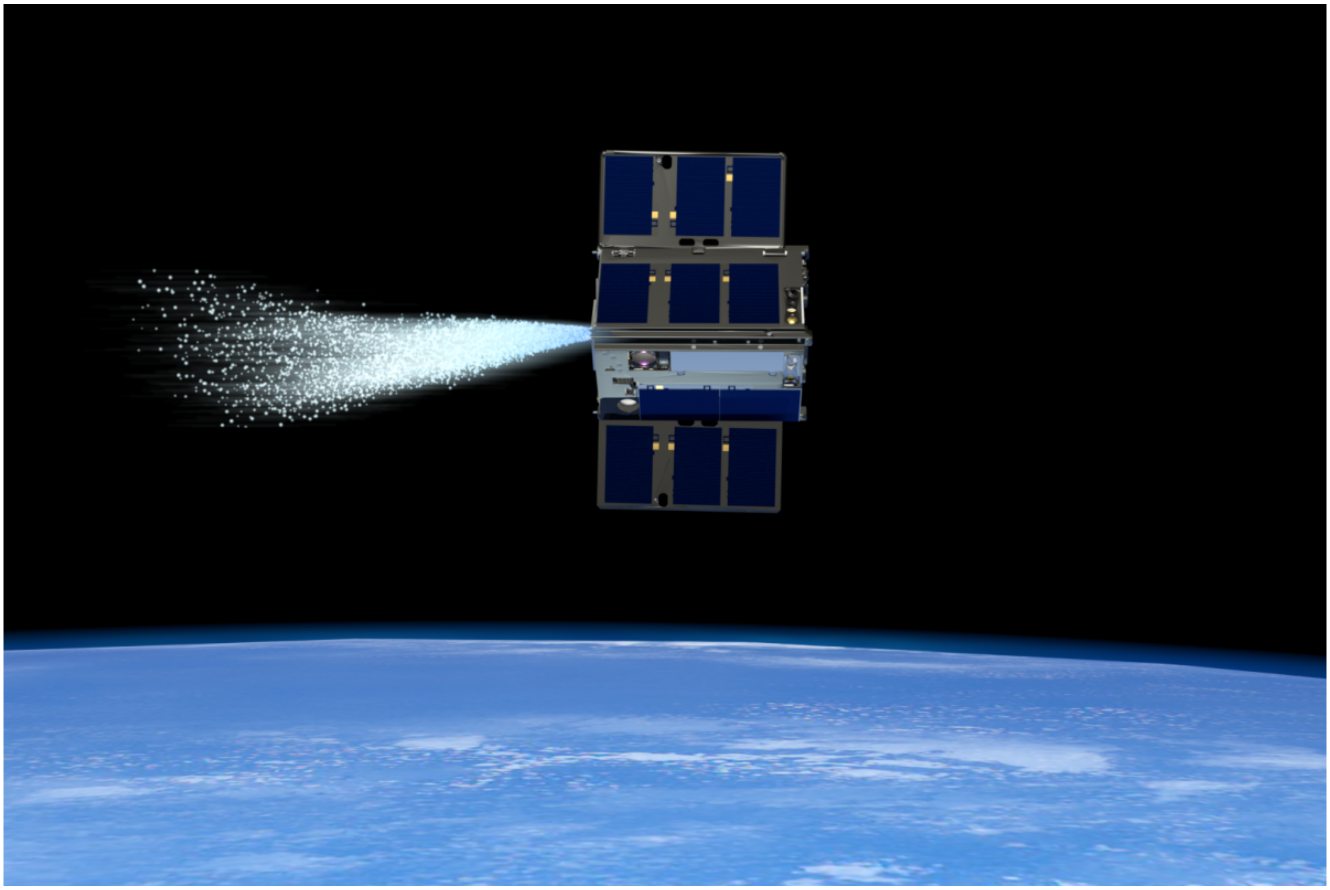
(VOCS) VENUS OBSERVATORY COMMUNICATION SATELLITE



SUMMARY:

The main objective of this mission is to study the atmosphere of Venus and search for exoplanets. The reason why Cubesats are the best for this is because these are very small and can be as powerful in communication with other

large satellites. With the help of these Cubesats we can know more about the atmosphere of Venus.

The unique thing about this mission is that this is going to be designed to study the ongoing changes on the planet and it will be able to study the atmosphere and use LIDAR and other systems study the atmosphere of Venus. These cubesats will be able to study the atmosphere, solar radiation. It will be able to study and go in detail on why the planet is even hotter than the Mercury. The VOCS 1 cubesat will furthermore be able to study the chemical composition as we get closer to the planet. This will be useful as we will be able to get insights into how the different substances react and exist on Venus. The last thing this cube sat does is that this will be designed to compare various greenhouse simulations. This is extremely useful as this can help us better understand how heat and other factors can affect a planet. The current temperature of Venus 864 degrees Fahrenheit with a composition of the atmosphere abundant in CO_2, nitrogen, sulfur dioxide, argon, water vapor, carbon monoxide, helium, neon, hydrogen chloride and hydrogen sulfide respectively. We know the composition of Venus but what we are unable to find out is how do the concentrations of the gasses mix and interact and get affected by the geology of Venus. We also don't know when the seasons of Venus change and how do the gasses react and how does the geology change over time. The best formula to get to know the geology of Venus is to master the atmosphere as that will automatically clear up a lot of doubts of scientists and researchers alike. The experiments on VOCS 1 have been designed to find out how exactly the atmosphere of Venus is at a very deep scale. The

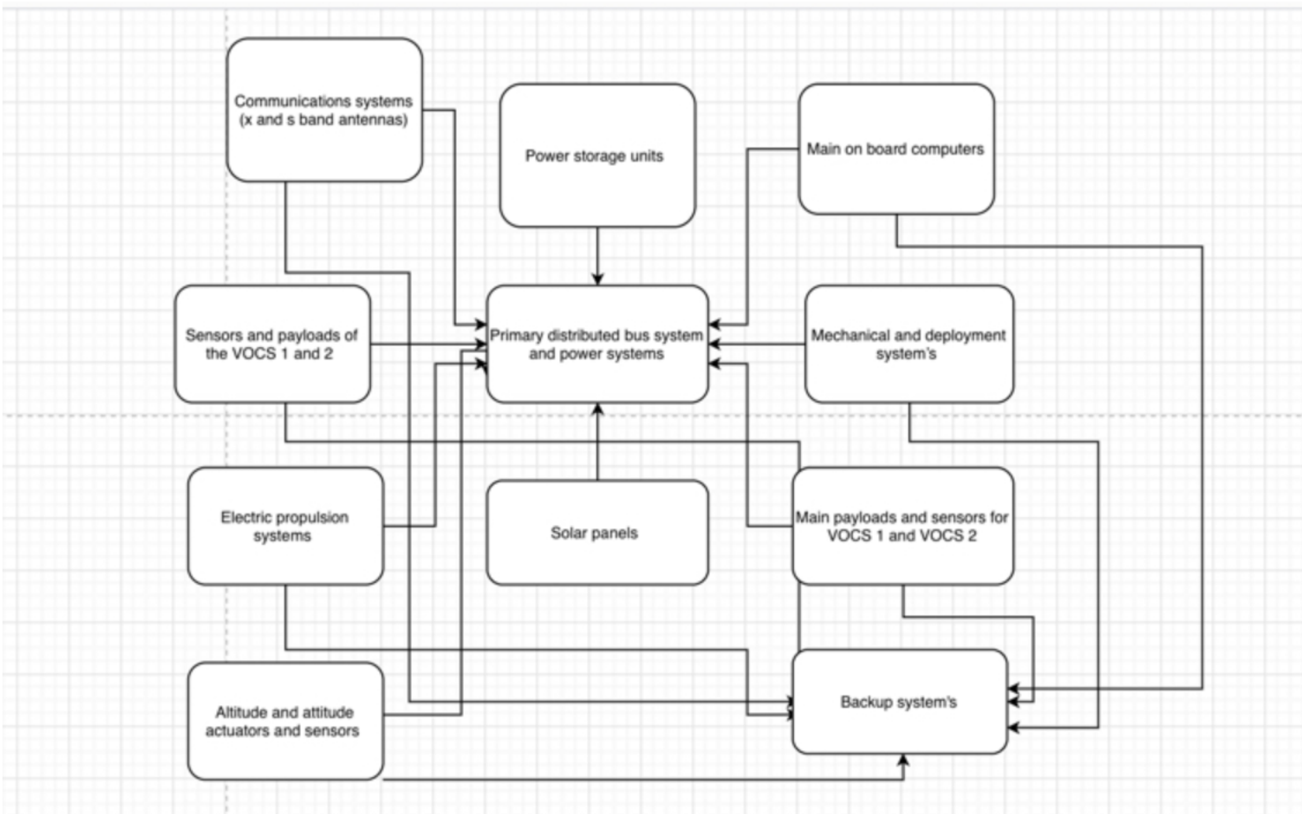
secondary objective of this satellite is to study the aerosols present on Venus. An aerosol is a suspension of fine solid particles or liquid droplets in air or another gas. An aerosol is a extremely important thing in studying the aerosols in the atmosphere can answer a lot of questions. Since every planet with a atmosphere develops aerosols. Studying these can answer things like the effect of possible water on the planet, chemical reaction on the planet and various other geologic features as well. All of these things can be answered through the instruments of VOCS1.

The objective of VOCS 2 is going to be able to search for possible exoplanets on its way to Venus. We will be doing this by deploying a star shade. Our cube sat will be designed and will be 20 U. Since there will be 2 cubesats in the entire mission one will be going towards Venus and this will be VOCS 1 and the other satellite which is VOCS 2 will break off and use the gravity of Venus to fly past the sun and collect solar energy to explore beyond the range of the sun. This will be done so we can search for possible exoplanets and conduct experiments by knowing in detail what the composition of the atmosphere is. The last thing that VOCS 2 will accomplish is that it will be plotting the effects of relativity in space and will test how and why the curves of gravity are there the way they are since they cause distortions and this can be an easy way to find wormholes or black holes. We will be using special kind of gyroscopes and sensors to show the effect of mass and gravity on light waves as this will prove the size of each bend and this can possibly help us find out the effect and the gravity being created by the object. This part of the mission can be very useful as this can give us insights into how and why our

solar system is the way it is and possibly how things and galaxies are made.

