**Crowd Adaptive Mask (CAM)**

By
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Face masks are, would be & ought to be a priority in personal health care kits, least in present and till a while in future. Continuous discomfort from wearing breathing mask or respirator or alike is obvious. Fact remains that its functionality is accomplished only when other people are around. This causes an on-off effect in masking ; people when socially close to others pull it up, and when socially distant (relatively alone) pull it down or even remove and pocket it. Not only is it an inconvenienced option, it can be an erroneous habit (forgetting many times to wear when mandatory). And frequent tinkering of protective nose-mouth device by not-always sanitized hands can increase chances of infection spreading. Mileage gained from use of mask can be lost or even overtaken by harm caused in such cases. Polices find it tough to differentiate or penalize this variable masking trend. A social contradiction, viz. wearing or not wearing mask is transformed to a technical contradiction and solution outputted is an adaptive mask with holes of varying size. A mask with dual-structure needs to be designed and manufactured; mask with holes far-apart when one is alone & same mask with holes closer-by when one is in a crowd. A functionally and structurally adaptive mask.

Example lifted from airplane: If wings of plane are broadened, lift increases but drag increases too. If wings of plane are narrowed, lift decreases but drag decreases too. In this case, 'width of wing' is a physical characteristic (one of important dimensions) of airplane, while lift and drag are system properties (actually forces in aerodynamics). If we frame this challenge in without 'width of wing', we get this: if lift improves i.e. increases, drag worsens, i.e. increases; if lift degrades i.e. decreases, drag improves i.e. decreases. Little need to mention, that lift is a desired property while drag is an undesired one- reduction of latter is effectually betterment. We call this a **Technical Contradiction** or **TC**. In TC, improvement of one system property inevitably leads to worsening of another system property. The same challenge could have been stated in terms of wing span alone: wings of plane must possess large area and small area together. We call this a **Physical Contradiction** or **PC**, wherein one physical characteristic like mass, size, length, temperature must have 'dual' values simultaneously.

The aircraft designer finally came with (partially) retractable wings: separation on condition has occurred. During take-off and landing when lift is supreme and necessary under low speeds, flaps are opened. During cruise when high speed can easily provide lift and drag becomes a strong evil, they are withdrawn. So this PC is resolved without a compromise.



**Problem encountered with conventional face mask:**

A conventionally designed mask has a fixed pore size. The pore size of any protective equipment is the main physical characteristic. It functions to permit or prohibit passage of concerned pathogen. I am herein not comparing or debating the pore size of surgical face masks with personal protective gear or ordinary cloth coverings as mask or N95 respirator. The common point in all masks worn is their fixed pore size. There is however a discomfort in wearing masks all the time. When in crowd, it is absolutely

essential but when alone it can be removed off for a sigh of relief. But this is bad habit and cannot be encouraged. Also frequent removal and placement can cause too many hand touches and in fact can itself be a threat. Mask must be worn at all times when out!

What if a mask exists that changes it's pore size upon condition: bigger pore size when alone & smaller pore size when in crowd.

A Physical Contradiction PC thus exists and needs be resolved.

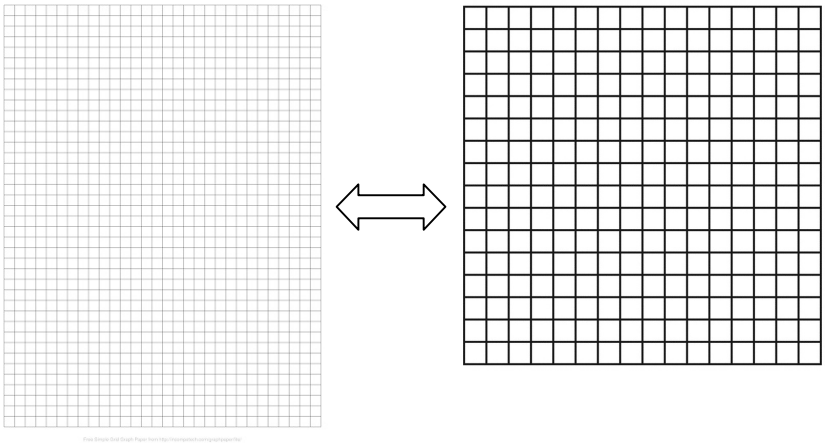
*If pore size is small, transmission of pathogen cannot occur but suffocation is felt*

