
DAY OR NIGHT
LiDAR
vs RADAR

About Ainstein

Our mission is to enable safer driving, flying, working and living through RADAR-based technology. We are in the business of improving safety and protecting valuable assets through innovations in RADAR technology.

Ainstein makes RADAR systems smarter, more affordable and easier to deploy. We offer complete solutions for autonomous drones, advanced driver-assistance systems (ADAS), autonomous vehicles and industrial sensing – incorporating a combination of millimeter wave (mmWave) RADAR, sensor fusion and artificial intelligence (AI).

For years, cost, weight and performance constraints have hindered the wider adoption of RADAR. Ainstein makes RADAR systems accessible to everyone by overcoming these constraints.

Radar systems and sensor data processing intelligence are keys to our autonomous future. We offer deep scientific, mathematical and engineering expertise along with a full spectrum portfolio (24GHz, 60GHz, 76-81GHz) of hardware and software to support our customers in developing highly customized solutions with unmatched precision in unpredictable environments.

Our core team has years of experience in RADAR research and development with deep knowledge gained through projects funded by NASA, the U.S. National Science Foundation (NSF), the European Space Agency and others.

Other RADAR companies are at least two to three years behind Ainstein. Startups have been slow to market and are unable to produce at scale, while established companies are slow to adopt the newest technological innovations.

Ainstein products can be fully customized to specific application requirements, have unmatched precision in ALL weather conditions and surface types, and are a fraction of the price of competitive products.

Visit our website (www.ainstein.ai) for more information.

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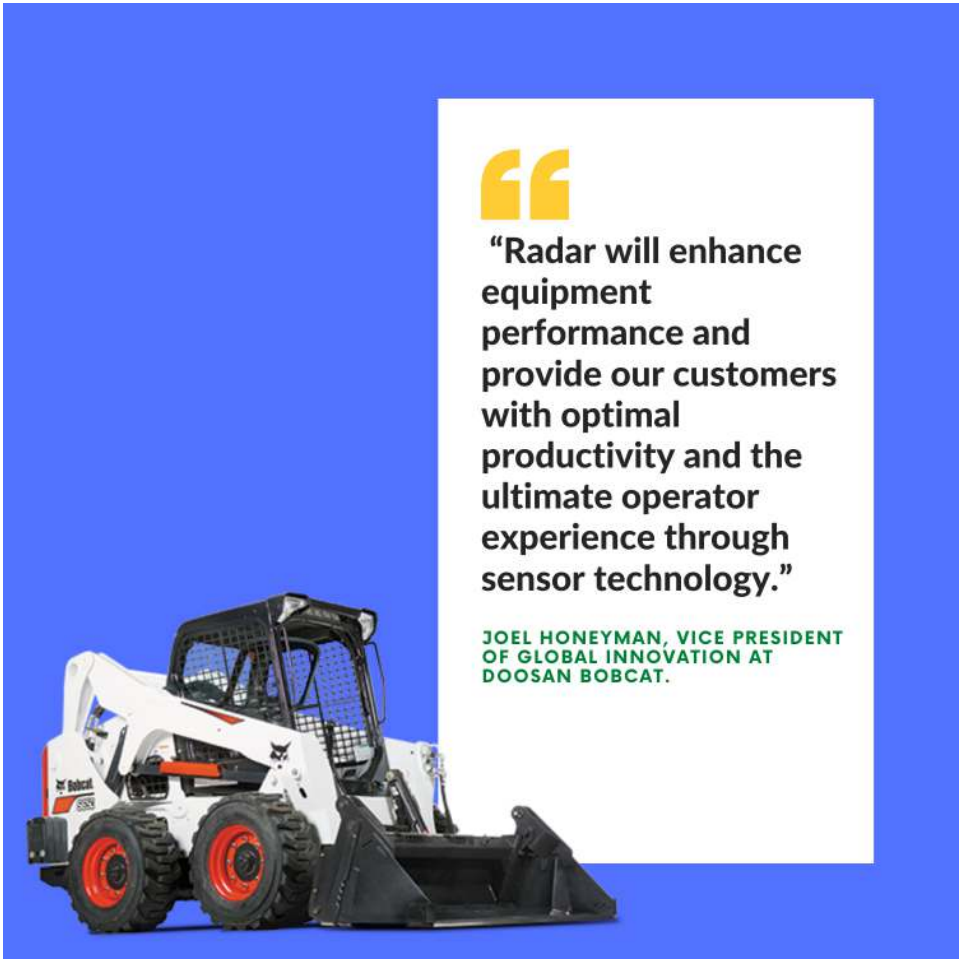
2 Big Announcements

