Innovative flapping umbrella or flapping shutter ornithopter

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Abstract

Just like the webs of duck feet or bird wings, human beings have struggled for many centuries to experiment flapping-wing aircrafts or ornithopters that shall vertically takeoff, but still failed to commercialize it. Until nowadays, only rotary propeller driven helicopters have achieved great success. Now I propose a flapping umbrella driven ornithopter that is powered by pulse power supply. Once upon commercialization of such inventions, humankind will benefit in many aspects, e.g. affordable personal aerial commuting, remote internet service, goods shipping, etc.

Dynamics abstraction

Umbrella-like or shutter-like pump, categorized in class of **Linear Type** (surface linear driving pumps) is basically the type that punches fluid directly with planar or curved surface, not by rotating blades as in traditional **Angular Type** (rotary angular driving pumps) where fluid direction is never vertical to any blade, but a small angle.

Linear type pumps comprise pistons and driving bars with reciprocal motion, and can interface with fluid by a square or rectangular or circular or even more complicated area with fluid, but the angular type only circular area.

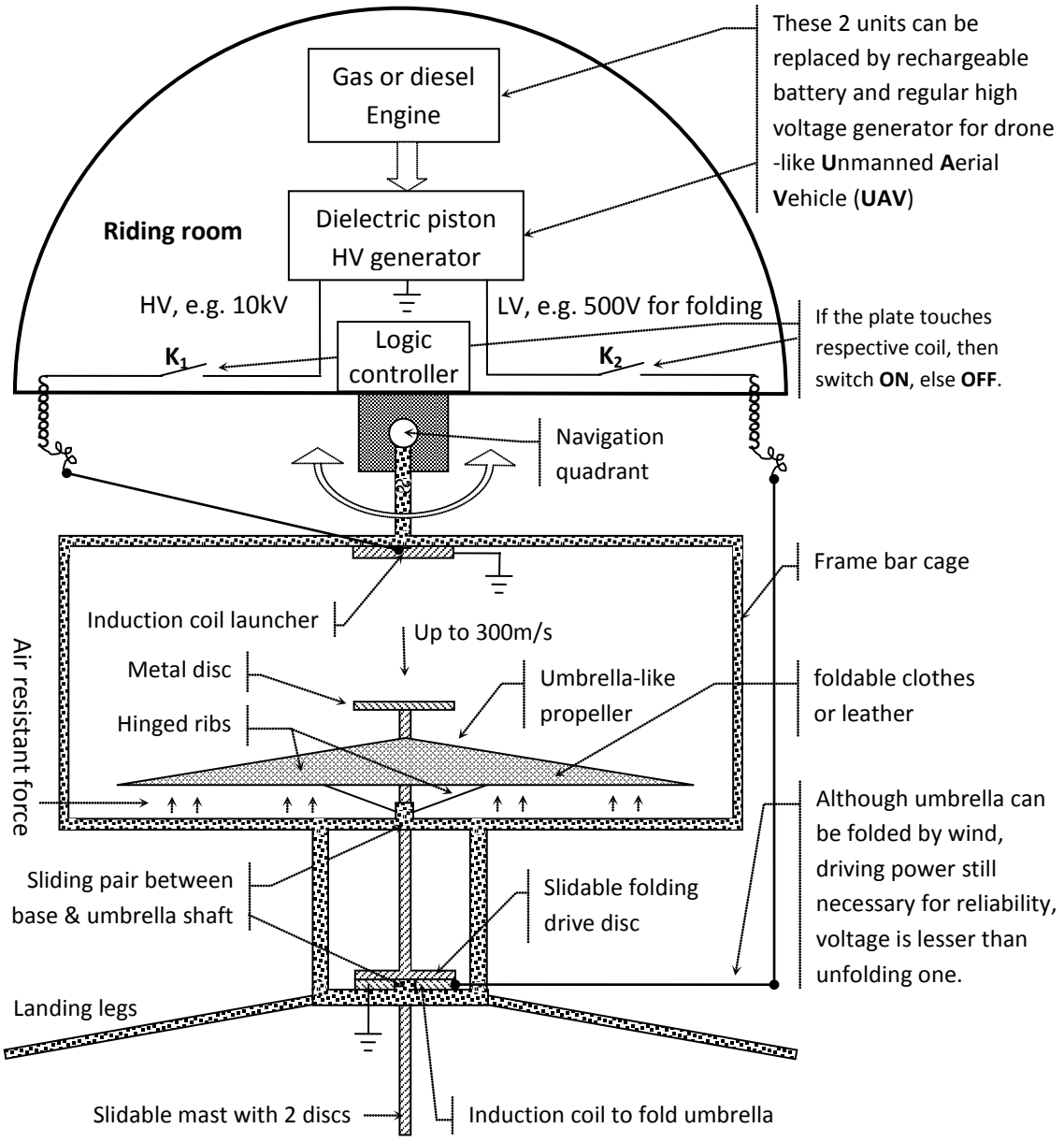
Abstractly, the linear pump piston reciprocal motion is analogue to alternative current, and fluid is driven in direct current motion, so in a sense, like a mechanic **AC-DC** rectifier.