*If pore size is large, transmission can occur, but suffocation isn't felt.*

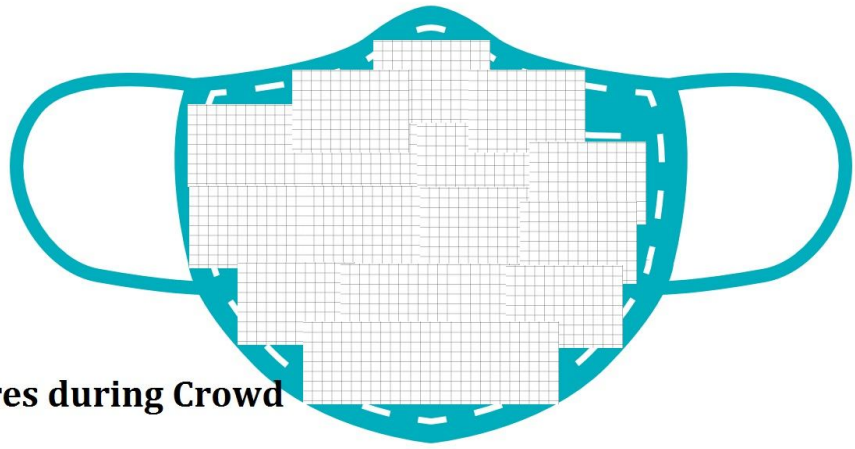
So pore size (a physical characteristic) must be small and large. Of course at different times only.

So, separation (separate pore sizes) upon condition is solution.

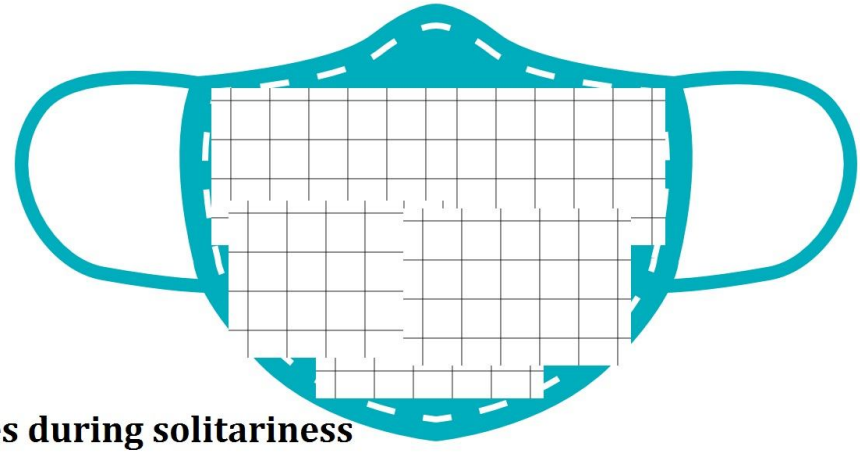
So, when near people, pores size should narrow. When away from people, pore size should widen.



small pore size in crowd  big pore size in solitariness



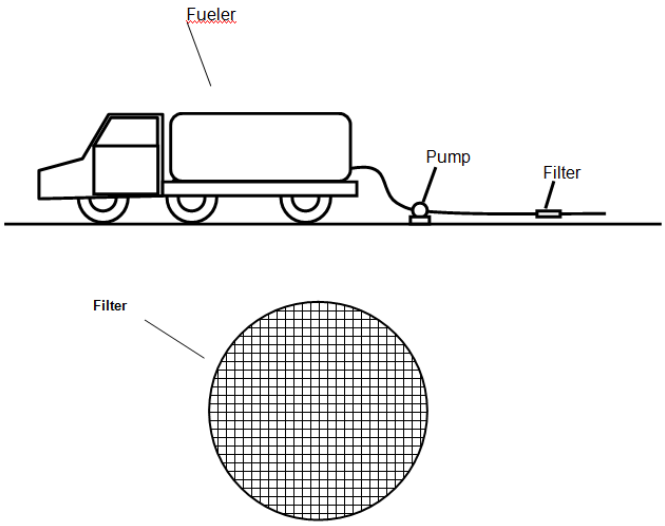
**Closed Pores during Crowd**



**Open Pores during solitariness**

1. A close-by problem

**Filter used for refining of aviation fuel at planes refueling station**. Refueling wagon moves close to airplane. Pollutants should be extracted right here - on the last stage of transport of kerosene. In order to catch fine (as much as possible) fractions, cells of the grid of filter should be small. However with fine filter, hydraulic resistance of system sharply grows, leading to dropping of efficiency. If dimensions of the cells of grid are enlarged for the reduction of hydraulic resistance, large fractions of pollution move through.