Specialty Vehicles Detect a Future in Sensing

Doosan Bobcat North America, West Fargo, North Dakota, completed a strategic equity investment with radar technologies startup company Ainstein AI Inc., Lawrence, Kansas, to continue the development of next-generation radar sensor systems for Bobcat equipment solutions. Doosan Bobcat's investment in Ainstein AI comes at the completion of a Series A funding round. The investment agreement was finalized in December 2020.[1]

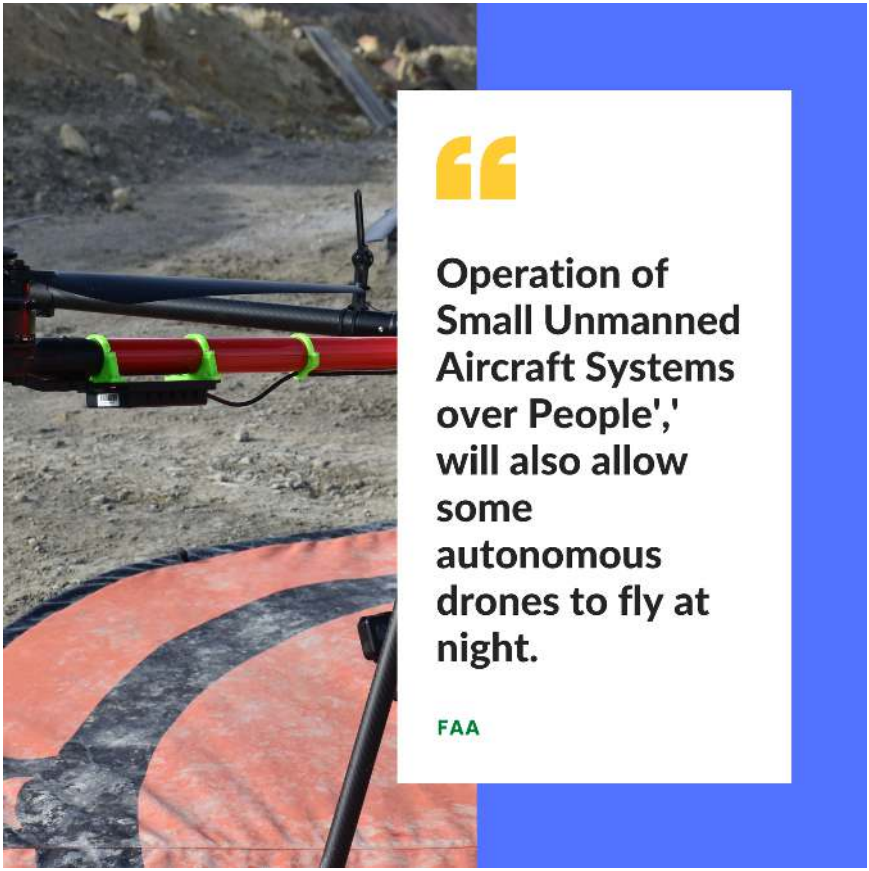


[1] https://igin.com/article-8481-Doosan-Bobcat-North-America-invests-in-Ainstein-AI.html

Autonomous Flying Over People Approved by FAA

American Robotics is the first FAA approved organization to operate smart drones without needing on-site pilots or spotters.[2]

As pointed out by the Wall Street Journal, this "also represents another step in the FAA's broader effort to authorize widespread flights by shifting away from case-by-case exemptions for specific vehicles performing specific tasks."[3]



[2]https://gizmodo.com/faa-authorizes-first-commercial-smart-drone-flights-1846072684

[3]https://www.wsj.com/articles/faa-approves-first-fully-automated-commercial-drone-flights-11610749377

WHAT CAN RADAR DO THAT LiDAR CAN'T?

