color	
			Flare gun	
			Smoke signals	
			Fire	
			Opening shape	
			Heater (external)	
			Cooler (external)	

Software							
Input Type	**Computer Languages**	**Deep Learning Framework**	**Cloud Platform**	**Annotation**	**Algorithm**	**User Interface**	**Data Storage**
Images	MATLAB	Pytorch	Amazon SageMaker	COCO	YOLOv4	Gradio	GoogleSheets
Videos	Python	MXNet	Google Colab	Pascal VOC	YOLOv5	TensorFlow	Excel
RGB	Javascript	TensorFlow	Google AI	YOLO	R-CNN	Keras	AWS Database
Infrared	C++	MATLAB	Azure AI	MakeSense AI	Fast R-CNN	Cuda	MS Access
		NVIDIA Caffe	IBM Watson	LabelImg	Mask R-CNN	PyTorch	MySQL
		Chainer	Run Locally	VGG image annotator	MobileNet	scikit-learn	PostgreSQL
		Paddle Paddle		LabelMe	SqueezDet	TensorFlow.js	MongoDB
				Scalable	SSD	Kubeflow	Firebase
				RectLabel	SPP-Net	ML Kit	DynamoDB
					R-FCN	CLI	Oracle
						Custom GUI	JSON
						Custom Web App	CSV/TSV