A **Technical Contradiction** or **TC** can be framed in two ways.

Cells should be small, but the resistance should be low at the same time (and fuel input should be high enough);

*or*

Cells should be larger, but at the same time they should delay even fine fractions.

So, solution can go along either of two directions. Small openings and all dirt is stopped, but liquid flows with resistance. Or, large openings and there is no resistance almost, but the particles of dirt do not pass through openings.

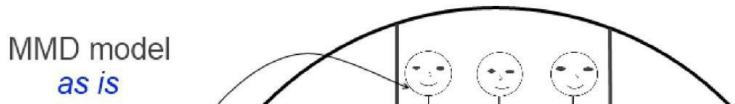
**As to the first direction:** it's necessary to activate openings in grid. They have to delay/arrest pollutants only but also push fluid through itself. Ultrasound oscillations are applied. Capillary effect aids and accelerates fluid as required.

**As to second direction:** it's necessary to activate particles, in order that they themselves not pass through larger openings in grid. The application of electrostatic field on grid causes electric charging of particles. As their coagulation grows, their mutual repulsion causes them to cross grid faster.

As said in problem, solution can go in either of two directions of TC resolution.

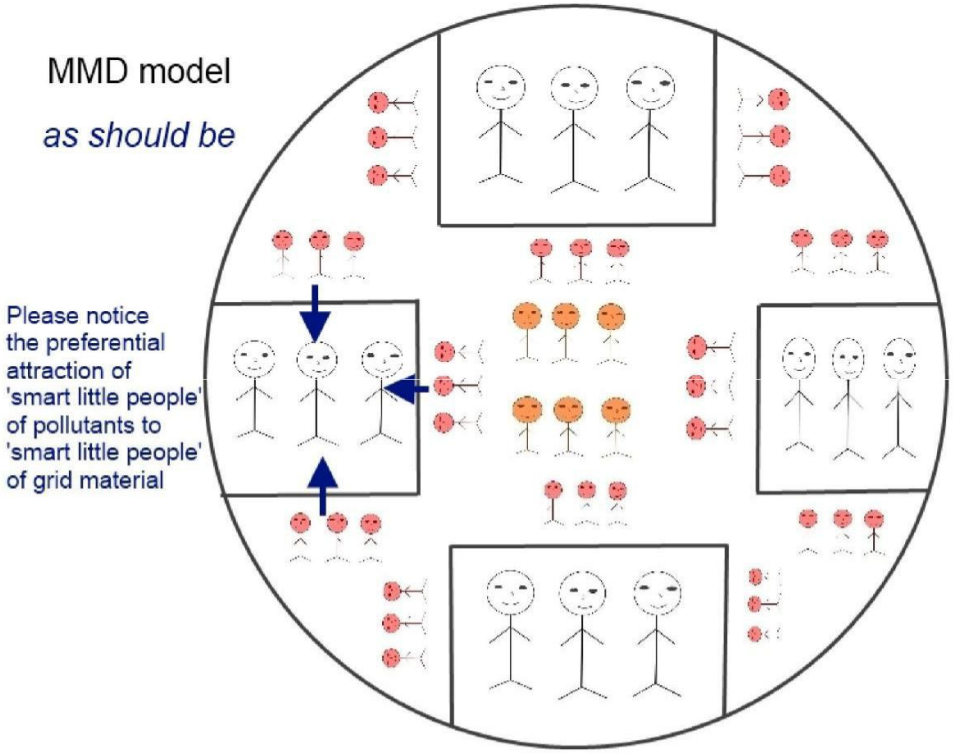
**We use larger cells** but still both system properties are improved– filtration flow rate is high & small fractions of pollutants are caught.