MAINTAIN HIGH PERFORMANCE IN ALL WEATHER CONDITIONS

Ainstein smart radar systems don't experience degradation in performance under low-light, rainy, dusty, foggy, or other similar conditions.

Furthermore, our collision avoidance radar is designed from the ground up to help all of your vehicles detect and avoid:

Buildings

Vehicles

Tree Branches

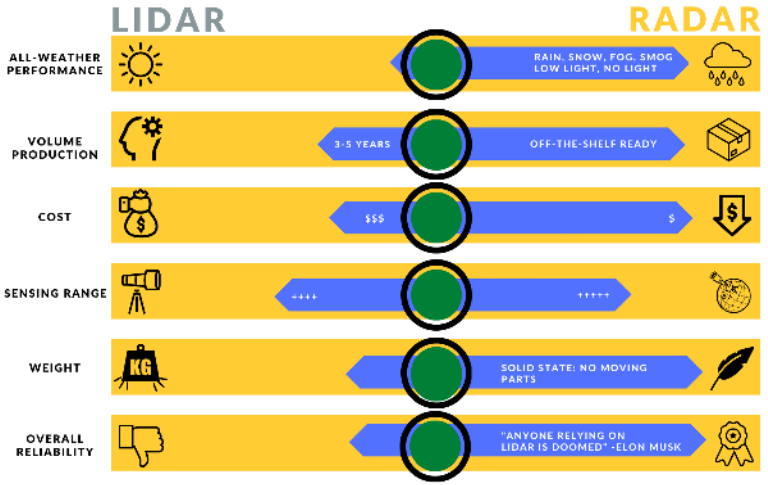
Powerlines

Ground Surfaces (AG Applications)

And more...

To be fair, they are similar in some respects, but they have some crucial differences. Here's why we believe RADAR technology is superior.

While LiDAR technology may continue to function in conditions of heavy rain, snow, or fog, its performance will be significantly degraded. But, RADAR will continue to function just as well as if it were a clear, sunny day! This makes RADAR technology ideal for real-world applications such as rain, ocean spray, fog, dust, and more.



Standard LiDAR technology is also not suited for applications like altitude management where water is present, as water absorbs the LiDAR signal. Radar technology, on the other hand, is very well-suited for applications where large bodies of water are present — such as over oceans or large lakes — and its performance will not suffer.

Similarly, RADAR can detect a glass wall or door while LiDAR will "see" through them. This makes RADAR a perfect sensor for robots that operate in commercial buildings, shopping centers, and sports stadiums.

Another notable difference to note is that Ainstein's RADARS are solid state devices while the LiDAR is not. Solid state has a longer lifespan and consume less power.

Standard LiDAR technology's performance will degrade in the presence of bush, overgrowth, or heavy vegetation. This means LiDAR technology isn't well suited for use in applications such as forest management, precision agriculture, or wildlands search and rescue. Radar technology, on the other hand, suffers none of these weaknesses and will continue to function at peak performance in such conditions.

Ainstein's RADAR-based sensing technology operates in the K-band (24GHz), V-band (60GHz), and W-band (76-81GHz) frequency microwave RADAR signals. These signals propagate through a multitude of atmospheric conditions and are less affected by rain, dense fog, blizzards or clouds, allowing for accurate measurement in all weather conditions, as well as superior performance in low light, such as during the night.

In addition, Ainstein has developed the intelligence to allow our UAV RADAR sensors to accurately detect items commonly found while flying in urban environments, items such as cars, buildings, pedestrians, power lines, and tree branches. Our solutions can even reliably detect small items such as city power lines within 0-5 meters range. With Ainstein's sensing solutions, UAVs have the ability to fly and land safely by detecting and avoiding these objects autonomously.