Table of contents

System diagrams for VOCS 1 and VOCS 2



Concept of operation

1) – The satellites with launch from Earth
2) – The satellites with provide health checks once in LEO and will be transmitting key telemetry
3) – The engines of the second stage will fire once to slowly break the orbit of Earth
4) – The 3 stage will fire and put the satellites on a course towards Venus

5) **– The third stage will make various trajectory and course correction maneuvers throughout the flight**
6) **– The VOCS 1 and 2 will separate**
7) **– VOCS 1 will prepare to get into the scientific elliptical orbit around Venus**
8) **– The third stage of the rocket will fire its thrusters one last time and put VOCS 2 on a escape trajectory**
9) **– VOCS 2 will separate from the third stage and now its going to be on its own**
10) **– The solar panels on VOCS 2 will completely charge**
11) **– VOCS 2 will coast till it encounters the Kuiper belt**
12) **– The VOCS 2 will still keep its shield intact since it will be encountering the Kuiper belt very soon**
13) **– Once the VOCS 2 has actively avoided rocks and is clear the spacecraft will separate and this is the beginning of the mission of VOCS 2**
14) **– The VOCS 2 will begin transmitting the telemetry**
15) **– VOCS 1 and 2 will check their vital systems**
16) **– The mission would begin officially**
17) **– When the mission has come to an end the VOCS 1 spacecraft will slowly enter the Venus atmosphere and VOCS 2 would have hopefully have reached interplanetary space by then and transmission of the 2 sattelites would have officially been ended marking the end of an successful mission**

POSSIBLE DISCOVERIES

The possible discoveries we hope to make is to find possible exoplanets. Since the names or the order of exploring planets is not decided this mission will most probably be a flyby since the likely hood of collecting key scientific data from these planets can be greater. In addition to this we are going to be following a path similar to the voyager which will include gravity assists from the exoplanets that may be of interest since we might be losing speed. The reason why we aim to go and explore the exoplanets which are interesting is because these planets have the power to actually tell us various mysteries of the universe and possibility of planets like ours. The idea of exoplanets discoveries has come from the various telescopes such as Hubble, Spitzer, TESS and other telescopes. The other possible discoveries we hope to make is to find out how heat affects the planet. The other discoveries we hope to make with the VOCS 1 spacecraft is how the geology interacts with the gaseous reactions on Venus and also on how the various gasses season or possibly cause seasons or effect the aerosols on Venus. We might also be able to study the evolution of Venus to a certain scale which can answer a lot of scientific questions such as why is Venus hotter then Mercury and also questions relating to the chemistry and geology of the planet and questions such as how does the green houses of Venus if any effect the temperature of the planet and also questions like how might Venus be similar to Earth and is Venus our past or future. The VOCS 1 can study the Venus atmosphere weekly and take more precise and accurate measurements because of this. The orbit of VOCS 1 will allow it to study most parts of

Venus which is better. The advantage of looking into the atmosphere is that we can actually know a lot of things that could have been there a long time ago. In addition to this the atmosphere of Venus is very thick so there is a high chance that the elements that once could have hosted life could be in the atmosphere. With constant observation we can know more and experiment on the atmosphere with the sensors. The VOCS 2 spacecraft is going to be studying the effect of relativity in the galaxy and the effects of gravity on a bigger scale. The other possible discoveries we are targeting at are planets like HD 189733B, Kepler 452 B, TOI 700 B (ASTREIA), TOI 700 C (ASTREIA), TOI 700 D (ASTREIA) and other planets. The reason why we believe that we might be able to find and study a lot of planets and astrophysical phenomena's is because the VOCS 2 will be able to study stars, planets and neutron stars like never before with the aid of new technology. In addition to this the cubesat will be having a similar focal length and telescope aperture to TESS and hence the results we can get can be significantly greater than smaller satellites like ASTREIA. The technologies used on VOCS 2 will be able to study dark matter and quantum points and atoms due to the areas of gravity and study how they might be effected. One such example of this is that gravity can travel across time and dimensions. To study this theory we can use various components like the main telescope, relativity sensors and the other components like the star shades and sun trackers to plot the effect of relativity and equate it to the various formulas that study and use the time and mass and energy similar to E=MC2.

The effect of gravity can be plotted by using extremely fine sensors on the satellite and the various cameras and telescopes that can plot and read relativity with the help of the various techniques like gravitational micro lensing, quantum relativity measurements which is using extremely precise instruments which are cryogenic and precise to measure aspects of relativity and gravitational distortions. These techniques among others can really aid us to know the mysteries about the universe. The last thing we aim to achieve is to possibly find is the different kinds of stars. The reason why this is the third objective is because the satellite is best optimized for searching for exoplanets, studying gravity, studying dimensions to a small extent and possibly space time to some extent and then also finding stars. This is because other than the stars that are found with planets there are other kinds of stars like medium, giant, brown dwarfs and other stars. These kind be easily identifiable. The reason why this is extremely important is because one day a lot of scientists predict that the universe will start getting so dim that it will be hard for life to exist due to the massive supernovas. Hence it would be good to use small scale satellites to study this from a distance and take measurements. Although smallsats are good for short distance and only discovery they can discover and analyze stars and the universe to a bigger scale. Due to the size this satellite will be slightly more efficient in discovering them compared to smaller LEO ones.

INSTRUMENTS AND COMPONENTS

The various instruments we are using are the

RAMAN LIDARS: OPTICAL

MOTHER BOARD

MAGNOMEMTER

ALTITUDE AND ATTITUDE SENSORS: OPTICAL

ALTITUDE AND ATTITUDE ACTUATORS

PREPULSION SENSORS

POWER SENSORS

TEMPRATURE SENSORS

SPECTROSCOPES: OPTICAL

HEAT AND THERMAL CAMERAS: OPTICAL

GECKO CAMERA: OPTICAL

STAR TRACKERS: OPTICAL

SUN SENSORS: OPTICAL

SPACE SEXTANT: OPTICAL

CHAMELEON IMAGERS: OPTICAL

GAS SENSORS

EXOPLANET DETECTORS: OPTICAL

COMMUNICATION SYSTEMS

OZONE SENSORS

RELATIVITY SENSORS

GYROSCOPES

GRAVITY SENSORS

STAR TRACKERS FOR RELATIVITY: OPTICAL

STAR SHADES

TELESCOPES: OPTICAL

PAYLOADS

The main payloads we want to put on the 2 satellites are the VES. These are the Venus environmental sensors and the ERDS which is the exoplanet relativity detection sensor. These payloads is going to be the main payload and instruments of the VOCS 1 and VOCS 2. Each of the suite of instruments will have the various cameras such as the Chameleon cameras, gecko camera, spectroscopes, magnetometer, RAMAN LIDARS, Altitude and attitude sensors, temperature sensors, ambient temperature sensors, pressure sensors, Ambient light sensor's, infrared imagers, star trackers, sun sensors, Space sextant. The next payload on the VOCS 2 is mainly focused on the exoplanet hunting this will have payloads such as the magnetometers, Altitude and attitude sensors, Light sensors, Infrared imagers, spectrum analyzers, spectroscopes, star trackers, sun

sensors, space sextant, cosmic ray detection sensors, radiation sensors, Light blocking sensors, exoplanet detectors, telescopes, gyroscopes, transit photometry sensors. Images of some of the cameras are:

Some of the sensors are going to be off the shelf products and some of them are going to be made out of scratch and in places like NASA. The instruments such as the MAGNOTOMETERS, ALTITUDE SENSORS, ALTITUDE ACTUATORS, PROPULSION SYSTEMS, POWER SENSORS, TEMPRATURE SENSORS, SPECTROSCOPE, DIGITAL TEMPRATURE SENSORS, HEAT AND THERMAL CAMERAS, GECKO CAMERA, STAR TRACKERS, SUN SENSORS, SPACE SEXTANT, CHAMELEON IMAGERS, GAS SENSORS, COMMUNICATION SYSTEMS are all going to be sourced from outside. Whereas the components like the STAR SHADES, TELESCOPES, OZONE SENSORS, RELATAVITY SENSORS, GYROSCOPES, GRAVITY SENSORS and the STAR TRACKERS FOR RELATIVITY, RAMAN LIDARS are going to be made from scratch at

NASA and with the help of organizations. The integration of lenses in telescopes can be done with the help of optical companies or in house in NASA. The various other systems like the processors and other systems are going to be done with the help of companies like Microchip and blue canyon technologies. All of these components are going to be a joint effort with the help of various different companies.

The spectroscopes are going to be built with the help of NASA and cubesatshop.com as well for the near infrared spectroscope as well as Ball aerospace. Aperture optical sciences and NITE Europe can help in designing the sensors and the lenses for the LIDARS and the telescopes so that they can be more powerful. Some of the other companies that we will be taking the help of for the sensors is going to be Hamamatsu photonics.

The ACS systems and the propulsion systems is going to be done with the help of Enpulsion and blue canyon technologies.

For the VOCS 2 mission the components are going to built specifically for deep space and will be able to handle high levels of radiation. The customized sensors like the relativity sensors and the telescope is going to be built with the help of NASA and aperture optical sciences.

The sensors in both of the satellites are going to be using remote sensing technologies and are all going to be able to work on their own in case of any malfunction. The main optical payloads are all going to be having lenses which will

be made with the help of Aperture optical sciences. These lenses will allow the sensors to look further then 40KM and higher. The maximum distance will be of 150 light years for the VOCS 2 cubesat. This can be done with the help of a f1.4 aperture lenses with a diameter of 5cm and a height of 20CM. The lens will not be able to zoom due to the chance of mechanical failure and additional complexity. The diameter of the lens is going to be 10 CM and can be achieved when the main telescope assembly will be in a conical like assembly. The main lens which will be inside a lens hood will achieve a diameter of 10 CM after it has crossed a height of 20CM. This is done to make sure that the lenses in the optical telescopes do not collide or cause friction when working. There will be a margin and the hoods of the sensors which will be having mirrors. These will aid in the reflection and will allow the sensors to look deeper into space and concentrate better. The reason why it is important for the satellite to look very far is because one of the objectives of VOCS 2 is to search for possible habitable worlds and they can be very far away. Hence the need for high performance yet small telescopes is important. The spectroscopes, thermal cameras, gecko camera, star trackers, chameleon imagers, sun sensors, exoplanet detectors, star trackers for relativity are all going to be needing these lenses to zoom. This is important as we need to look deeper in time to understand the light since parts of light will slowly fade off over the distance light has travelled. Hence our telescope needs to have a powerful yet small lens size so that it is able to look into the past or things which

