

# Design and Prototype Modelling Of Foreign Object Debris Detector and Remover

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**Abstract**— FOD interference for an aircraft in runway would cause damage. In severe cases, “Foreign Object Debris” can directly threaten safety of flight crews and integrity of the aircraft. Anything that can find its way into an aircraft engine or flight control mechanisms is a recipe for foreign object debris. So, Innovative future in airport can be reached here we implement the idea of FOD detection and removal in the airport runway into the concept that we designed a vehicle that can be radio controlled which will consist of Radar and a camera that will be used for detection, and Magnets with vacuum cleaner for removal of the detected debris. We consider different airports and their physical characteristics for implementing this concept. Our undertaking holds the imaginative engineering by more reliable by uses our vehicle in the service line in the airside and detect the FOD in Runway. This extend additionally includes the few numbers of vehicles, situated in an extra constructed area connected to the runway. Situated areas are constructed as per the calculations using the standard Runway length and time gap. Process will continue for each time gap. This vehicle would surely help to aircraft safety and do not need to hold it. The highlight of our concept is the mobility and the freedom that one gets in controlling and detecting the FODs.

**Index Terms**— Airport Runway, Foreign Object debris(FOD), Detection, Sensing, Removal, Model Design and Specifications, Methods Of placing FODer,

## 1 INTRODUCTION

### 1.1 What is FOD?

Foreign Object Debris (FOD): A substance, debris or article alien to a vehicle or system which would potentially cause damage.

Foreign Object Damage (FOD): Any damage attributed to a foreign object that can be expressed in physical or economic terms which may or may not degrade the product’s required safety and/or performance characteristics.

Most frequently, FOD damage is caused by bird strikes, stones, hail, ice, or bolts and metal shavings left on runways. Any of these can cause an engine to ‘throw a blade’ – to break apart in a way where parts fly off at high speed.

It is estimated that FOD costs the aerospace industry some US\$4 billion per year causing:

- Expensive, significant damage to aircraft.
- Death and injury to workers, pilots and passengers.

### 1.2 Why are we concerned with FOD?

Foreign object damage preven is necessary because of:

- Safety – avoid life or health hazard.
- Costs – warranty, deficiency, rework.
- Customers expectation/requirements.

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### 1.3 FOD can cause:

- Loss of health and life
- Delay time of delivery
- Loss of customer trust and satisfaction
- Costs of extra work, repair
- Lack of new orders from customer

## 2 CURRENT SCENARIO

### 2.1 Methods involved:

#### 2.1.1 FOD Parade:

This is the method that is most oftenly practiced in most of the airports or hangars. A group of people or maintenance personnels walk along the runway or taxiways in search of the FOD’s. This method is more prone to Man made mistakes and it require quite an amount of time.



#### 2.1.2 FODetect (Xsight Systems)

FODetect is an automated and comprehensive FOD detection solution collocated with runway edge lights and is the most powerful solution to improve runway safety, operational efficiency and increase runway capacity.

But this method can only detect the FOD and not remove it by itself, a ground staff has to be assigned to retrieve it.



### 3. IMPLEMENTATION OF OUR CONCEPT

Here we plan on Embedding a Detector & a Remover on a mobile vehicle which will be radio controlled. This vehicle will be controlled by FOD officer or other designated engineers.

We have separated the concept into 2 modes,

#### 3.1 Detection of the FOD:

Detection of the FOD is the primary objective of this designed vehicle, removal comes later.

For detection we use a "Dual Head Sensor". This is manufactured by the company "XSIGHT systems"

Xsight Systems Dual Sensor Head (DSH) is an integrated sensing platform, combining a Mini Radar sensor and a day/night Vision sensor, mounted on a 2-degree-of-freedom motion pedestal and including a powerful built-in processor and a communications module.

The DSH offers a unique platform for advanced sensing and surveillance applications.

The Radar sensor provides complementary performance even when the Vision sensor has limitations during low visibility conditions.

#### Some of the salient features are:

1. 77GHz FMCW radar.
2. Day/night color/monochrome camera, with remote zoom and focus capabilities.
3. Near IR (NIR) illuminator for extreme night operation.
4. Pan and tilt motion axes (Configurable).
5. Powerful processor for signal and image processing.
6. Supports wireless (WiFi), copper-based LAN (10/100 Ethernet), and fiber-optic based LAN communications.
7. Built-in heater circuits for extreme weather operation.
8. Environment control of the Vision window (heated optical surface, cleaning mechanisms).
9. Mechanical protection door for Vision sensor protection during extreme weather conditions.
10. Automatic scan and manual motion control capabilities.
11. Data recording capability.
12. BIT and self-diagnostics.