With advanced algorithms, our solutions provide smooth, above ground altimeter measurements for water surface and bushes; other sensors may be confused by jittering measurements in such environments.

PRODUCT FIT: AINSTEIN ALTIMETERS

US-D1

AINSTEIN UAV STANDARD RADAR ALTIMETER

Ainstein's UAV Standard Radar Altimeter US-D1 is a must-have mmWave Radar sensor, enabling autonomous takeoff and autonomous landings for drones, as well as terrain tracking commonly required for precision agriculture and other critical drone applications.

BUILT TOUGH FOR TOUGH ENVIRONMENTS

Water proof – meets the IP67 Ingress Protection rating requirements for water

Dust proof – meets the IP67 Ingress Protection rating requirements for dust

Robust for high speed and turbulent flight – single board electronics design leaves no room for failure

COMPACT SIZE
Fits in the palm of your hands, Ainstein UAV Standard Radar Altimeter US-D1 is small and light enough even for your small camera drones

EASY TO USE
Plug-and-Play and CAN/UART firmware upgrade

The Standard Radar Altimeter US-D1 is designed to work in a multitude of environments from mountainous terrain to tree canopies, sand and water.

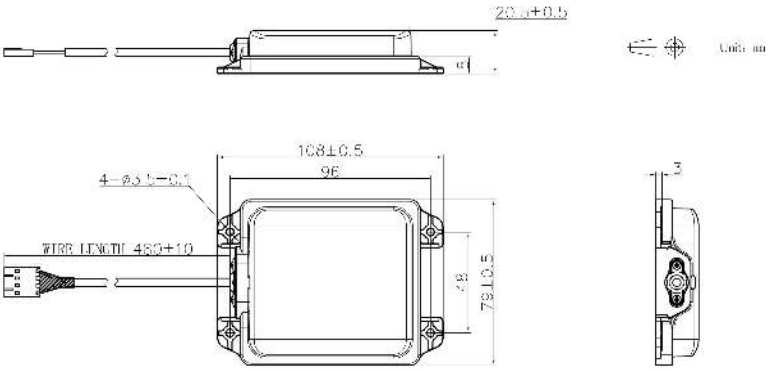
Do you fly over lakes or the ocean? It's normal for your UAV's components to get wet from choppy water, or simply from rain or fog. Worried about your expensive UAV electronics getting coated
in mist from agricultural spraying, or covered in dust during takeoffs and landings?

Worry no more! Your drone's performance shouldn't suffer because of these real world operating conditions. We've designed Ainstein UAV Standard Radar Altimeter US-D1 to meet IP67 requirements for dust and water – making it impervious to these conditions and more.

The result? Better performance and a longer lifespan for your UAV.
Will your drone fly at extreme speeds with lots of twists and turns? No problem! Thanks to Ainstein's UAV Standard Radar Altimeter US-D1, your drone will come through without a scratch — even after all the sudden drops and vibrations!

TECHNICAL SPECS

SENSOR PERFORMANCE INTERFACE		INTERFACE	
FREQUENCY RANGE:	24~24.25 GHz	SUPPORTED INTERFACE:	UART or CAN
RANGE:	1.64' to 164'	SUPPORTED CONNECTOR:	4 Pin GPIO
ACCURACY:	0.164' (5cm)		
MAX OUTPUT POWER:	23dBm	OTHERS	
UPDATE RATE:	100Hz	POWER CONSUMPTION:	~2W
FOV (-3DB) (AZIMUTH X ELEVATION):	43° x 30°	OPERATING TEMP. RANGE:	-40° F to +185°F


20.5±0.5
Unit: mm
108±0.5
96
4-ø3.5-0.1
WIRE LENGTH 450±10
78±0.5
3

LR-D1

AINSTEIN UAV PRO RADAR ALTIMETER

Ainstein UAV Long Range Radar Altimeter LR-D1 is a low cost high performance mmWave Radar altimeter targeted for advanced unmanned UAV and manned helicopters and other GA aircraft.