might have occurred 150 light years ago. The rest of the sensors which are also optical like the LIDAR and altitude and attitude sensors and the other optical sensors of VOCS 2 (not the telescope) will be using a smaller lens to save space and be geometrically proportional. The size of the total lens is going to be 5 CM in diameter and 10 CM in height. This is half the size since the altitude and attitude sensors don't really need to see as far as the rest of the sensors and the LIDAR will and can only be used when close to the expected planet or even when on Venus. The main telescope unit will also be similar but will be able to go in much deeper with a expected ratio similar to the TESS space telescope itself. The aperture of the telescope will be 100NM and the focal ratio of f8. The expected size of the telescope will be 70CM. This will be partly inserted inside the VOCS 2. The telescope will be taking 3-4 U and the rest of the 30 CM can come outside. The shape of the telescope however is slightly different and will be following a v ritchey-chrétien telescope design. The telescope will only be designed for the VOCS 2 since it aims to study astrophysical phenomena's in more detail. Other then the exceptions of the relativity sensors, telescopes and the size of the telescope the rest of the lenses as well as the sensors is going to be the same for the VOCS 1 satellite. The reason why we feel that the lenses and these sensors are appropriate for these 2 satellites is because the main lenses and the main systems have been tested in 2 areas. One is the TESS satellite and because they both follow similar specifications in telescopes and also because they have mostly been tested by various companies and most of the

sensors (other then the ones we hope to work with NASA on) have a rich flight heritage. The main missions that have helped us to make this idea possible is the TESS, ASTREIA, SPITZER, HUBBLE, SPITZER, CHANDRA X RAY TELESCOPE, and even the MARS 2020 ROVER. These ideas have helped us add the sensors and most of the telescopes have helped us in comparing and verifying our theories and our predictions using past and new data. This is why we feel that the specifications and the sensors are able to use budget friendly methods as well as new systems and technologies to aid in the search of possible life or new planets similar to our own and to better understand the dynamics and the nature of the universe. To finalize our theory we reduced the size by half since our satellite was small and was intended to look very far. Since TESS can see 300 light years away we calculated that our telescope due to the size should be able to see half of that and we added some more calculations like the lens magnification and we get the results that our telescope can look into the universe 150 light years. Since the focal ratio is f8 we think we can get some important close-ups and also possibly make up for the lack in the lens size. Even though the VOCS 2 mission is not able to see extremely far the satellite uses instruments that will be able to study relativity, gravity and also study distortions that can find new and interesting astrophysical phenomena's. The entire size of the lens is 70 CM and the aperture of the telescope is 100NM and this will be for the VOCS 2 telescope. This has been tested with the help of aperture optical sciences a company in the USA. Hence we

believe using existing technology improvised in a new manner we will be able to efficiently use the satellite design and hopefully achieve our goal.

COMMUNICATION:

1. **We are going to be communicating with Earth at most of the times. The satellite is going to be having a 4 way communication device. This means the first channel will go to transmitting data using a cloud system which is specifically designed for the 3 spacecraft's which is the cubesats, star shades to communicate. This is going to be using a neural network system as well. This system is going to be utilizing a special kind of neural network which is going to be a perceptron neural network system. This is because it is extremely effective and can be multiplied easily. An example and a prototype code of the technique we plan to use can be found bellow: (This code has not been tested on a satellite and is only intended for demonstration purposes and is not the code for any space related computer)**

2. `activation = sum(weight_i * x_i) + bias`
3. `1`
4. `activation = sum(weight_i * x_i) + bias`
5.
6. `prediction = 1.0 if activation >= 0.0 else 0.0`
7. `1`
8. `prediction = 1.0 if activation >= 0.0 else 0.0`
9. `w = w + learning_rate * (expected - predicted) * x`

```
def predict(row, weights):
activation = weights[0]
for i in range(len(row)-1):
activation += weights[i + 1] * row[i]
return 1.0 if activation >= 0.0 else 0.0

X1 X2 Y
2.7810836 2.550537003 0
1.465489372 2.362125076 0
3.396561688 4.400293529 0
1.38807019 1.850220317 0
3.06407232 3.005305973 0
7.627531214 2.759262235 1
5.332441248 2.088626775 1
6.922596716 1.77106367 1
8.675418651 -0.242068655 1
7.673756466 3.508563011 1
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X1 X2 Y
2.7810836 2.550537003 0
1.465489372 2.362125076 0
3.396561688 4.400293529 0
1.38807019 1.850220317 0
3.06407232 3.005305973 0
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5.332441248 2.088626775 1
6.922596716 1.77106367 1
8.675418651 -0.242068655 1
7.673756466 3.508563011 1

# Make a prediction with weights
def predict(row, weights):
activation = weights[0]
```

```
for i in range(len(row)-1):
activation += weights[i + 1] * row[i]
return 1.0 if activation >= 0.0 else 0.0

# test predictions
dataset = [[2.7810836,2.550537003,0],
[1.465489372,2.362125076,0],
[3.396561688,4.400293529,0],
[1.38807019,1.850220317,0],
[3.06407232,3.005305973,0],
[7.627531214,2.759262235,1],
[5.332441248,2.088626775,1],
[6.922596716,1.77106367,1],
[8.675418651,-0.242068655,1],
[7.673756466,3.508563011,1]]
weights = [-0.1, 0.20653640140000007, -0.23418117710000003]
for row in dataset:
prediction = predict(row, weights)
print("Expected=%d, Predicted=%d" % (row[-1], prediction))
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for row in dataset:
prediction = predict(row, weights)
print("Expected=%d, Predicted=%d" % (row[-1], prediction))
activation = (w1 * X1) + (w2 * X2) + bias
1
activation = (w1 * X1) + (w2 * X2) + bias
activation = (0.206 * X1) + (-0.234 * X2) + -0.1

Expected=0, Predicted=0
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Expected=0, Predicted=0
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Expected=0, Predicted=0
Expected=0, Predicted=0
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Expected=0, Predicted=0
Expected=0, Predicted=0
Expected=1, Predicted=1
Expected=1, Predicted=1
Expected=1, Predicted=1
Expected=1, Predicted=1
Expected=1, Predicted=1
w(t+1)= w(t) + learning_rate * (expected(t) - predicted(t)) * x(t)
bias(t+1) = bias(t) + learning_rate * (expected(t) - predicted(t))

# Estimate Perceptron weights using stochastic gradient descent
def train_weights(train, l_rate, n_epoch):
weights = [0.0 for i in range(len(train[0]))]
for epoch in range(n_epoch):
sum_error = 0.0
for row in train:
prediction = predict(row, weights)
error = row[-1] - prediction
sum_error += error**2
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
print('>epoch=%d, lrate=%.3f, error=%.3f' % (epoch, l_rate, sum_error))
return weights
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# Estimate Perceptron weights using stochastic gradient descent
def train_weights(train, l_rate, n_epoch):
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error = row[-1] - prediction
sum_error += error**2
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
print('>epoch=%d, lrate=%.3f, error=%.3f' % (epoch, l_rate, sum_error))
return weights

# Make a prediction with weights
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```

```
sum_error += error**2
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
print('>epoch=%d, lrate=%.3f, error=%.3f' % (epoch, l_rate, sum_error))
return weights

# Calculate weights
dataset = [[2.7810836,2.550537003,0],
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[6.922596716,1.77106367,1],
[8.675418651,-0.242068655,1],
[7.673756466,3.508563011,1]]
l_rate = 0.1
n_epoch = 5
weights = train_weights(dataset, l_rate, n_epoch)
print(weights)
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for row in train:
prediction = predict(row, weights)
error = row[-1] - prediction
sum_error += error**2
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
print('>epoch=%d, lrate=%.3f, error=%.3f' % (epoch, l_rate, sum_error))
return weights

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# Calculate weights
dataset = [[2.7810836,2.550537003,0],
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[6.922596716,1.77106367,1],
[8.675418651,-0.242068655,1],
[7.673756466,3.508563011,1]]
l_rate = 0.1
n_epoch = 5
weights = train_weights(dataset, l_rate, n_epoch)
print(weights)

>epoch=0, lrate=0.100, error=2.000
>epoch=1, lrate=0.100, error=1.000
>epoch=2, lrate=0.100, error=0.000
>epoch=3, lrate=0.100, error=0.000
>epoch=4, lrate=0.100, error=0.000
[-0.1, 0.20653640140000007, -0.23418117710000003]
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>epoch=0, lrate=0.100, error=2.000
>epoch=1, lrate=0.100, error=1.000
>epoch=2, lrate=0.100, error=0.000
>epoch=3, lrate=0.100, error=0.000
>epoch=4, lrate=0.100, error=0.000
[-0.1, 0.20653640140000007, -0.23418117710000003]
# Perceptron Algorithm on the Sonar Dataset
from random import seed
from random import randrange
from csv import reader

# Load a CSV file
def load_csv(filename):
dataset = list()
with open(filename, 'r') as file:
```

```
csv_reader = reader(file)
for row in csv_reader:
if not row:
continue
dataset.append(row)
return dataset

# Convert string column to float
def str_column_to_float(dataset, column):
for row in dataset:
row[column] = float(row[column].strip())

# Convert string column to integer
def str_column_to_int(dataset, column):
class_values = [row[column] for row in dataset]
unique = set(class_values)
lookup = dict()
for i, value in enumerate(unique):
lookup[value] = i
for row in dataset:
row[column] = lookup[row[column]]
return lookup

# Split a dataset into k folds
def cross_validation_split(dataset, n_folds):
dataset_split = list()
dataset_copy = list(dataset)
fold_size = int(len(dataset) / n_folds)
for i in range(n_folds):
fold = list()
while len(fold) < fold_size:
index = randrange(len(dataset_copy))
fold.append(dataset_copy.pop(index))
dataset_split.append(fold)
return dataset_split

# Calculate accuracy percentage
def accuracy_metric(actual, predicted):
correct = 0
for i in range(len(actual)):
if actual[i] == predicted[i]:
correct += 1
return correct / float(len(actual)) * 100.0
```

```
# Evaluate an algorithm using a cross validation split
def evaluate_algorithm(dataset, algorithm, n_folds, *args):
folds = cross_validation_split(dataset, n_folds)
scores = list()
for fold in folds:
train_set = list(folds)
train_set.remove(fold)
train_set = sum(train_set, [])
test_set = list()
for row in fold:
row_copy = list(row)
test_set.append(row_copy)
row_copy[-1] = None
predicted = algorithm(train_set, test_set, *args)
actual = [row[-1] for row in fold]
accuracy = accuracy_metric(actual, predicted)
scores.append(accuracy)
return scores

# Make a prediction with weights
def predict(row, weights):
activation = weights[0]
for i in range(len(row)-1):
activation += weights[i + 1] * row[i]
return 1.0 if activation >= 0.0 else 0.0

