Highly maneuverable systems for confined & helicopter impenetrable environments

Dr. Alex Ramirez-Serrano
Founder & President
Email: aramirez@4frontrobotics.com
Phone: 1.403-400-2991

www.4frontrobotics.com
AB company, founded 2012 after 17 years of developing UGV and UAV systems.

Leader in highly maneuverable ground & aerial unmanned vehicle systems.

Proprietary UAV, control and navigation mechanisms technology is second to none.

UAVs designed for complex, confined spaces and helicopter impenetrable environments.

Engineers provide custom concept design.
Cable stay snow & ice removal robot

Reconfigurable UGV
Proprietary navigation control technology
4Front Robotics’ Clients & Collaborators

• We have strong relationships with companies, organizations, federal and provincial organizations in diverse ways.
• Collaborate with organizations using complementary skills to develop effective and cost effective solutions for civil applications.
• Our products are used across countries and areas of expertise. Our customers solve their problems while reducing time, costs and efforts.
• An example of our clients and collaborators include:

![4Front Robotics Clients and Collaborators Logos](image-url)
Highly Maneuverable VTOL UAV for operations in challenging environments

- Oil & gas pipeline leak inspection
- Forestry
- Agriculture
- Fire
- Surveillance
- Etc.
- Search & Rescue
- Urban policing (tactical applications, Hazardous materials (Meth labs), etc.)
- Infrastructure inspection (e.g., pipeline right of ways, flare stack tips, bridges, power lines)
**High Maneuverability**

What is this?

**Maneuverability**: The ability to change attitude and direction on three axes/dimensions.

In our UAVs maneuverability is decoupled from velocity, thus retaining the ability to change attitude & direction even zero airspeed.

Navig8 uses **Thrust vectoring** and an **active centre of mass change** device to maintain a perfectly balanced aircraft despite fuel consumption or the addition of payload sensors.

**Control Moments:**

At low and zero air speeds, Navig8's control moments surpass those of existing VTOL aircrafts by actively changing the aircraft's location of the center of mass.

**Forces:**

Navig8's available thrust, is enhanced by using an optimal ducted fan designs with **increased thrust by 50-60% of traditional systems.**
Navig8 UAV™
Proprietary control and navigation technology (history)

- **2005**: First developed heavy lift UAV using ducted fan design *(weight: 12 lbs, Payload capacity: 5 lbs)*.
- **2007**: Redesigned for confined spaces
  - Precise 3D autonomous navigation
  - Twin-ducted fan *(using thrust vectoring and optimal ducted fan design)*.
  - Control under ground and wall effects.
- **2012**: “Navig8 UAV”
  - Fully scalable (small and medium)
  - Gas & electric versions available.
- **2013**: Composite materials for reduced weight and increased fly time”
  - Newest version includes variable pitch propellers for increase response and increased stable control.
  - A thrust-vectoring Quadcopter *(TV-quad)* is being developed.
• **Portable highly maneuverable** VTOL UAV (electric or gas powered depending on payload needs).

• Control using thrust vectoring (Active Titling) and CofG active change.

• **Navigate in confined spaces** and perform maneuvers such as pitched hover, land & take off from highly (unprepared) slopped surfaces (i.e., 0° to 45°).

• Can execute missions in open as well as **confined spaces** (e.g., urban, caves), and fly at low altitudes & in close proximity to objects.

• Can be **deployed from any prepared or un-prepared** (e.g., roughed, slopped) terrain.

• Cost-effective & **scalable**.
Navig8 UAV™

Navigation video

• Precise 3D autonomous navigation (*safe autonomous fly at all times*).

• Effective control under ground and wall effects (*using thrust vectoring and robust control*).

• Fail safe navigation (*fly under external and internal disturbances*).
Simulation: UAV navigating in a confined space (3D)
UAV specifications (gas powered)

- Navigate confined spaces
- Pitched vertical take off and landing
- Increased flight time
- Increased payload capacity (70 lbs)
- Maximum vehicle weight (150 lbs)
- Can be carried by a small team
- Deployable from a pick-up truck
Technical Specifications:

*(medium size - gas UAV)*

**Dimensions:**
- L x W x H
  - 108 x 90 x 36 in (large size gas UAV)
  - 68 x 428 x 28 in (medium size electric UAV)
  - Fully scalable, can be enlarged/reduced