For an aircraft, air and plane are both movable, so while air is pumped backwards, the plane must be propelled forwards. Jet plane works in same principle.

Rationale of flapping umbrella ornithopter

The aerial propellers in my inventions can mechanically either be the umbrella-like or planar shape (synonymous designations include board propeller, linear propeller). **Fig. 1** illustrates a simplest umbrella-like propeller for light duty aerial vehicle

Fig. 1: Typical umbrella-like propeller for light duty aerial vehicle



The propulsion force comes from a very short time powerful acting energy release, such

as pulse electromagnetic energy discharge or explosion driven mechanic thrust.

By abruptly discharging high voltage in capacitors to a base-fixed disc-shape coil that contacts with a metal disc, such as aluminum disc, the huge current in the coil will induce a very strong magnetic field, and the induced eddy current in the metal disc will generate a matchable pulse repelling magnetic field, so as to launch the metal disc in very high velocity. The subject figure shows the moment of reaching bottom dead point.

After umbrella is fully unfolded and aircraft is pushed some distance, it should return to the folding status for next propulsion. Luckily the moving aerial vehicle itself can help to retract the umbrella, and fold it, however, driving power is still necessary for reliability, though the applying voltage to the folding launcher no longer as high as unfolding voltage. This can be done by the same electromagnetic mechanism, just acting on the opposite position under umbrella.

Sometimes the umbrella top needs to keep in touch with the launcher coil for short awhile if inertial energy enough to maintain flight, but gravitation always droops it though the wind resistance can fold the umbrella, so in order to overcome the gravitation, a proper auxiliary permanent magnet may be needed to secure the folded moment, despite of undrawn in the figure.

Dynamics and aerodynamic analysis

For example, for a **10KV** voltage charged capacitor with **2.2KJ**, experiments show that the pulse discharge can accelerate a **4** ounces projectile to about **160m/s** initial speed**,** or if driving a realistic aerial vehicle of gross weight **200kg**, it may theoretically lift about **2200/(200*9.8) = 1.12m** for a single pulse discharge, as per energy conservation law.

According to aerodynamics, for **50m/s** typhoon wind speed, the pressure on facing surface can reach about **150kg/m^2**, and rough proportional to the square of wind speed. That means **1** square meter umbrella with high enough speed of treading air may levitate a regular adult plus reasonable weight of driving module.

That higher the initial speed of umbrella, the stronger the propelling force, so by

optimization of design, a proper umbrella area can be determined.

Power source and energy dispension logics

Almost all engines in market are the type of rotary, however if the type of reciprocal fuel engine is accessible, though not good pulse power, it may still be possible to directly drive the umbrella, just with a large degradation of linear velocity because piston's speed of most internal combustion engines is usually at max about **20m/s** which is far inferior to the pulse jerk propelled by electromagnetic catapult, but increasing area of umbrella can offset the degradation, and in turn, increase of volume and gross weight.