# Estimate Perceptron weights using stochastic gradient descent
def train_weights(train, l_rate, n_epoch):
weights = [0.0 for i in range(len(train[0]))]
for epoch in range(n_epoch):
for row in train:
prediction = predict(row, weights)
error = row[-1] - prediction
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
return weights
```

```
# Perceptron Algorithm With Stochastic Gradient Descent
def perceptron(train, test, l_rate, n_epoch):
predictions = list()
weights = train_weights(train, l_rate, n_epoch)
for row in test:
prediction = predict(row, weights)
predictions.append(prediction)
return(predictions)

# Test the Perceptron algorithm on the sonar dataset
seed(1)
# load and prepare data
filename = 'sonar.all-data.csv'
dataset = load_csv(filename)
for i in range(len(dataset[0])-1):
str_column_to_float(dataset, i)
# convert string class to integers
str_column_to_int(dataset, len(dataset[0])-1)
# evaluate algorithm
n_folds = 3
l_rate = 0.01
n_epoch = 500
scores = evaluate_algorithm(dataset, perceptron, n_folds, l_rate, n_epoch)
print('Scores: %s' % scores)
print('Mean Accuracy: %.3f%%' % (sum(scores)/float(len(scores))))
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# Perceptron Algorithm on the Sonar Dataset
from random import seed
from random import randrange
from csv import reader

# Load a CSV file
def load_csv(filename):
dataset = list()
with open(filename, 'r') as file:
csv_reader = reader(file)
for row in csv_reader:
if not row:
continue
dataset.append(row)
return dataset

# Convert string column to float
def str_column_to_float(dataset, column):
for row in dataset:
row[column] = float(row[column].strip())

# Convert string column to integer
def str_column_to_int(dataset, column):
class_values = [row[column] for row in dataset]
unique = set(class_values)
lookup = dict()
for i, value in enumerate(unique):
lookup[value] = i
```

```
for row in dataset:
row[column] = lookup[row[column]]
return lookup

# Split a dataset into k folds
def cross_validation_split(dataset, n_folds):
dataset_split = list()
dataset_copy = list(dataset)
fold_size = int(len(dataset) / n_folds)
for i in range(n_folds):
fold = list()
while len(fold) < fold_size:
index = randrange(len(dataset_copy))
fold.append(dataset_copy.pop(index))
dataset_split.append(fold)
return dataset_split

# Calculate accuracy percentage
def accuracy_metric(actual, predicted):
correct = 0
for i in range(len(actual)):
if actual[i] == predicted[i]:
correct += 1
return correct / float(len(actual)) * 100.0

# Evaluate an algorithm using a cross validation split
def evaluate_algorithm(dataset, algorithm, n_folds,
*args):
folds = cross_validation_split(dataset, n_folds)
scores = list()
for fold in folds:
train_set = list(folds)
train_set.remove(fold)
train_set = sum(train_set, [])
test_set = list()
for row in fold:
row_copy = list(row)
test_set.append(row_copy)
row_copy[-1] = None
predicted = algorithm(train_set, test_set, *args)
actual = [row[-1] for row in fold]
accuracy = accuracy_metric(actual, predicted)
scores.append(accuracy)
```

```
return scores

# Make a prediction with weights
def predict(row, weights):
activation = weights[0]
for i in range(len(row)-1):
activation += weights[i + 1] * row[i]
return 1.0 if activation >= 0.0 else 0.0

# Estimate Perceptron weights using stochastic gradient descent
def train_weights(train, l_rate, n_epoch):
weights = [0.0 for i in range(len(train[0]))]
for epoch in range(n_epoch):
for row in train:
prediction = predict(row, weights)
error = row[-1] - prediction
weights[0] = weights[0] + l_rate * error
for i in range(len(row)-1):
weights[i + 1] = weights[i + 1] + l_rate * error * row[i]
return weights

# Perceptron Algorithm With Stochastic Gradient Descent
def perceptron(train, test, l_rate, n_epoch):
predictions = list()
weights = train_weights(train, l_rate, n_epoch)
for row in test:
prediction = predict(row, weights)
predictions.append(prediction)
return(predictions)

# Test the Perceptron algorithm on the sonar dataset
seed(1)
# load and prepare data
filename = 'sonar.all-data.csv'
dataset = load_csv(filename)
for i in range(len(dataset[0])-1):
str_column_to_float(dataset, i)
# convert string class to integers
str_column_to_int(dataset, len(dataset[0])-1)
# evaluate algorithm
```