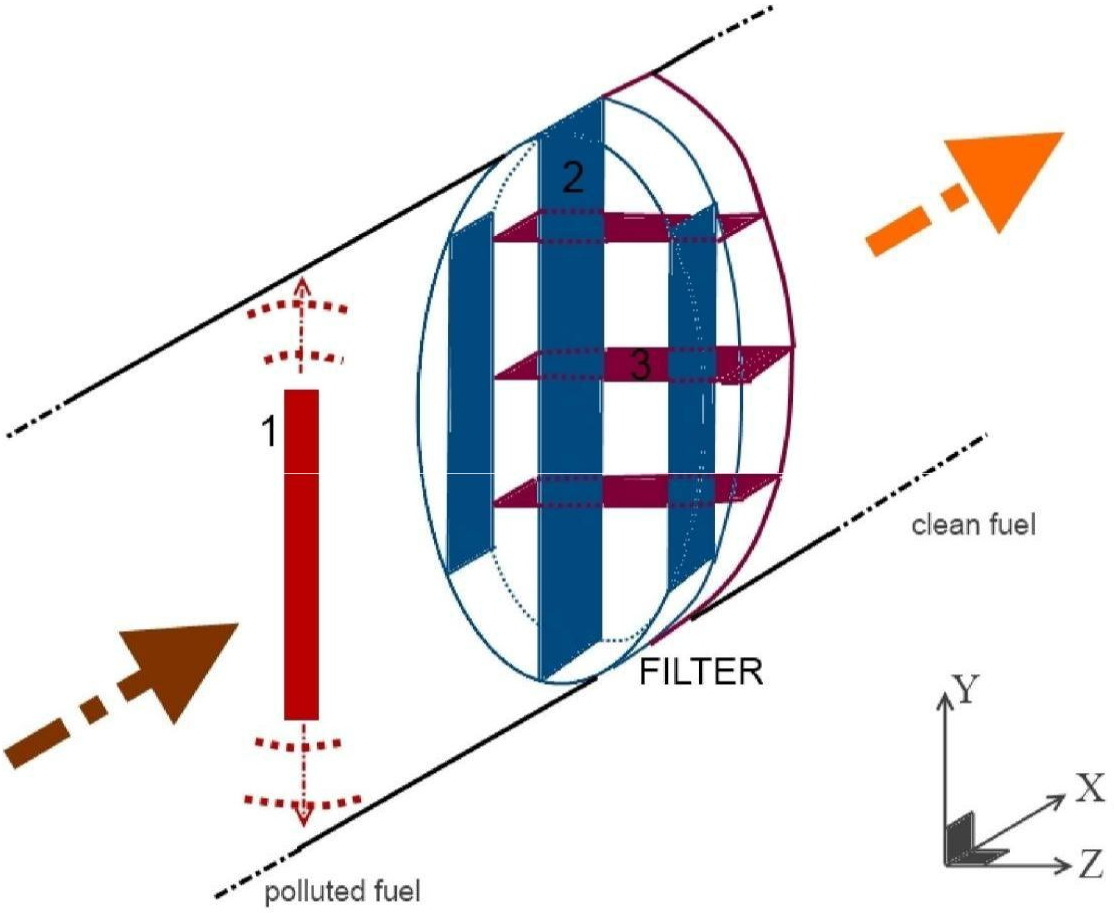
Please see the use of Model with Miniature Dwarfs (MMD). Figure below shows 'as is' state.



Note that larger grid is unable to ‘catch’ smaller pollutants. Flow rate is good but TC remains unresolved. Smart little people of grid (black) allow smart little people of fuel (yellow) & smart little people of pollutants (pink) to pass through. Unless pink people are big enough, black people cannot stop them from passing through. So it is all a question of size! Static black people can only prevent dynamic (moving) pink people if they are big enough. Of course, yellow people are smaller (fluid molecular clusters) & they pass through comfortably. Here MMD model displays sieve function at scaled down level.

What to do? Somehow, black people MUST attract pink people while not attracting yellow people. Thus preferential field is suggested. See MMD diagram below.






Toolkit of Innovative Design suggest usage of Effects : Substances : Separate : Electret Filter. Electret is a source of permanent electric field for a long time without external power supply. Just like a permanent magnet is a source of magnetic field without external power. Grid is made of electrets fibers. Fiber has some depth or thickness in direction of fluid flow also. This enhances area of contact of fuel (+pollutant) with grid with even larger cells. Figure below shows this.

On MMD level, this happens. As mixture of pink & yellow dwarfs flows through black dwarfs, black dwarfs (permanently aligned electric dipoles) induce charge in pink dwarfs and attract them.

The only problem with this solution would be cleaning clogged filter. Because, black dwarfs won't release pink dwarfs even during filter removal and cleaning.