Thus the feasible way is by first converting torque energy to electricity, and then dispense pulse energy from electricity to thrusting mechanic energy.

The power source can be a regular gas or diesel engine, and the engine usually drives a rotary dielectric replacement high voltage generator or other type pulse high voltage generator with **2** output terminals marked as **HV** and **LV** in figure.

For details of dielectric replacement high voltage generator, check the reference **2**.

HV output is used for umbrella unfolding that pushes vehicle in desirable direction, and **LV** for folding umbrella propeller.

When the top disc of umbrella touches the launcher coil, the switch $\mathbf{K_1}$ is turned on, high voltage discharge occurs, the umbrella pushes air backwards quickly, hence propelling force accelerates vehicle in opposite direction of fanned air.

When folding disc touching the folding coil, switch $\mathbf{K_2}$ is turn on, the umbrella changes direction and is folded under wind pressure, until next propulsion to be ready.

In fact, for mini **UAV**(Unmanned Aerial Vehicle), engine can be replaced by rechargeable lithium battery, even the dielectric **HV** generator can be replaced by regular oscillation and rectification **HV** generator.

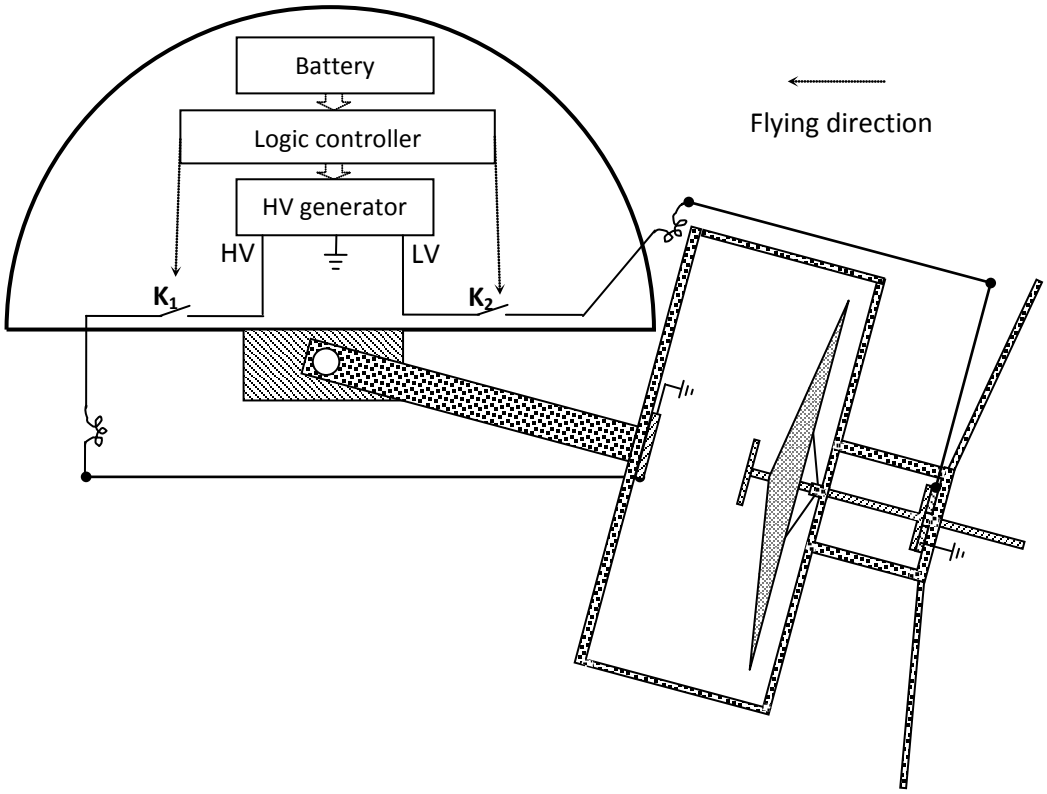
How to navigate during flight?