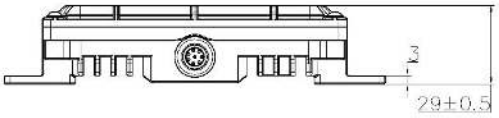
BUILT SOLID FOR TOUGH ENVIRONMENTS

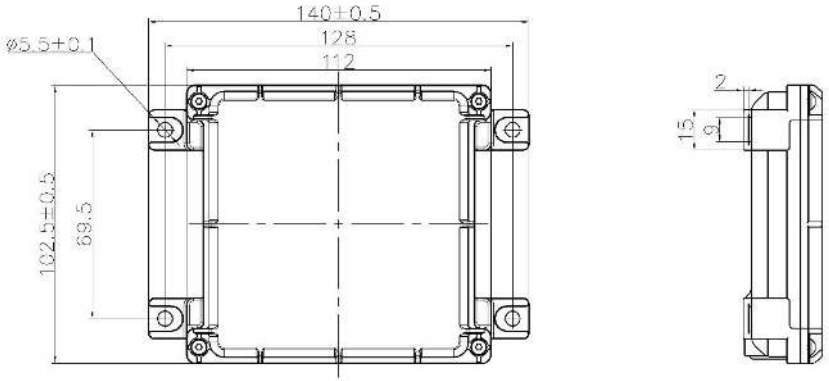
- Small footprint
- Ruggedized design meeting IP67 requirements
- Smooth, consistent readout regardless of the rough terrain, tree canopy or choppy water.
- Up to 500 meter range measurement
- Low cost

It's perfect for experimental helicopters and pilots under training in safe takeoff and landing; it's also a must-have for advanced UAVs in automatic takeoff and landing.

TECHNICAL SPECS

SENSOR PERFORMANCE		GENERAL	
FREQUENCY RANGE:	24 GHz ~24.25GHz	SUPPLY VOLTAGE:	12v ~ 30V
RANGE:	4.59' ~ 1640'	POWER CONSUMPTION:	<12W
RANGE ACCURACY:	4.59'	SUPPORTED INTERFACE:	RS-232
PITCH ANGLE & ROLL ANGLE:	Max +/- 20°	SUPPORTED CONNECTOR:	8 Pin GPIO
MAX DETECTION SPEED:	Max 60 m/s (TBD)	Weight:	<300g
OPERATIONAL TEMP. RANGE:	-40°F ~ 140°F	Dimension:	140mm x 102.5mm x 30mm
		(mounting bracket is NOT included)	





FEATURE COMPARISON TABLE

	US-D1	LR-D1
MAXIMUM DETECTION RANGE:	164’	1640’
SIZE (MOUNTING BRACKETS INC.):	108mm x 79mm x 20mm	140mm x 102.5mm x 30mm
POWER SUPPLY:	1.5W	<12W
POWER VOLTAGE:	5.2V~13V	12V~30V
ENVIRONMENTAL CONDITIONS:	IP67	IP67
VERTICAL SPEED DETECTION:	No	Max 60m/s vertical take off & landing
MAXIMUM DETECTION RANGE:	164’	1640’