```
n_folds = 3
l_rate = 0.01
n_epoch = 500
scores = evaluate_algorithm(dataset, perceptron, n_folds, l_rate, n_epoch)
print('Scores: %s' % scores)
print('Mean Accuracy: %.3f%%' % (sum(scores)/float(len(scores))))
Scores: [76.81159420289855, 69.56521739130434, 72.46376811594203]
Mean Accuracy: 72.947%
```

The second channel can be used to send continuous telemetry using high and low gain antennas whereas the third channel in the satellite will be used for sending the big data such as pictures back to Earth. The fourth channel is backup for all the channels in the unlikely case the sattelites malfunction. The backup will use a 6-10 MGZ range. The rest will be 20-30 MGZ. Another feature of the satellite is that it can transmit and use other satellites as relay. This means if there are other satellites that are using a similar kind of frequency range the antenna's can relay the data. This system of using satellites as constellations has a lot of advantages. One such advantage is that the size does not matter to a great extent and the data can be transmitted over long distances. The larger the satellite the longer the distance the communication can travel. Since there are much bigger satellites that are flown to interplanetary destinations this can be an advantage as there will be a larger communications relays to Earth. Since there are time delays due to the distance, the commands on Earth will be given based upon previous performances of the satellite like weekly or monthly performance. This is why these spacecraft's are going to be relying 90% on the AI and deep

learning capabilities on the spacecrafts. We are also going to be using high bands and low bands antennas. This means we will be able to change the frequency of the communication like a radio station on Earth. This will mostly be done from ground stations on earth. This is going to be done as frequencies band which are too weak the satellite will be able to transmit the data and send it back to Earth and if the transmition is higher due to solar radiation we will then also be able to pick them up and transmit them. This system is important as useful data could be lost if this feature is not there on the spacecraft's. The main communication motherboards are going to be the TOTEM SDR platform board. This board is very good as it has a lot of capabilities such as SDR + UHF front end platform

- 5 W @ 30 dBm in 437 MHz
- SDR tunnable from 70 MHz to 6 GHz
- UHF front end as a piggyback board
    - Unregulated voltage supply from EPS and 3V3
    - Multiple GPIOs and DACs available
- Embedded Linux
- Multiple interfaces: CAN, UART, Ethernet
- PC/104 standard
- Physical properties
    - Mass: 131 g (shieldings included)
    - Dimensions : 89.3 mm x 93.3 x 13.9 mm
    - Power consumption
    - ~ 5 W @ 30 dBm output power
    - < 2 W in RX mode
    - 1.36 W with front end OFF

This makes this board very useful as this is also compatible with the other motherboards for command and data

handling. This board is also very good as this board is also easily programmable. TOTEM is a high-performance SDR platform designed for nanosatellites which include a UHF front end TOTEM Motherboard is the control unit and the RF transceiver while TOTEM UHF front end is an external UHF front end piggyback board An embedded Linux and a wide frequency range transceiver allows the user to fully cover most used nanosatellite frequency bands and quickly deploy multiple SDR applications. The last and final thing that we are also going to be including on this cubesat is also using a 0-1HZ transmitter and receiver. This will be inserted on the VOCS 2 only. This is because other than the Venus satellite the VOCS 2 cube sat will have to travel extremely far when searching for exoplanets and hence will need this. A link to the main features and other parts can be found http://space-for-space.com/wp-content/uploads/2019/10/TOTEM-Alen-Space.pdf and https://www.cubesatshop.com/product/totem-nanosatellite-sdr-platform/

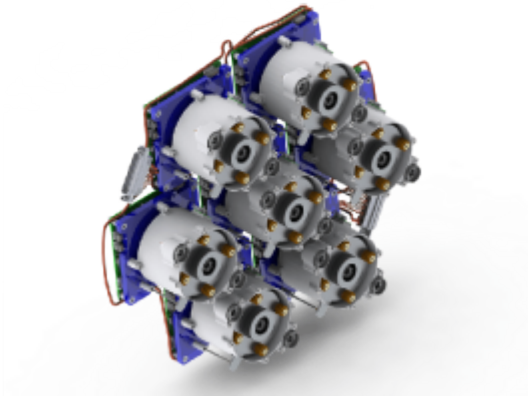
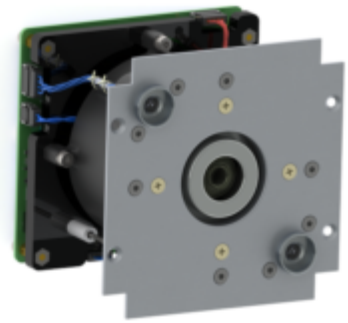
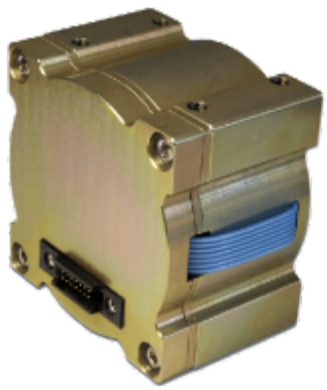
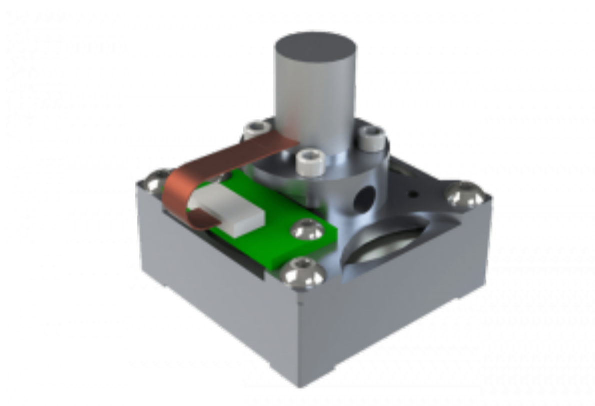
PROPULSION:

For propulsion we are going to be using electric propulsion as the main source of propulsion. This is perfect for deep space as we can accumulate the solar energy and convert it energy and then into propulsion. Due to the distance of

Venus and due to the location of VOCS 2 this makes it perfect and an ideal propulsion technique. This system can be used for small maneuvers like adjusting orbits or trajectory. These can also be good as it is cost affective. We are reducing the size of the nozzle to increase the pressure and thereby increasing the thrust by at least 10%. The main propellant is going to be iodine thruster combined with electric. This is because this system is a low mass and a energy efficient solution which can give a lot of power. The altitude and attitude actuators will be used to help change the altitude or attitude or maintain it. The other sensors like the star tracker, altitude and attitude actuators and the reaction wheel will also help us in monitoring and achieving the stabilization and if needed the change of altitude. We are using a medium sized cube wheels and a reaction wheel to steer us to Venus for VOCS 1 and towards exoplanets and beyond for VOCS 2. The main ACS which is the altitude control systems are going to be interlinked to the main command and data handling as they will be using timers and AI using other altitude sensors combining all of these we will be able to search for anomalies and react to steer the spacecraft appropriately (most likely the spacecraft will do it on its own in most cases). With the help of these sensors and systems we will be able to adjust the amount of fuel used and we will be able to adjust the delta V burns or the orbit maneuvers or the trajectory correction maneuvers. The total amount of fuel that is going to be on the spacecraft is going to be going to be worth 5U of space. If the spacecraft has enough fuel it can get into selected planets orbits to further

examine them but if fuel is less we will be able to continue the flybys and gather data while doing so. Even though the cubesat will be doing a flyby there will be enough time for the spacecraft to take photos and key data of the planets. We are going to be using orbital mechanics to bounce off the planets atmosphere or use gravity assists by comparing the gravity using the sensors to go further using less propellant. Since most planets have some atmosphere and possess gravity we will be able to calculate the gravity and the friction and make important judgments to allow the spacecraft to continue or not although if the spacecraft is very far away it will need to use the On board computers to take the decision and then downlink it to the space centers to verify.

Images to the propulsion components is given here:

Command and Data handling:

We are going to be using some already built boards such as the ISIS flight computer and the command and data handling board. Some of the systems are going to be customized but the general architecture is going to be similar to the ISIS boards. The boards are going to be using I2C busses and systems. There are going to be GPIO pins with a total of 48 pins. There are going to be 16 extra pins as well. The general architecture of the MCU board is going to be made out of the microchip and Texas instruments

products and Intel products. All of the components is going to be radiation and temperature hardened to work in deep space. The custom PCB is going to be having various components like resistors, capacitors and lots of other radiation hardened materials. Every single component is going to be an SMD. This is a surface mounted systems and this will reduce the size of the PCBS greatly. The PCB is going to be programmed with the help of Linux and is going to be combining the Raspberry pi 4 architecture as well to program it and make it easier to work. This board is going to be developed with the help of various companies and the main MCU and the processor is going to be developed with the help of Microchip and Texas instruments. This entire board is going to be having a Arm 9 processor. The operating power is going to be about 5V. The board is going to be vary efficient and will not be needing a daughter board. This entire system is going to be having a operating power of 400 MGZ. There are going to be a lot of logic convertors, timers, resistors, capacitors and other components. The design is going to be printed and developed on software's like Eagle CAD. This entire board is going to be custom made. Due to the similarity of the ISIS boards the main GERBER file will be generated and changes such as the material, number of components used such as the ATMEL chip will stay the same. The main processor is also going to be staying the same. The entire board once printed will have the materials and the copper mounting, number of components and the IC programmers changed. The board can be programmed with the help of a micro-USB port. The