The whole propeller module is hinged to base of riding room, and navigation can be at

least done by swinging the propeller to some slant angle.

Following figure shows an **UAV** in flying transition.

Fig. 2: UAV with umbrella-like propeller in flying



To have more payloads and easy navigation, all parts, including landing legs, engines, powertrain, their respective materials and sizes should be well balanced.

Variety 1-- quartet flapping umbrella propeller

For convenience of characterization, as the operating rationale is well explained in the context of all above description, I abstract and define such a rationale as **fluid-AC-DC** that means the fluid air is treaded by alternating movement of propeller in alternating **90°** differential orientation of windward or leeward so as to generate unidirectional direct fly. It applies to both planar and quasi planer propeller, such as plain board, shutter-like, and umbrella-like.

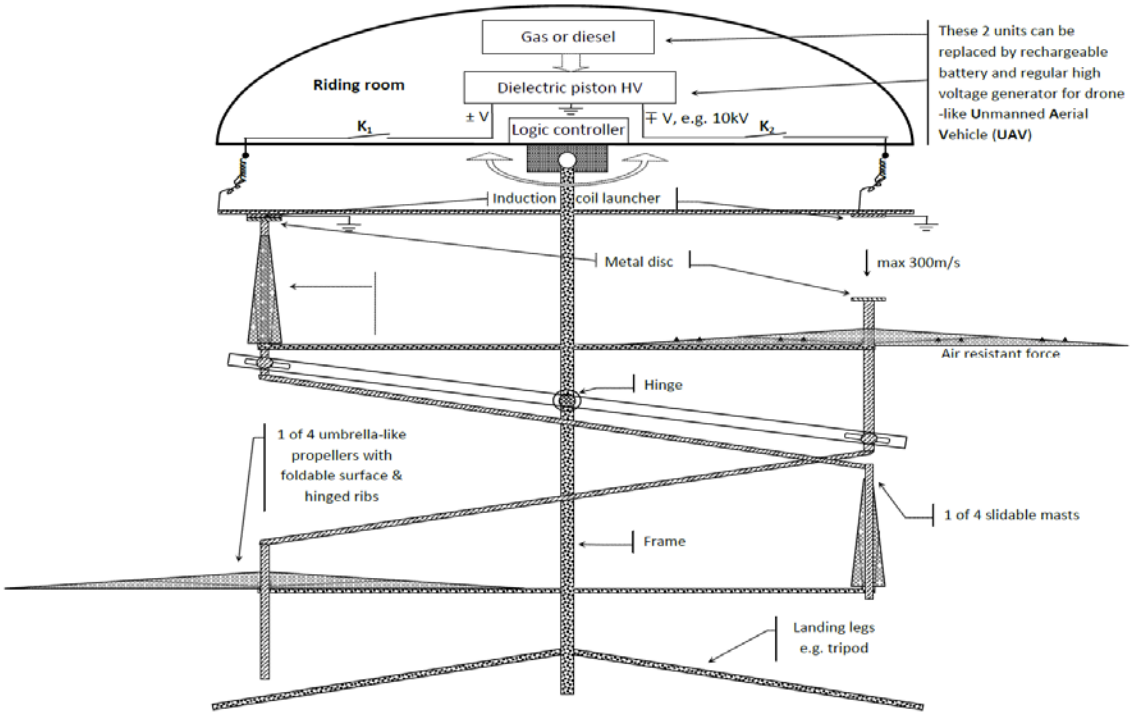
Analogue to that AC-DC electric rectifier can not only comprise single diode but also **4-**diode-bridge with great performance enhancement, the fluid-AC-DC can do the same.

The previous **fig. 1** model can be regarded as simplex style, but duplex style always doubles the efficiency of simplex, here I present an improved **double duplex** style that comprises quartet flapping umbrella propeller, featuring excellent mass center balance and **4** times of efficiency of simplex style.

Fig. **3** is a modification to previous design. It is equipped with 4 umbrellas, obviously air treading area covers full chassis, so its duty performance can be greatly improved.