**Realized solution that was implemented is:** filter consists of bundles made from magnetostrictive material, like baked nickel wires. Alternating magnetic field excites ultrasonic oscillations into the capillary structure of filter. The influence of these oscillations leads to significant increase in capillary

pressure which effectively decreases the dynamic hydraulic resistance of the filter. The degree of refining of liquid and speed of passage are connected with the tension (voltage) value on the winding. At some value of voltage, the pump is generally is turned off, because filter itself under the action of ultrasonic becomes a pump with low pressure and adjusted efficiency. A constant filtered volume per unit time is attained.

2. Another close-by problem:

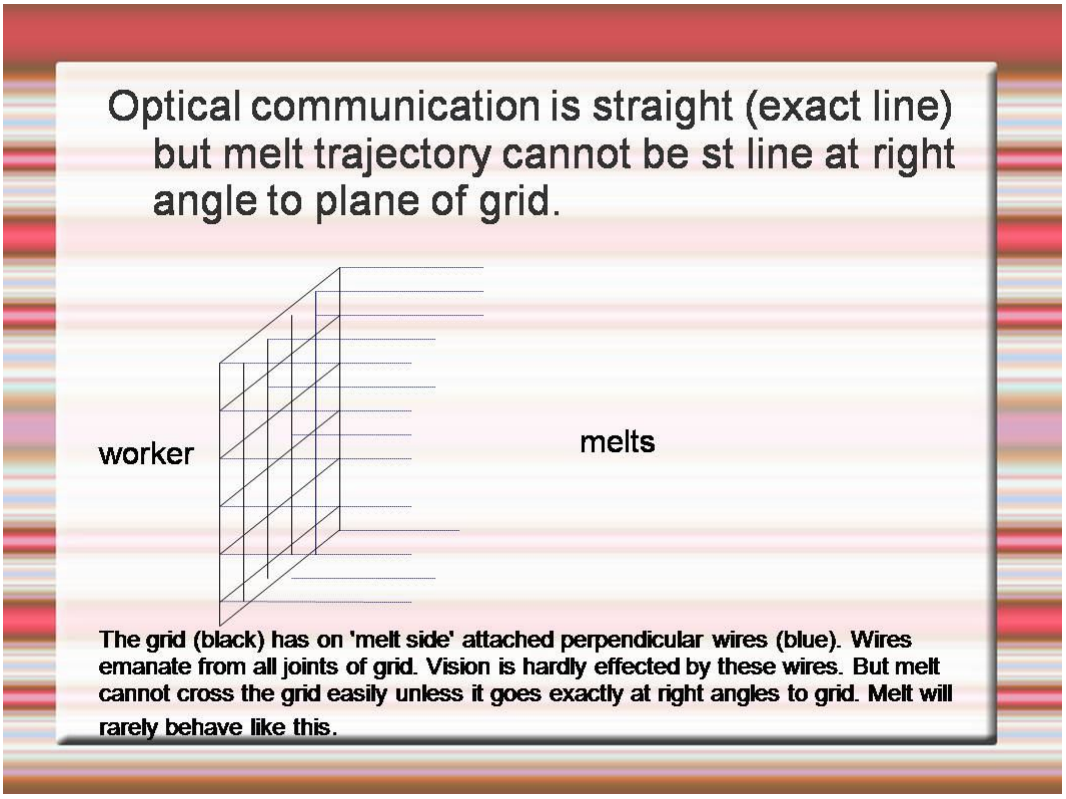
**The operator of the melting device to produce special refractory melts** should see the manipulator well. Everything: capture of scoop with melt, line of crucibles, where melt be poured into. That's why he sits very close and he's got to be protected from hot metal sprays. People tried to use glass and many other materials, but nothing suited. They came to conclusion that only way of protection was a wire grid of the same metal. But they faced a contradiction:

To see well, holes of the grid should be large (otherwise there should be no grid);

For good protection from metal sprays, there should be small holes (smaller than sprays).

The cells of grid should be small, in order well to defend eyes (face) of operator, and the cells of grid should be larger, in order to see without obstacles.

**Physical Contradiction, PC**: Cells should be simultaneously small-large.



Final Technical Solution adopted in industry: To vibrate grid in the planes perpendicular to axis of sight. The frequency of oscillations is about 25 Hz (the grid becomes invisible). For the small cells the amplitude is low enough, for larger cells the amplitude should be close to ½ of cells size (in order to prevent the way of flying metal drops). In order words, grid of any size can be made and a commensurate vibration can be applied.