**Weight:**
- No payload: 250 lbs (medium size gas UAV)
- 15-70 lbs (small size electric UAV)

**Payload:**
- 10-47 lbs (electric), 95 lbs (gas)

**Max speed:**
- 55+ km/hr (electric), 100+ km/hr (gas)

**Control Modes:**
- Manual
- Thrust vectoring + Semi-Autonomous
- Active CoF change: Fully Autonomous

**Endurance:**
- 40-55 min (electric)
- 100+ min (gas)
  - Depends on power supply and UAV size/configuration

**Sensors:**
- Dual EO/IR cameras, LiDAR, GPS, IMU, Altimeter, Gas sniffers, 3D camera, etc.

**Electrical Power:**
- Electric: Lithium Ion batteries (number & capacity depends on UAV size)
- Gas: RT600 engine, 3kW generator, Onboard engine starter & Electronic control unit controlled altitude compensation.

**Flying Modes:**
- Pitched Hover (up to 60° pitch), Vertical hover is possible with mechanical changes.
Technical Specifications:

*(Small size - electric - UAV)*

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions:</strong></td>
<td>9-27 x 23-30 x 7-11 in (various sizes)</td>
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<tr>
<td></td>
<td>Fully scalable, can be enlarged/reduced</td>
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<tr>
<td><strong>Weight:</strong></td>
<td>6-25 lbs (not including batteries)</td>
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<tr>
<td></td>
<td>11-35 lbs (with full payload &amp; batteries)</td>
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<tr>
<td><strong>Payload:</strong></td>
<td>5-10 lbs (including batteries)</td>
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<tr>
<td><strong>Max speed:</strong></td>
<td>55-65+ km/hr</td>
</tr>
<tr>
<td><strong>Control Modes:</strong></td>
<td>Manual, Semi-Autonomous, Fully Autonomous</td>
</tr>
<tr>
<td><strong>Endurance:</strong></td>
<td>40-50 min (electric)</td>
</tr>
<tr>
<td></td>
<td>depends on power supply and UAV size/configuration.</td>
</tr>
<tr>
<td><strong>Sensors:</strong></td>
<td>Dual EO/IR camera, IMU, GPS, LiDAR</td>
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<td></td>
<td>Altimeter, 3D camera, magnetometer, etc.</td>
</tr>
<tr>
<td><strong>Electrical power:</strong></td>
<td>Lithium Ion batteries (number &amp; capacity depends on UAV size and config)</td>
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<td></td>
<td>There is the option to recharge the UAV by simply plugging it to a standard 120 VAC outlet (this is not a standard feature).</td>
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What is on the works (R&D):

(*Highly maneuverable TV-quad*)

**Thrust-Vectoring Quadcopter:**

- **Robust** to wind gusts & other disturbances.
- **Highly maneuverable** within the range of 2 ducted fans in operation.
- Proprietary control and navigation mechanisms enabling the aircraft to perform maneuvers that no traditional quadropter can.
- **Capable of carrying a robot arm to manipulate the environment.**
Spherical LiDAR (LiDAR in the Pilot’s Seat)

**R&D version:** navigation in mines, collapsed bldgs., urban environments, harbors / docks, etc.

- **Coverage:** Spherical region surrounding the UAV (front+/left+/right+/down+/up/back+).
- **Sensing rate:** 50 Hz
- **Sensitivity:** <1.5 mm @ 10-15 m
- **Re-use:** various applications (SAR, inspection, identification of branches, etc. while moving)
- **Scalable:** various sizes

- **Sensor output:** High density point in a 3D map continuous/on demand
- **Robustness to ambient light:** Operational in both day & night conditions, as well as indoor and outdoor environments.

- **Weight:** 5 lbs (medium size UAV), 2 lbs (small size UAV)

Identification and classification of objects for situational planning
Summary of Highly Maneuverable UAVS:

- **High Speed Flight:**
  Possible transition to high speed flight

- **Hovering, landing and taking off - anywhere:**
  Helicopter impenetrable environments, capable of pitch hover at any angle between -60 and +60° (of pitch)

- **Silent:**
  Low noise signatures (and emitted has high decay)

- **Advance 3D maneuvering and mobility:**
  Impervious to ground and wall effect disturbances as well as wind while precise 3D maneuvering and mobility within restricted spaces.

- **Robust to disturbances:**
  Control takes into account computed ground & wall effects as well as other external/internal disturbances.

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**Features**
Using novel navigation mechanisms these UAVs can perform inspection tasks in close proximity to objects (e.g., pipelines, buildings) and within confined spaces, while able to generate a real-time 3D map of the leak/pipe conditions and the leak source.

- **Autonomous or semi-autonomous operation**
- **Easy (i.e., single man) deployable and recovery**