Although it is implemented by rigid cross-joint between top duet and bottom duet, if fact, toothed bar gear transmission or other means can also do.

Fig. 3: quartet flapping umbrella propeller equipped aero-vehicle



Usually the quartet design creates two quasi air channels where mutual interference may exist, but no significant negative effect, as long as there is proper separation distance between the channels.

Variety 2-- quartet flapping board or shutter propeller

Is umbrella propeller good enough? Not really though simple enough.

In fact, the surface of unfolded umbrella is not perfectly vertical to motive direction because of the structural restriction, despite the angle is very close to **90°**.

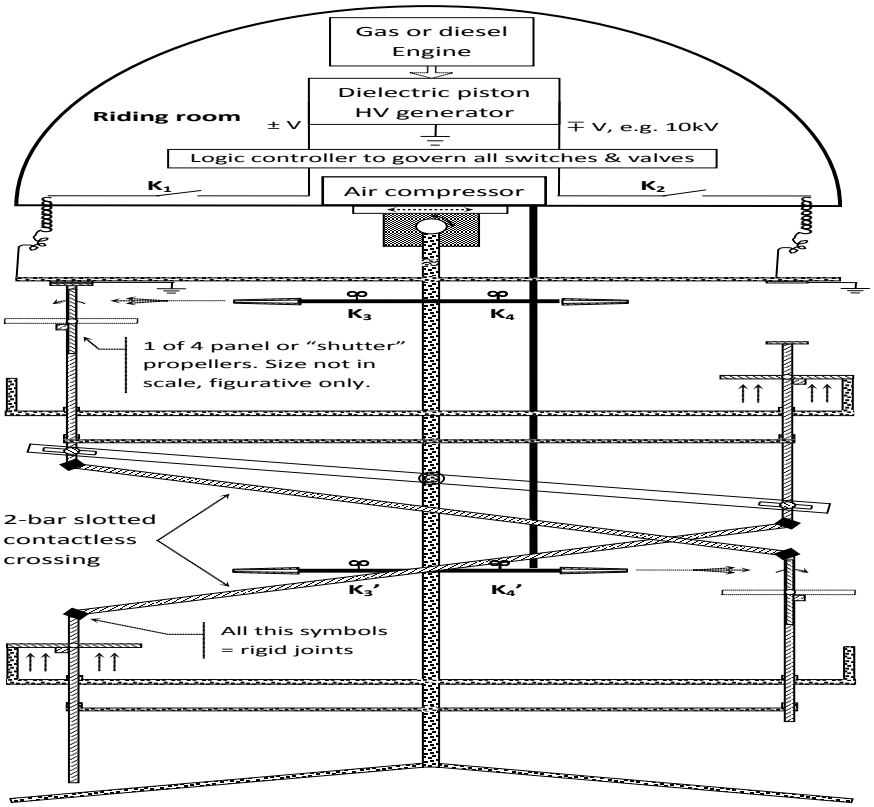
Also the height of folded umbrella may be embarrassedly ugly, thus entering pilothouse may need long ladder and is not convenient.

By replacing umbrella with board-like or shutter-like propeller, above demerits can be overcome, even efficiency can be further enhanced somewhat, though implementation is complicated, however worthwhile.

Fig. 4 is an implementation with **4** board propellers working in quartet duplex mode.

Ideally speaking, when the propeller's thrust creates useful work, the planar wind board should be vertical to the sliding mast, so as to have maximal surface to tread air, but when retract, the same board shall be turned **90°** so as to reduce wind resistance.