Ainstein Imaging Radar O-79

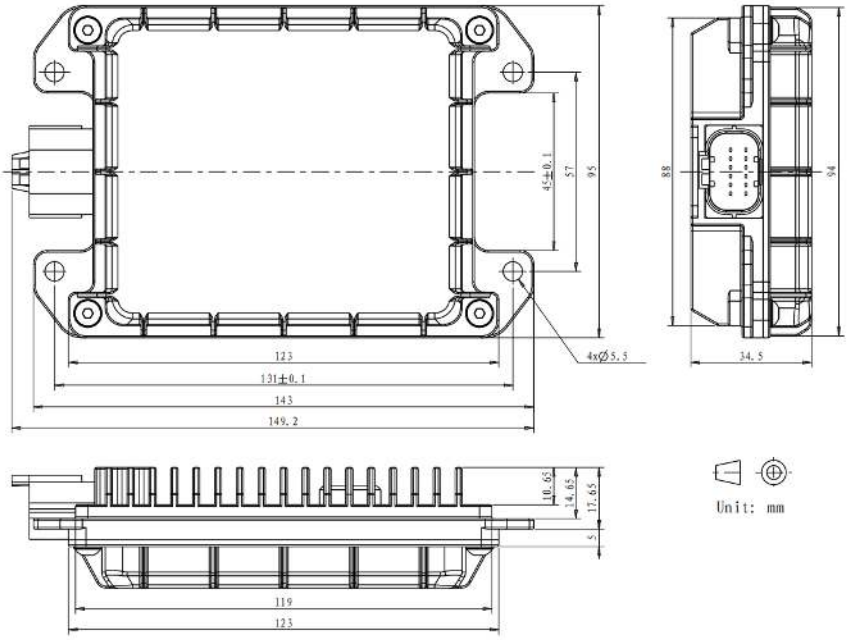
Aistein's mmWave O-79 Imaging Radar sensor module brings an unprecedented understanding of the real-time operating environment for autonomous robots and specialty vehicles operating in complex environments. The sensor module captures details of the surrounding scene of moving objects such as vehicles, bikes, and pedestrians, as well as stationary objects including light poles, railings, etc.

Ainstein's Imaging Radar pinpoints the location of detected objects with range, azimuth, elevation, and velocity data in order to generate a 4D point cloud mapping of the surroundings.

Specifications

Specification:	Current:
Operating Frequency	77 GHz
Field of View (Azimuth x Elevation)	~90° x 30°
Angular Resolution (Azimuth)	~5.7°
Angular Resolution (Elevation)	~18°
Detection Range	20 m
Range Resolution	< 0.2 m
Max Velocity	2.28 m/s
Velocity Resolution	0.0357 m/s
Update Rate (Point Cloud)	5 Hz
Update Rate (Tracker)	5 Hz to 20 Hz
Interface	CAN, Ethernet
Safety Rating Target	SIL2
IP Rating Target	IP 67

Mechanical Drawing



T-79 Medium-range automotive radar

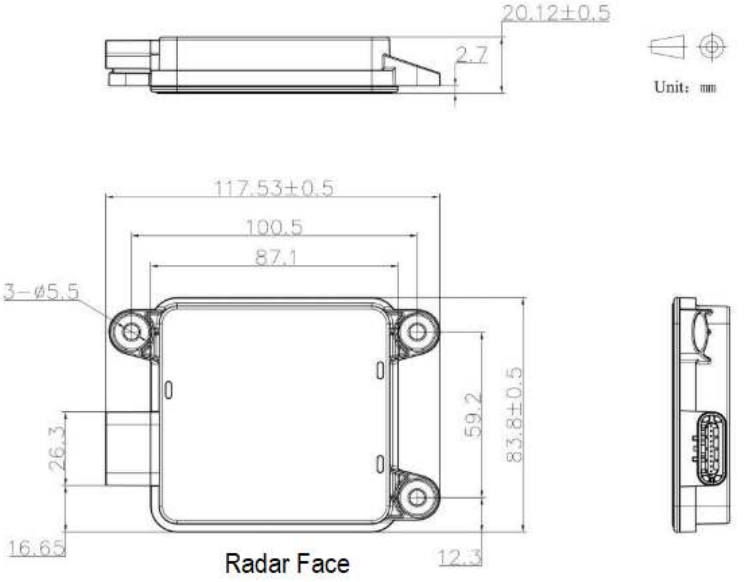
Ainstein's T79 SRR is positioned as the next generation of revolutionary short and medium-range automotive millimeter wave radar for ADAS and autonomous driving. Using next generation 79GHz RFCMOS technology, highly integrated hardware design, and advanced radar signal processing algorithms, creates a 360-degree smart car perception solution without blind spots.