**Returning to mask problem:** Is a simple stretchable material suitable? How will it be stretched /relaxed? Will it be automatic or manual? Will it cause discomfort as forces act on facial structure. How many cycles can it endure? What be its fatigue strength?

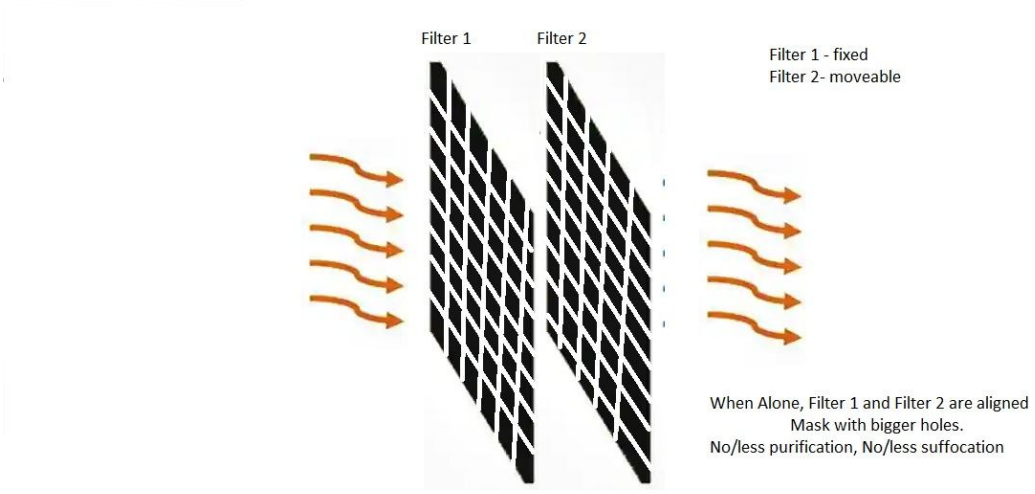
Can we use other controlling fields like electromagnetic on masks having ferromagnetic particles embedded in fabric? Optical fields?

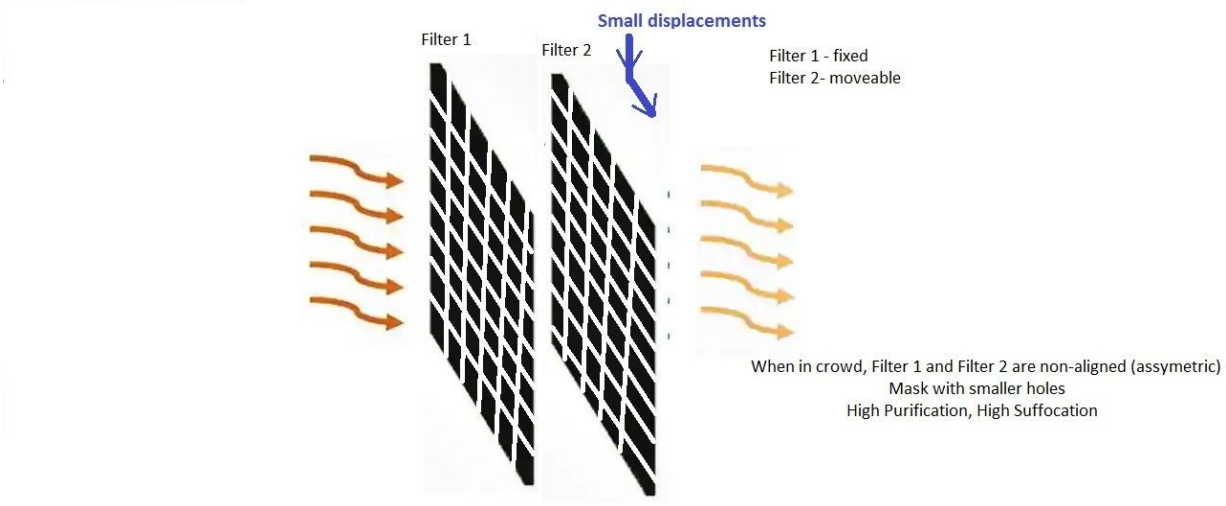
Technical Solution 1: Dynamization trend: Use two identical, parallel air-filters both with larger holes, whose relative position adjustable.

Two states can exist:

When alone, filters aligned: mask with effectively larger holes

When in crowd, filters non-aligned: mask with effective smaller holes



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