Fig. 4: quartet propeller for aero-sedan



After the action of treading down air is completed, the **turn-90°-trigger** flanges in the

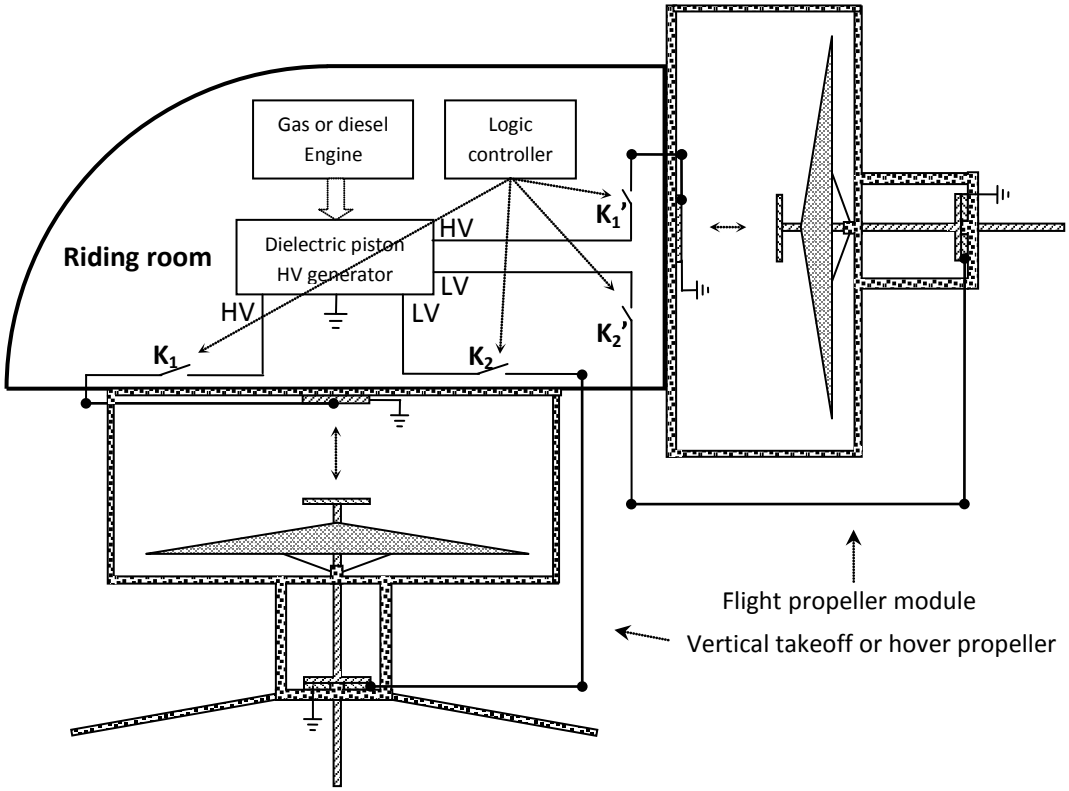
figure makes the board parallel to the mast, then ready to retract; and when the mast's top touches the coil launcher, before applying high voltage, the board should be turned vertical to mast, and this is done by switching on respective air blower valve solenoid that is connected to air compressor.

Although the air compressor and control solenoids need consume energy, however it is acceptable insignificant energy and worthwhile.

The big size of whole wind boards may motivate the replacement with **shutter-like propellers**, and such a variety is equivalent to slice the whole board into a plurality of small pieces that are collectively manipulated, so as to reduce flipping turn-around space, as well as to take advantage of less toggling energy.

The ugly height of pilothouse can be greatly beautified if shutter-like propellers are equipped, for example, if a flapping board ornithopter is **5** meters high, then the same payload ornithopter with shutter-like propellers may be less than **1** meter.