Specifications

Table 1

Frequence Range	76 ~ 77 GHz
Power Consumption	4.5 W
Quiescent Current	< 1 mA
Radar Operating Voltage	12 ~ 24 V DC
Operating Temperature	-40° ~ 85° C
Protection Rafting	IP67
Detection Range	0.5 ~ 80 m
Range Accuracy	0.4 m
Range Resolution	0.78 m
Maximum Detection Velocity	±200 km/h
Velocity Accuracy	0.13 m/s
Velocity Resolution	0.4 m/s
Field of View (Azimuth)	±60°
Field of View (Elevation)	±4°
Angle Accuracy	0.4°
Update Rate	20Hz
Maximum Tracked Targets	64
Output Date Interface	CAN

Mechanical Drawing



USE CASE: WATER

About FIT

Ian Fairweather of FairweatherIT (aka FIT) runs an applied science and technology consulting firm. Ian founded FIT eight years ago to provide technical support to a mining remediation client in Montana. They began by collecting high resolution multispectral imagery for vegetation health analysis on mining remediation sites. Since its inception, FIT has moved into doing photogrammetry mapping missions creating 3D data product to collect physical environmental samples and other geophysical data. In most cases, FIT operates in extremely toxic or dangerous environments -mostly large toxic bodies of water. They provide a service that can monitor and collect data in a safe manner.

For example, they've worked in large water filled former mining pits that have diameters of a mile and is has depths of upwards of 815 feet. Collecting physical samples was extremely dangerous due to the hazardous temperature and thermal characteristics of the water. Manned collection of water is not allowed but they suntil need to know what the water quality and chemistry data is in such a pit.

FIT developed a safe method to remotely collect physical water samples and do deep call water column profiles using a UAV. They created the patent-pending technology WASP (Water Sampling Platform) to go out and safely collect those water samples. What makes it different than other methods is it's not really feasible and safe to tie a 200 foot rope to the bottom of your UAV, fly out to grab a water sample, and pick up a 2 kilogram load suspended 200 feet. This type of activity creates a very dangerous pendulum effect which can result in the loss of aircraft.

The WASP has set a depth record of 813 feet below the water surface which to FIT's knowledge hasn't been accomplished by anyone else to date.

Flying Away and Down (versus up and over)

Some of the biggest hurdles FIT has had to overcome with operating in mining pit environments is operating at distance. Their UAV can be up to a kilometer away which eliminates the ability to visually look at the mechanics of the WASP plate to make sure it's operating correctly. They are forced to depend on telemetry data from their onboard sensors and the onboard cameras.
This puts all the responsibility on both the piloting command and the equipment operator.

FIT's UAV operates below the team as the zone of safety is approximately 60 meters above the surface of the water.

Therefore, they're flying and collecting water samples up to 50 meters below the team.

Most UAVs are designed for flying above. The FIT team has reconfigured their UAVs by flipping the antennas around as fail safe. In the event there is a loss of communication, this prevents the UAV from lowering automatically and, instead, rising to a safe altitude.

Why RADAR?

The last challenge the FIT team needed to deal with was the water beneath the machine. On average, they need to be five to eight meters above the water before deploying their sampling equipment. If they're too high, it's too much space between the water and dropping the payload. If they're too low, this can cause spray from the prop wash to rise and hit their instruments -which, with high acidity is very problematic.

They used to rely on the onboard GPS and barometer for altitude. Then they would point the camera down on the water and would lower it slowly until the prop wash on the water itself was visible. From there, they would rely on a series of estimations to ensure safety. This lead to multiple problems. What they needed was a rangefinder that would actively detect how far above the water the UAV was. They considered a LiDAR rangefinder which was excellent over land but could not operate over water. They would experience sporadic measurements of 100 meters down to zero and everywhere in between.

They found Ainstein's US-D1 RADAR altimeter worked perfectly into their craft and have been using it ever since.

"We don't need a companion computer such as Raspberry Pi or anything. It plugs into the telemetry port on the pixhawk. The pixhawk provides the power. As you have your parameters set up correctly, which you can all find that online, you turn it on. You just make sure that those values are being shown in your flight app and on your controller," said Fairweather, "It just plain works."

Your UAV's performance shouldn't suffer because of these real world operating conditions.

ainstein.ai