port will be soldered into the board and can be easily programmed. As mentioned above the main software operating system will be Linux and the language used to code the board is going to be python. Due to the fact it works very well with Linux it is the best candidate. In addition to this complex AI commands can be easily prepared with the help of Python. The architecture is going to be user friendly and will be completely easy to use. A reference website to the board designs is :
https://www.isispace.nl/wp-content/uploads/2016/02/isis_iobc_revc_asm_stp.zip

https://www.isispace.nl/wp-content/uploads/2016/02/isis_iobc_revc_asm_igs.zip

The main core of the entire spacecraft is going to be EXA spacecraft core boards. The reason why we are using this board instead of the ISIS board is because this board is more powerful than the ISIS board. ICEPS is the spacecraft system core designed to be the central operational piece of CubeSats enabled to use higher performance hardware and features. ICEPS compresses the functions of many cards into a single one 25mm thick, using modularity as a central approach to a fully customizable hardware that can range from being simply an EPS or including all the features. Among many others, the central features are: Embedded Laser Communications, Integrated Epik Z2 OBC with 2 SDR radios, USB and I2C bus, SSD storage up to 512GB, Automatic control of deployables, 100W capable EPS, 6-axis IMU, etc. (full list in Datasheet). ICEPS can interface and

work with any compatible USB hardware, but it is designed to optimally operate in conjunction with EXA developed hardware like BA0X Battery Arrays, DSAs (Deployable Solar Panel), and SEAM/NEMEA shielding. ICEPS is also the central piece and system core of the EXA's KRATOS Spacecraft Bus including all of these components. Although initially designed to handle requirements for a 1U CubeSat, ICEPS is ready and able to handle all these requirements for larger CubeSat missions. As of writing, ICEPS has no flight heritage and is set to launch on IRVINE03 onboard NASA ELaNa launch on Q4/2020. It is also the system core of an upcoming lunar mission onboard the Astrobotic Peregrine Lander set to land on the moon on Q3/2021. This makes the board perfect for our mission requirement. The core system is also compatible with the ISIS board. This make the entire boards and computers even more efficient. The ISIS board will command the sensors. The core board will be understanding the information and replying back to Earth for the further commands to be sent. Both the boards will be receiving commands in C++.

https://www.cubesatshop.com/wp-content/uploads/2020/05/EXA-ICEPS-Brochure-v1.2.pdf

https://www.cubesatshop.com/wp-content/uploads/2020/05/ICEPS-Compact-all-purpose-USB-2.0-based-small-satellite-Sytem-Core.pdf

https://www.cubesatshop.com/wp-content/uploads/2020/05/ICEPS-Drawing.pdf

https://www.cubesatshop.com/wp-content/uploads/2020/05/ICEPS-System-Core-Description.pdf

https://www.cubesatshop.com/wp-content/uploads/2020/05/ICEPS.zip

https://www.cubesatshop.com/wp-content/uploads/2020/05/ICEPS-Compact-all-purpose-USB-2.0-based-small-satellite-Sytem-Core.pptx

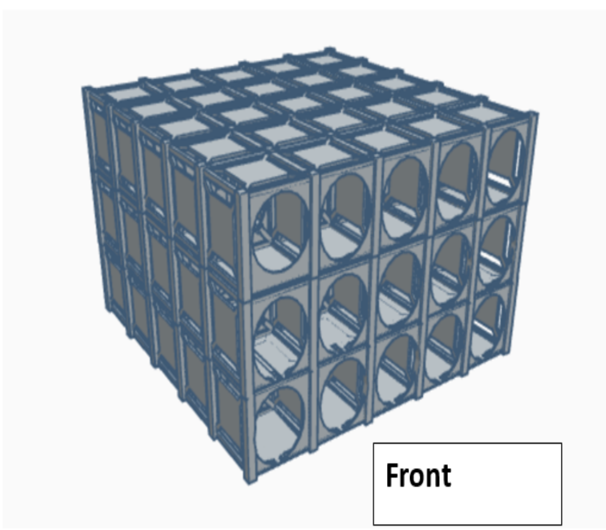

ISIS

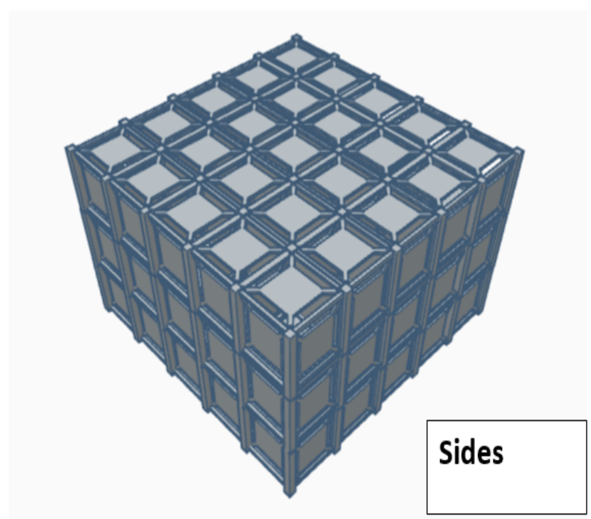
CUBESAT STRUCTURES

The entire spacecraft structure is going to be out metals and alloys such as titanium and aluminum. We are going to be using these kind of materials due to their durability and strength. We will be using materials with near 0 thermal expansion. The entire cubesat structure is going to be following the laws of thermodynamics and thermal expansion. We are going to be using materials such as aerospace gold, hafnium carbide and titanium and aluminum. These materials are powerful and can survive deep space. The entire spacecraft structure and the buses is going to be having a internal voltage of 50V. The 2 satellites are going to be 20 U which is 200 by 200 by 300 CM each. This is chosen as we are making 3 layers which means each layer is going to be 200 by 200 CM each. The first zone is going to be used for the ACS which is the altitude and attitude control systems. We are allotting 10U for the prolusion and 5U for the propellant. The rest which is 5U is going to be for the sensors and the control systems in the first layer. The cubesat structure is designed to be for optical sensors as well. This means there are going to be spaces for the optical sensors which would need some space for the extra lenses. We are allotting 3-4U for the telescopes. We are

keeping enough space for each sensor in the second layer. The second layer will be hosting most of the sensors on the cubesat other then the propulsion and altitude and attitude sensors. The last layer is allotted to the communication and the deployable Starshade system. This is going to be using a small door system for the Star shade to deploy. The star shade only takes 2U and hence we are able to give the rest of the space to the command and control systems as well. The entire model saves a lot of space. The entire cubesat structure is going to be like a square as that can survive in the deep space radiation. The entire spacecraft is going to be having Multi-layer insulation systems as well to protect it from deep space environments.

A 3D model of the spacecraft is:





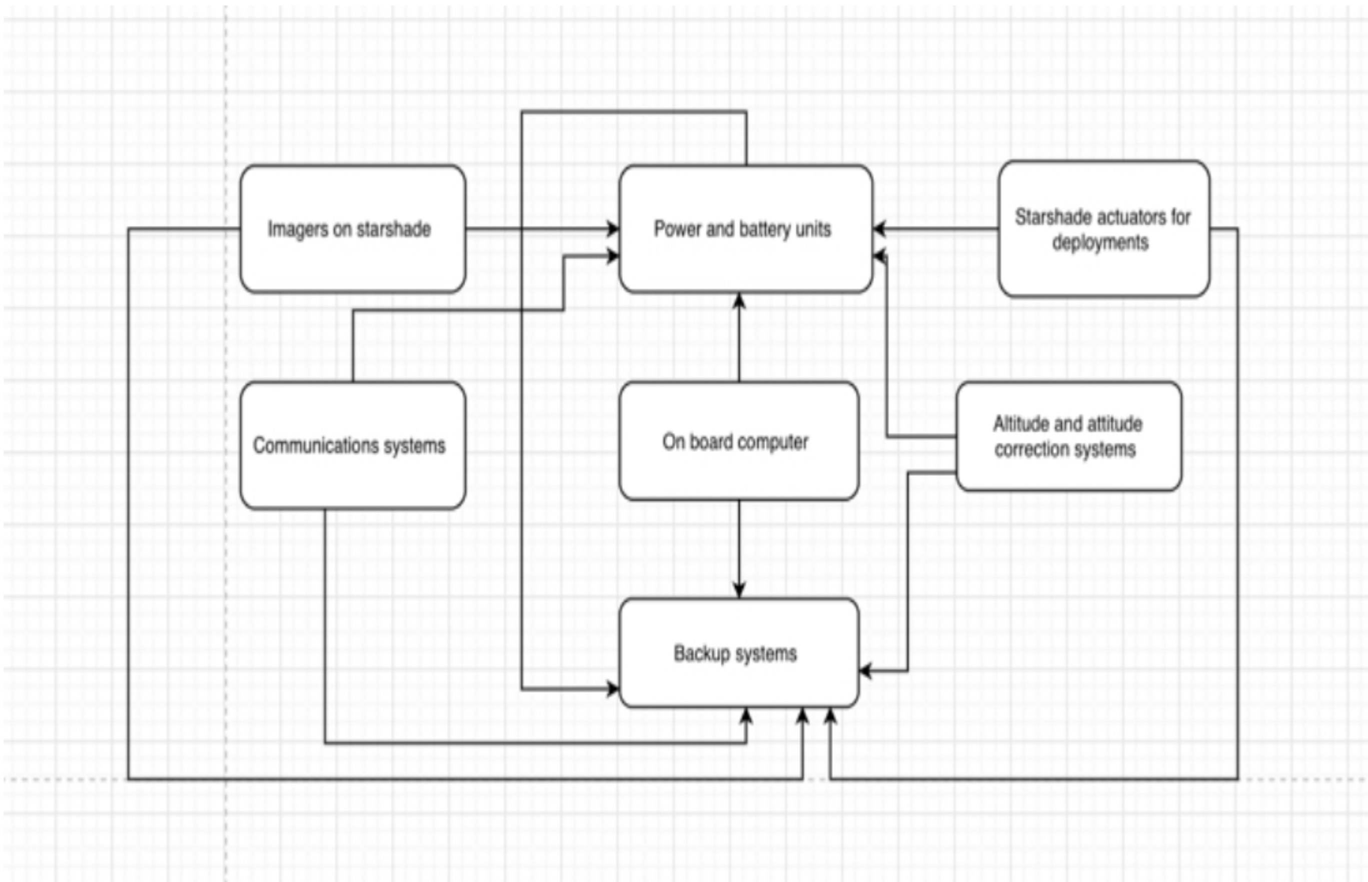
STAR SHADES

The reason why we are going to be using star shades is because we are going to be following the most common method of detecting exoplanets. The name of that method is the transit method. The reason why we are using this method is because it is an already established method with a high TRL rating by NASA and other agencies and also because this techniques has been used by many satellites and also because the instruments we have on this space craft will be able to use different sensors that are resistant to light and calculate the drop in the brightness in a star which in this case are the stars and the sun of the planets. A common feature of exoplanets is that they orbit a star. We will be able to check the drop of the brightness and then we will be able to calculate the size of the planet on mile scale or more. In addition to this we will also have other sensors to further sense the planets and check if it is not a already existing planet that we know as the objective of the mission is to search for exoplanets that we do not know of yet. The star shade is the best for doing this as we will be able to use the star shade to search for exoplanets as whenever a planet is orbiting a star there will be a dip in brightness and the light can get focused on the near by planets orbiting it making it easier to use the Cubesat telescope combined and get insights into it. Inside the cube sat the star shade is going to be 3 times smaller and can be deployed. The cubesat will have a micro deployer similar to a PE-POD of a cubesat. The star shade will have a 1U systems like propulsion, altitude and

attitude control. The star shade will also be having a small camera which will be multispectral. All of these will help us in knowing possible details on the newly discovered planets. With the starlight suppressed, light coming from exoplanets orbiting the star would be visible. The shape of the petals, when seen from far away, creates a softer edge that causes less bending of light waves and allowing a clearer picture of the planet or object we are seeing. The Star shades will unfold and when this happens the space craft will reorient itself facing the right direction with the help of the altitude/attitude and the small actuators. The star shade is going to be in the shape of the flower since this will allow the light to be bent evenly and also because we will be able to better compress the light so that the telescope of VOCS 2 can see it. The star shade will be spring deploying its petals since there cannot be too many mechanical components in deep space due to the temperatures. The star shade will be deploying its petals very slowly. This is to make sure that there is stability. There will be a chain reaction using hinges after one is deployed all of them will unfold like a petal opening up 360 degrees in a circular motion. The star shade is going to be fully deployed 24 hours after its deployment in space. This means in a 24 hour time line nearly every system will start giving feedback and the entire systems will be able to communicate with VOCS 2 and further to Earth. The Star shade main components and shape inside VOCS 2 will be in a square to prevent the sensors from getting damaged and will unfold later on into the mission. The Star shade is very useful as this can get