Fig. 5: vertical and horizontal double umbrella propellers model



Simple improvement on navigation performance

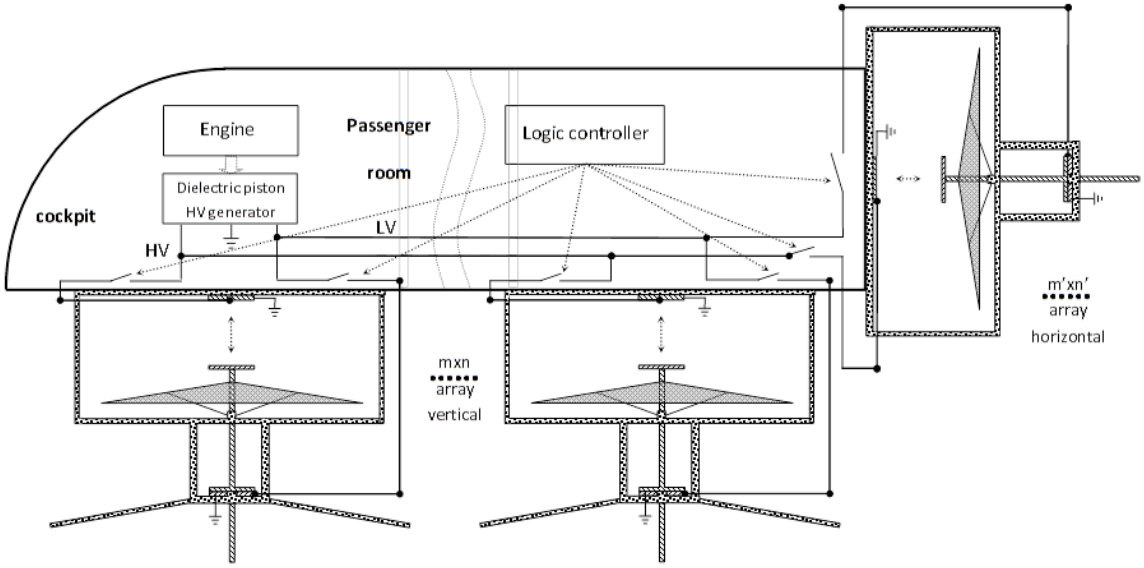
In all aforementioned cases, the navigation quadrant can be unnecessary if horizontal propulsion is governed independently by another similar propeller deployed along the horizontal direction, and then the vertical one only responds for the vertical climbing or landing or hovering, as illustrated in fig. **5**.

With proper separation of the left-right propellers plus independent arbitrary control for all four wind boards or shutters, the quartet propellers can even perform steering and reverse, though there is no need of reverse function and other mainstream steering means is always available.

Comprehensive Improvement by distributed propellers array

Fig. 6 shows a great plan that features independent vertical and horizontal propulsion systems that are deployed in array of **m*n** and **m'*n'** umbrella propellers respectively.

Fig. 6: Array of umbrella-like propellers for commercial aerial vehicle



Array deployment can optimize the entire geometry configuration, for example, if **10** square meter umbrella area is required, then for single umbrella solution, the umbrella height could be **2** meters, in contrast, if **10** umbrellas array with **1** square meter each, then it can better match the chassis shape, e.g. in **2*5** array, and the height could be about only **0.6** meters.

Extended application – ship propeller and fluid-AC-DC reciprocal pump

a. Marine application

Although only aerial propulsion emphasized hither, in fact, even marine vehicles can also adopt this new kind of propellers, just the pulse property is no longer unnecessary or the rising time of "pulse" should be intentionally adjusted to very slow elapse, because water body's density is far higher than air.

In this case, a dedicated reciprocal engine can be better than mechanic-electric-mechanic pulse power supply.

b. Pump application

It is well known that most electric motors can also be used as generators with minor modification, though efficiency could be very low.

This quartet propeller assembly can also be abstracted as a general model that can be shared by not only propellers but also future conceptual design of fluid pumps, as long as compact enclosed form factor and separator of channels are considered at least.

In this case, the static leaking of fluid may frustrate some applications if substantial modification is not done.

Reference

1. **Shutter-like fluid driven motor and tide power harvest system,** by Yanming Wei, 2017 Researchgate, DOI: 10.13140/RG.2.2.28522.72648 or viXra:1705.0030

2. **Dielectrodynamics and applications -- Part one Dielectric blade comb piston mechanic-electric bi-direction converter,** by Yanming Wei, viXra:1704.0386 or 2017 Researchgate, DOI: 10.13140/RG.2.2.29374.69448.