We also have integrated a pedestal for the camera so that the controller of the vehicle will not only know the location of the Detected FOD but also a visual of the same.

#### 3.2 Removal of the FOD:



Removal of the FOD is secondary mission but is also important. In our concept the vehicle is remote/radio controlled, so the maintenance personnel need not come all the way to retrieve it.

For this purpose of removal, two equipments are being used:

#### 3.2.1 Magnetic sweeper:

This equipment is used to sweep off the metallic particles that is present in the runway or taxiways.

MKS4000 Tow Behind Magnetic Sweeper for roads and airfields. The MKS4000 tow-behind magnetic sweeper features a super-strength tow magnet ideal for sweeping roads, parking lots, driveways, airport runways, flightlines, etc.

#### Some salient features:

1. Tow behind magnetic sweepers are the most effective method of removing ferrous metal from concrete grooves.
- 2.2" clearance at 13 mph with road magnets in sweeping position, 5" clearance with magnets in traveling position.
3. Trailer-type frame constructed of heavy gauge steel for long-lasting performance and durability.

#### 3.2.2 Vacuum Pump:

This is used for the suction of the non metallic materials. This is as necessary as the magnetic sweeper.

The pump used is of very high CFM (cubic feet per minute) such as a positive displacement blower.

The necessary features of vacuum/pressure pump are as



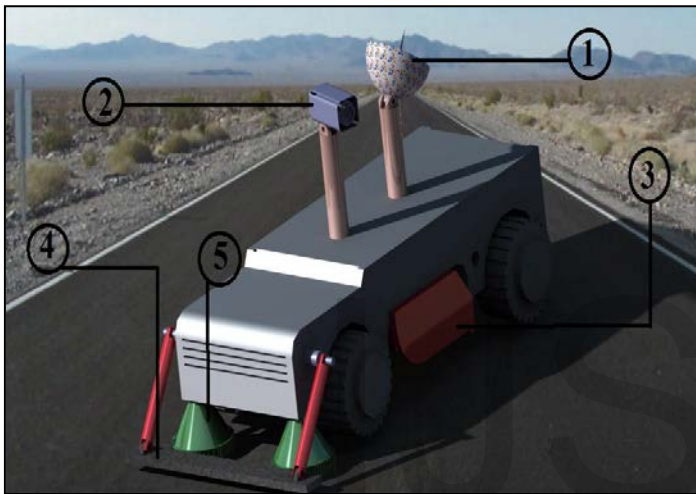
follows:

- 250 CFM free air
- 27" maximum intermittent vacuum

- 30 PSI maximum intermittent pressure
- Clockwise or counter-clockwise rotation available
- RPM range from 800 - 1400
- 3" flanged NPT port
- Manifold with four-way valve
- Bearings sealed from pump interior
- Anti-spin check valve
  
- Automatic lubrication system optional
- 3 1/4 quarts oil tank
- Weighs 343 pounds

#### 4. Model Design and Specifications:

Integrating all the equipments above into our design



"FODeR" is illustrated using the software CATIA V5.

All the equipments used in this model/design can be changed according to the needs of customer/manufacturer

##### Specifications

1-Radar/Dual Head Sensor

2-Camera

3-Vacuum tank(The vacuum pump will be placed on top of this tank i.e. inside the metal casing)

Specifications: Length-1000mm

Breadth-730mm

Width-350mm

4-Magnetic sweeper (equipment specified above)

5-Brush

Specification of the whole vehicle (FODeR):

Length- 2465mm

Breadth- 900mm

Height- 707mm

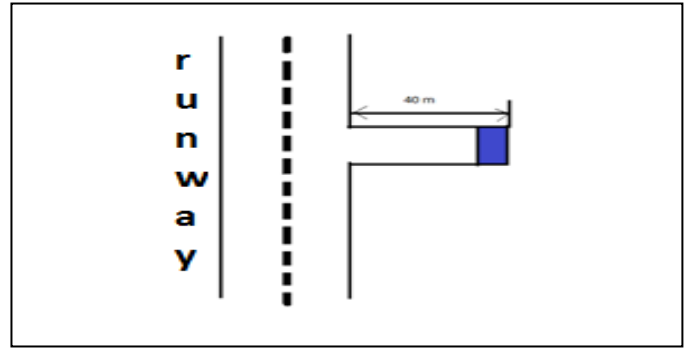
The Pedestal that holds the RADAR and the camera is of retractable type.