closer and it can also give us more data. The Star shade will be deployable and after a certain time will stop working. The Star shade will only deploy when there is a confirmation for a possible Earth like planet or an special kind of planet that is extremely unique. The spacecraft will still conduct research and will find other kinds of exoplanets. Although this is true if the Cubesat has enough speed and momentum the star shade can continue moving towards outer space but the star shade is too far or is non effective due to the time it has been deployed it might not be able to work with VOCS 2 again (this might be expected to happen but only after an extremely long period of deployment. The star shade can however still continue to use it camera and give little data but after the shade is out of range even that cannot be done due to the operational capability). The star shades will have propulsion for 3 hour in total. Since the Starshade blocks the light from the stars we only see the light on the planets and the star is blocked making the planet that is orbiting it brighter and allowing the telescope on the star shade and the satellite to see deeper and use the main optical instruments to examine the planet. Another thing the star hade will aid us in doing is to search for planets with gas disks this is going to be working when the light from the stars nearby is going to be causing a effect to expose the light on the nearby area instead of the light being exposed from the front. This is because the light is being compressed but needs to get out somehow. Hence the light comes on the sides and the shape of the petals will allow the complete exposure of light on its surroundings. The imagers on the cubesats and the

Starshade will study the gasses and the interplanetary dust particles. The starshade is going to be unfolding when the motorized hinges start expanding in opposite directions. The starshade mirrors are going to be made out of aluminum and magnesium fluoride. The mirrors will slowly unfold allowing the light to be focused or reflected. This system is inspired from the solar sail. The star shade when on VOCS 2 will be slightly protruding since only part of the star shade can fit into the VOCS 2. There will be a internal motor inside the star shade to deploy it mechanically and there will be a additional structure for the telescope and sensors. In the satellite the size of the star shade will be 2U but once fully deployed it will be 6U in total. A concept and a system diagram of the star shade is here:



The main concept of operation of the starshade is:

1) – the star shade will get deployed from VOCS 2

2) – the star shade will wait for 1 hour hour and get away from the spacecraft

3) – the star shade will begin deploying the petals using the motors and actuators which will spin in opposite directions opening the shade like a flower petal

4) – once fully deployed the star shade will use the small altitude and attitude thrusters to go the target and align with the VOCS 2 so that VOCS 2 can take the measurements

5) – VOCS 2 will begin making important measurements

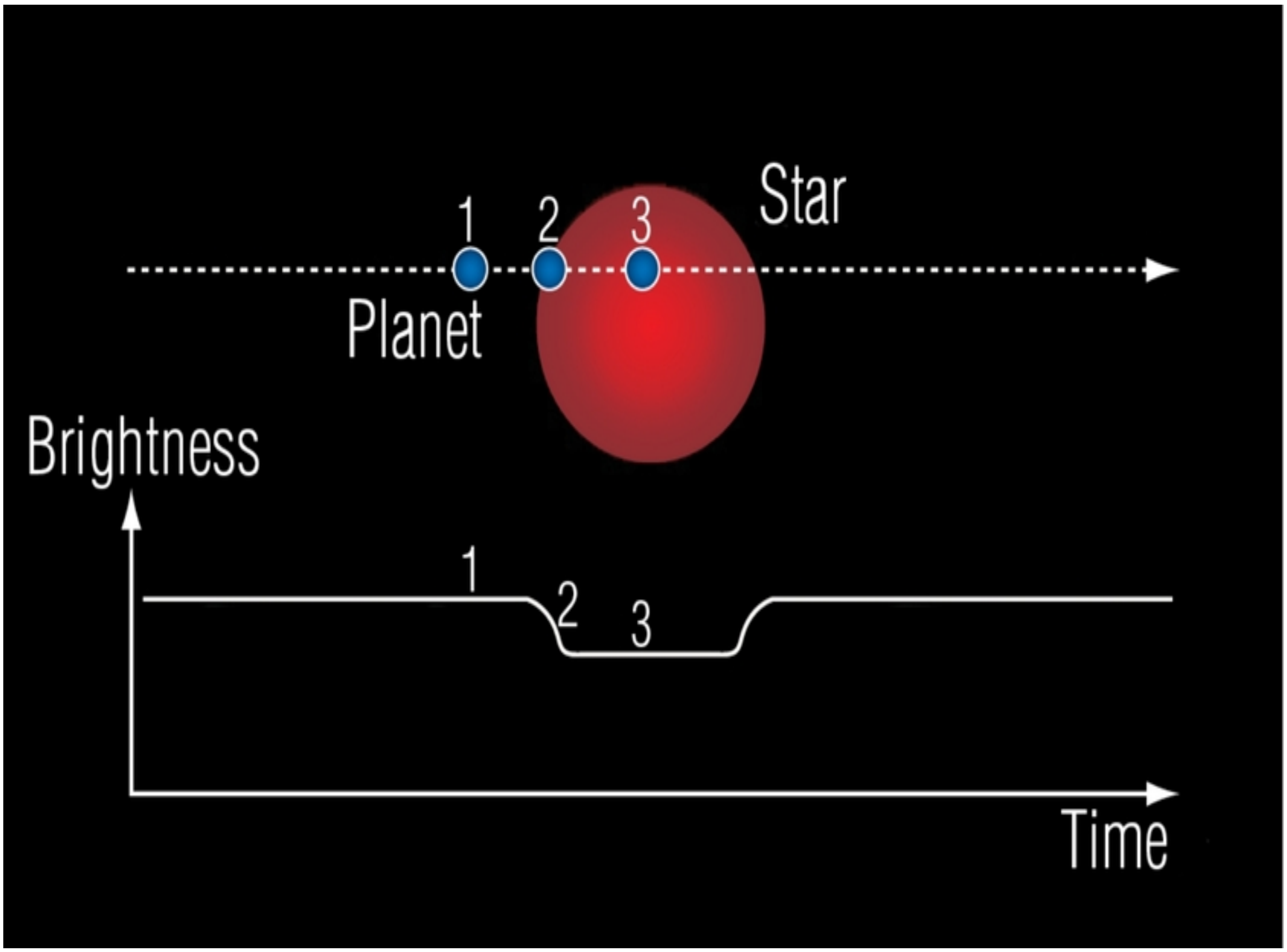
6) – After the star shade has been used it will pass by nearby planets and explore them with its imager and downlink it back to the CubeSat

7) – after the star shade is fully used it would have officially ended the lifetime of its objective and is floating towards interstellar space

TECHNIQUES USED IN DETECTING AND SEARCHING FOR EXOPLANETS:

When we are detecting exoplanets we are going to be using the transit technique this is proven technique as mentioned above. The transit technique will work as Planets may give themselves away when they pass in front of a star and dim some of its light. The passage of a planet between a star and Earth is called a transit If such a dimming is detected at regular intervals and lasts a fixed, repeated length of time, then it is very likely that another, dimmer object is orbiting the star. Some of these transiting objects might be small, dim stars (in which case the pair is called an eclipsing binary), but most of them are planets. Another reason why we are using this is because this has also been used on the keplar missions as well and the ASTRIA missions. Hence the cubesat using its telescopes will be able to see planets a long

distance away and study them in detail. Since this mission is a flyby the telescope will be able to look at the planet for a long time until it crosses it. In some scenarios using fuel efficient solutions cubesats can change its direction or stop for a short while. A image to conceptualize the concept is given here:



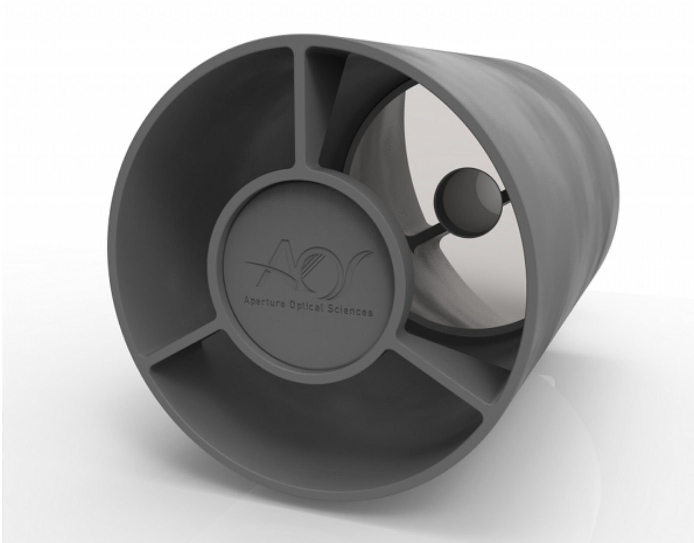
TELESCOPE SENSORS:

The main telescope is going to be one of the most important part of the VOCS 2 spacecraft. This sensor is only going to

be 7U although the sensor and the telescope is only going to be 3-4 U inside the satellite and the rest is going to be sticking out for size efficiency and geometric size and proportion. This specific type of telescope is going to be a refractive telescope. This is because the lenses and the mirrors can really help us in getting into detail when taking pictures or capturing phenomena's. The other imagers like the hyper spectral imagers is also going to be designed in the same way. The main imager is going to be an off the shelf already developed imager like a gecko imager or a chameleon imager. We can then add lenses to it to go in detail when searching for planets. The objective of the hyper spectral imager is to make the telescope change spectrums when required to get a complete picture of things and planets. This can really help in studying the universe or searching for exoplanets and other astrophysical phenomena's. The telescope is going to be using the ritchey-chrétien telescope view. This is going to be developed with the help of SiC aperture optical sciences and their products as well as products from cubesatshop.com. The aperture of the telescope is going to be 100 MM. The size of the telescope aperture is because we are trying to search for exoplanets and searching for phenomena's that are very far off and the size can really help us to focus light and get into the details of the thing or the phenomena we are observing. In addition to this the telescope architecture is perfect because it mixes the lenses and mirrors rather than using just one kind of technique. The mirrors will help in expanding the light waves and magnifying them. The lenses is going to be

helping in expanding and further absorbing the light waves. The entire diameter of the telescope with lenses is going to be 10CM. With the help of the sensor interpreters and main motherboards and command units we will be able to convert the light waves and use it to finally convert it to electronic waves which will be read with the help of the light absorbers and converters. The field of view for the telescope is going to be 0.5 to 1.2 degrees. Even though this is small this will be able to help us in searching and focusing at one point. We can further use motors and sensors to change the direction of the telescope although this might not be necessary. The focal ratio of the telescope is going to be f/8. The telescope will be able to bear the temperatures of space due to extra materials to shield it. Some of these materials are hafnium carbide, aerosols and other materials as well. The telescope is going to be designed with the help of a company called aperture optical sciences which is our primary affiliation in this system. The majority of the telescope is going to be reflective. The CC series of space telescope by aperture optical sciences.inc is going to better due to the fact that it is smaller and more effective. This is why we are using this system in our mission. The telescope of VOCS 2 is going to be a fixed one. This means it cannot zoom in and out. This feature is not there due to the conditions in deep space and due the added complexity to the mission. The telescope of this mission is going to be having a resolution of 16 megapixels. The telescope is going to be able to view objects that might be 150 light year away. This is the farthest area the spacecraft can view because of the size of the spacecraft

and the telescope which is going to be close to 7U but 3-4U inside the body of the spacecraft. The reason why the telescope is going to be only 3-4U inside the spacecraft is because the rest of it is going to be lens and extra space which the spacecraft might not be able to fit in. In addition to this the telescope systems and the PCB is going to be using various kinds of traditional ICs. The telescope will allow us to also see distortions since we also aim to study relativity and find possible black holes. Black holes due to their gravity absorb everything and hence there are distortions because of the gravitational fields which can be noticed by VOCS 2 over a period of time.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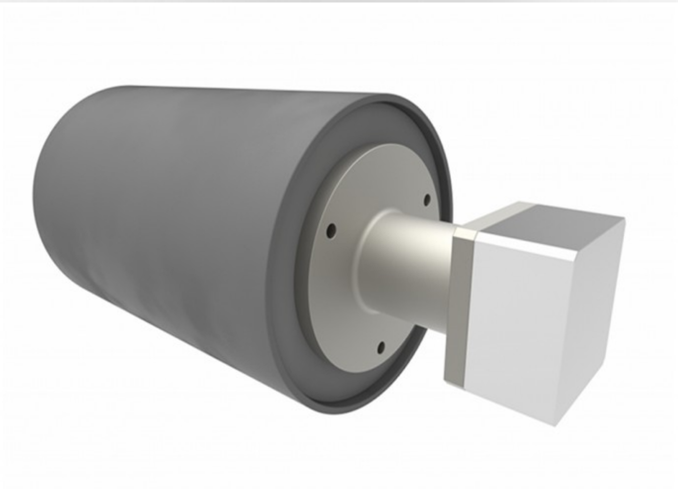

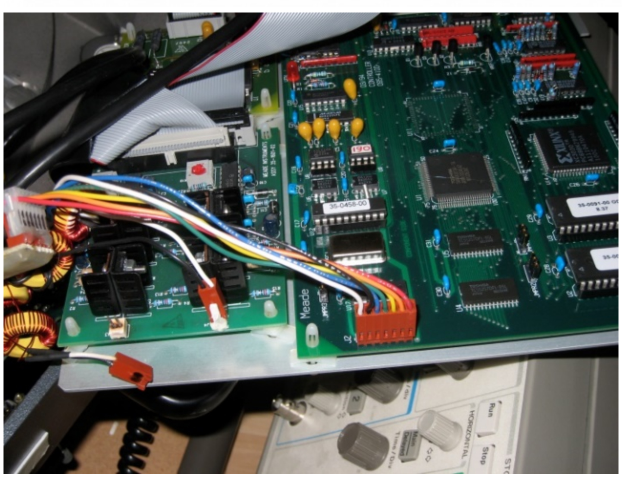
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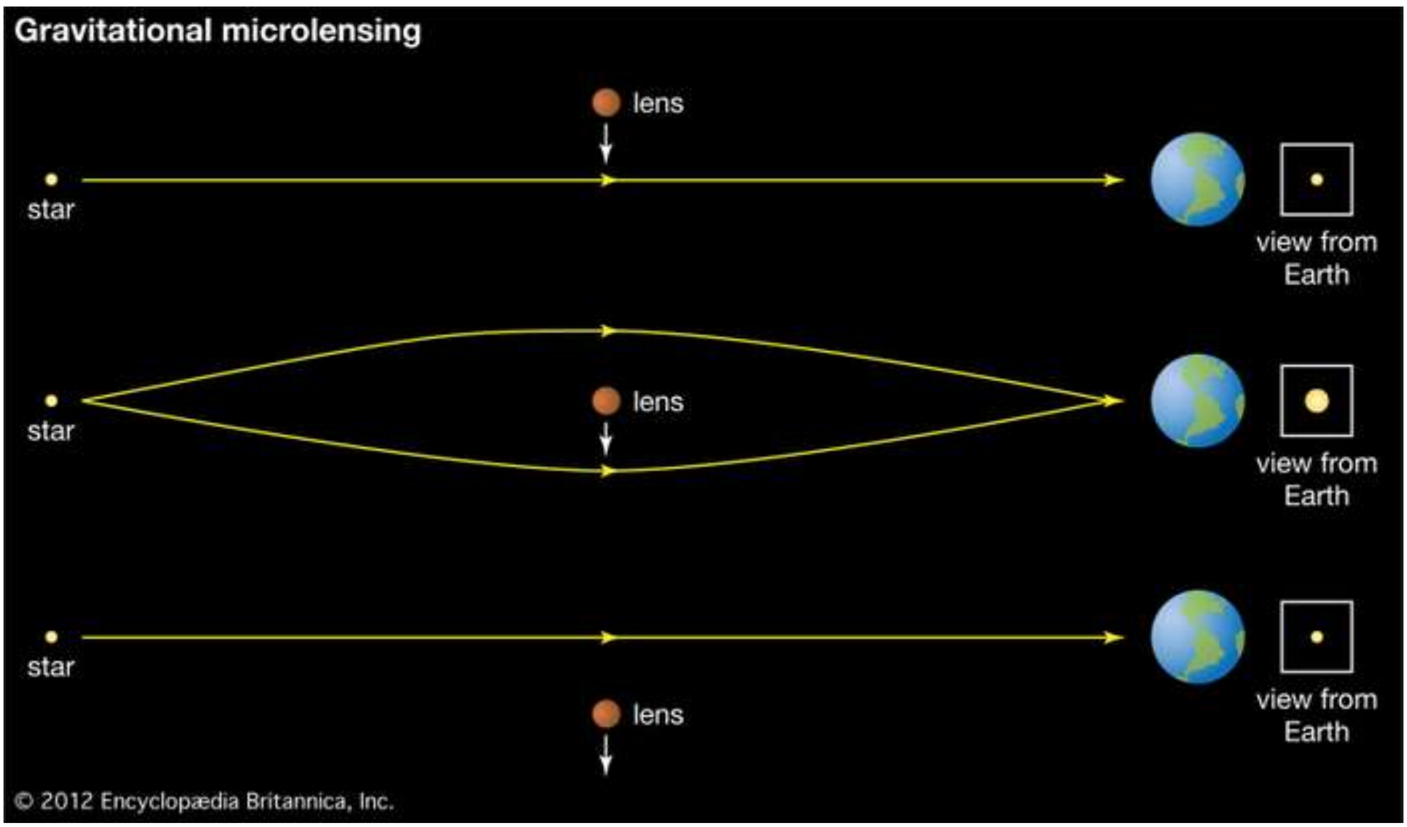
RELATIVITY SENSORS:

One of the most important parts of VOCS 2 is the relativity sensors. This sensors is going to be a combination of gravity sensors, star tracker and a telescope. What we aim to predict in this technology demonstration is how new techniques to measure the planets gravity to the speed of the satellite. This is going to be working when a planet is observed. We will be using the telescope and the exoplanet detector to use the time in space for the planet to take one orbit. We will the use the star tracker to use and position the location the planet is from the star. We will then use the gravity sensor and a magnetometer to study a magnetic field and then compare the effect of gravity and the magnetic field in the gravity sensor. There are going to be 4 gravity sensor to measure the magnetic field and the inclination at any one point while keeping a reference point. By the drag of the gravity we can observe the effect of relativity. This kind of systems can only be used when in the planets gravity. When the planet and the star come closer we can further compare the results to understand at what angle does each gyroscope turn. After using the inertial mass after direction we will be able to plot the effect of gravity and the magnetic field on the spacecraft. Further this will give us a conclusion that space-time can be bent. The similar thing is going to be on the VOCS 1 spacecraft. As the spacecraft is orbiting Venus we will be able to reference the direction of each gravity sensor on a 3 axis scale to give better insights into the observation. Over a

period of time and reference on Earth we will be able to plot it on a graph and get better insights into the observations. This can be a game changer as we can insights into already discovered planets and new planets as well. This technology can help us understand gravity of a planet very precisely. The second part of the mission in VOCS 2 is going to be measuring the time delay In signal acquisition. On VOCS 2 using the planet discovered there will be 4-10 transmissions. The time it takes for each to come back might change. When we use the formula we will get to know how and why light waves can be affected by gravity and electromagnetic radiation. This can also be very useful in future missions as we can study planet in detail. Since on VOCS 1 there is going to be a consistent orbit we are going to be comparing various positions of the planet and track the signal accusation. We can know this is effective as we know that if a planet has strong gravity it can affect the waves we can also cross reference as we know no 2 points have the same signal acquisition time. With this we will be able to plot and know the time it takes and the status of relativity of planets. The first experiment is going to be taking 1 U for each gravity sensor and will be placed in separate corners. Since this would not require optical payloads it is going to be inside the body of the spacecraft. These gyroscopes are going to be very precise and can take perfect measurements with the help of slight pressure the attract and repel of the spacecraft will be calculated by the precise gravity sensor. The gyroscope is also going to be playing a part and that is taking slight observations on the spacecraft's position and

then graphing it. This can be calculated with internal sensors. This would prove that this technique is effective. The second relativity experiment would also only take 1 U for the time to produce and signal and to absorb it. The gyroscopes are going to be built in NASA and the entire sensor and the experiments is also going to be built in NASA. The main gravity sensors are going to be extremely precise which is why we are going to be using special kind of sensors which are going to be placed downwards like a gyroscope. Once the ball crosses a certain dip in original position we will get to know the slight bit of gravity and further plot it better. Since there will not be too much difference if the gravity is strong then we will be able to speed up a little. This technique will apply when we are doing fly pasts. Once we are over a planet we will first search for a earth like planet. If so we can further circle it for sometime and calculate it. After sometime we can escape the gravity and carry out the same experiment. The same system will apply to the VOCS 1 spacecraft. Another technique used to study the relativity is going to be micro lensing. From a distance using a telescope and a star tracker we will be able to study the light waves by the direction of the planet. After comparing both of them we can know the gravity and thereby letting us know about the gravitational waves. After looking at the planet and the direction of the light waves we can compare the waves at the start of the planet and the end. The advantage of this technique is we can adjust the angle of the spacecraft by using small burns and then get back to its original course by using small amounts of fuel. Another

added advantage to the design of VOCS 2 is that it has a fixed telescope. This is a advantage because the telescope is fixed we will be able to observe the gravitational lensing technique better. An example of a gravitational technique is bellow. This is going to be different though depending on the planet. The time it takes to get a signal to plot relativity can be got when also orbiting a planet. Although the gravitational micro lensing system can be done anytime and is slightly more efficient.



IDARS.

The main LIDAR system which is going to be on the VOCS 1 spacecraft is going to be 3U specifically. This type of

LIDAR system is a atmospheric LIDAR system and this LIDAR is going to be done with the help of Ball aerospace. This LIDAR system has been designed for deep space and the PCB will be able to bear the radiation. This system is going to be using the remote sensing technique. This LIDAR is going to be using new types of LIDAR technologies such as RAMAN LIDARS. We are giving 1 U for the lasers absorbing system and another 1 U for the motor and the laser generator. Similar to a gas sensor when a laser beam is given out the rotation in the absorber is going to be picking it up and it will be understood with the help of a gas sensor and a multi gas sensor. The gas sensor is going to built with the help of NASA and other organizations. Due to the complexity and the size of long range traditional LIDAR systems for satellites we are going to be using a space grade LIDAR system and we are going to be using the help of our partners like Aperture optical sciences.inc we are going to be using their small telescopes so that we can increase the length from 500 M to 1000 KM above the atmosphere of Venus or exoplanets. We are adopting already developed RAMAN LIDARS and customizing it in NASA and further use it with the help of a telescope lens which can be small. The total space the LIDAR is going to be taking is going to be 3U. The LIDAR systems are going to be capable of rotating at a max speed of 100 RPM. We are using a rotational LIDAR because we want to get a 360 degree view. A solid state LIDAR would restrict us from doing so. The LIDAR is going to be able to study the atmosphere of Venus and it is going to be specializing in studying the aerosols.

This is a very important and a very valuable thing to study because it can give us information about the atmosphere of Venus in more detail. In addition to this the radio frequency and the pulses generated will be very fine so that we can do this feature. The RAMAN LIDAR is going to be working when the pulses and the electronic beams are going to be sent and the response that can be got from the atmosphere can be distinctive for each gas. Hence when can measure the difference in light and work it in a spectrum scale. This technique is quite similar to the spectrometers but this can be more efficient.

BIBBLOGRAPHY:

https://www.planetary.org/explore/space-topics/exoplanets/transit-photometry.html

https://www.google.com/search?q=parts+of+a+weather+satellite&rlz=1C1SQJL_enAE833AE833&oq=Parts+of+a+&aqs=chrome.1.69i57j69i59l3j0l3j69i65.2914j1j4&sourceid=chrome&ie=UTF-8

https://nanoavionics.com/cubesat-components/cubesat-propulsion-system-epss/

https://www.cubesatshop.com/products/

https://www.google.com/search?q=gecko+imager&safe=strict&rlz=1C1SQJL_enAE833AE833&sxsrf=ALeKk01GzJ67j679fK1g4eT38_AW0uGqxw:1591096880800&tbm=isch&source=iu&ictx=1&fir=rUtI5D-YP9Tk4M%253A%252CYf84ZTYj17y5BM%252C_&vet=1&usg=AI4_-kREDI8ieteD7fZS1RgV9OxIZ_2cHg&sa=X&ved=2ahUKEwiz8YfjgePpAhURXxoKHVj4D-QQ9QEwAXoECAoQGA#imgrc=rUtI5D-YP9Tk4M:

\http://einstein.stanford.edu/content/sci_papers/papers/PhysRevLett.106.221101.pdf

https://www.space.com/17661-theory-general-relativity.html

https://www.nasa.gov/press-release/goddard/2019/oxygen-planets

http://einstein.stanford.edu/highlights/status1.html#PRLpaper

http://einstein.stanford.edu/content/press-media/results_news_2011/C_Will-Physics.4.43-Viewpoint.pdf

https://arxiv.org/abs/1705.10475

https://www.nasa.gov/tess-transiting-exoplanet-survey-satellite/

https://heasarc.gsfc.nasa.gov/docs/tess/the-tess-space-telescope.html

https://www.nasa.gov/kepler/fuel-status-faq/

https://exoplanets.nasa.gov/alien-worlds/ways-to-find-a-planet/

http://www.apertureos.com/products/cube-sat/

https://www.nasa.gov/smallsat-institute/nasa-smallsat-opportunities

https://www.google.com/search?q=how+does+a+atmospherc ic+LIDAR+work&oq=how+doe&aqs=chrome.1.69i57j69i59l 2j35i39j0l4.9611j0j7&sourceid=chrome&ie=UTF-8

https://ohsonline.com/Articles/2015/10/01/Choosing-the-Best-Confined-Space-Gas-Detector.aspx