#### 4.1 Methods of placing FODeR

We have planned two methods of placing FODeR in the airport.

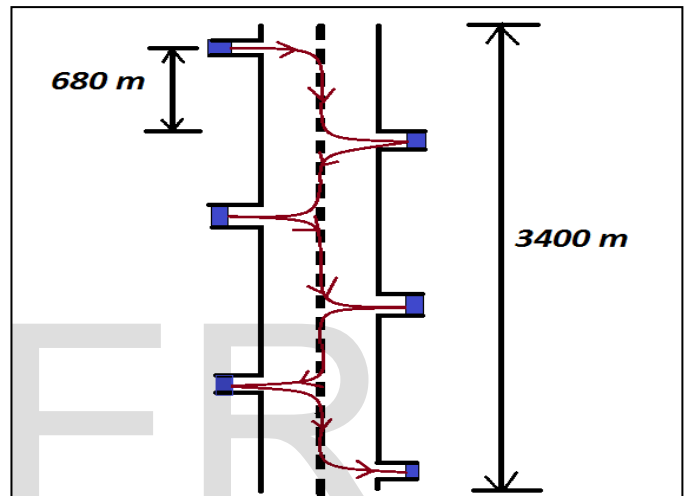
**First** method is to place it along the runway in certain distance which will be constructed separately. According to the rules of Airport Authorities, there should be no vehicles or obstacles in a 40meter gap from the runway.

As shown in the above illustration the blue colored in the



protruded area is where the FODeR will be placed.

This illustration is designed considering Cochin Interna-



tional airport which is of 3.4km in length and 45m in width.

Each protrusion is of 40m length and the distance between each protrusion is 680m. This is determined by calculating the runway length and minimum time gap between each take-off and landing.

Five FODeR will be placed in each protrusion and it will move from one protrusion to another in this time gap available.

##### As per the Calculation:

Speed of the Vehicle (FODeR) = 10 km/hr

Time between Each take off

and Landing = 5 min minimum

Distance Travelled in 5 min = 833.33 m

Number of Vehicles necessary

for the whole runway = 5

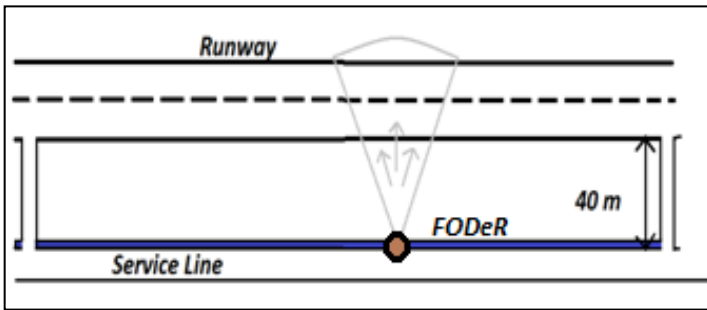
So keeping the speed of FODeR 10 km/hr the detection and removal can be done successfully.

To implement this method, construction of the additional area that is illustrated above is necessary. This is easier to implement in the newly constructing airports than in an existing airport.

**The Second** method can be implemented in the airports that are presently functional. Since it does not need any additional area. This method uses the SERVICE LINE that is there in the airports.

The FODeR is placed in the SERVICE LINE and from there it scans the runway.





The below illustration portrays the runway and the service line (blue colored area). As shown, the FODeR is placed in the service line, from there the FODeR scans the runway as specified earlier. So by moving to and fro in the service line the runway can be scanned on the whole. Once the FOD is detected the FODeR will go to the runway using the links that connect the runway and service line.

## 5. CONCLUSION

The technologies discovered or the Machines that are engineered is to make a human to work easier. From the stone age to the present new era of technology the standard of living has improved in all aspects or in any field/discipline. The point of introducing every new technology is for the betterment of our future. Each technology assures the basic aspects such as Safety, Reliability, Consistency and Durability. So we have made it reliable and safe for the Maintenance personnels or any designated officers to detect the FOD and remove the same. Further more to this concept we can introduce the sonic canons for the wildlife control in the airports or in similar locations.

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