TECHNOFEST AVIATION, SPACE AND TECHNOLOGY FESTIVAL

TECHNOLOGY CONTEST FOR HUMANITY
PROJECT DETAIL REPORT

PROJECT CATEGORY: Social Innovation

PROJECT NAME:
WinDew - Vertical Blind

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Application ID:
69568

TEAM LEVEL: University-Graduate

Contents

1. Project Summary (Project Description)

Clean water shortage is a common problem in most places, regardless of its seasons. We offer a way to battle this problem through a fog harvesting system that we combine with window blind, called WinDew. This product itself has two main functions as fog harvester and window blind. Later when the fog is harvested, it will provide clean water output that can be used for daily needs. WinDew also can be used as window blind during the daytime. Despite most window blinds are placed in the building, WinDew is placed in front of the window, so this robust design is needed to withstand environmental weather changes

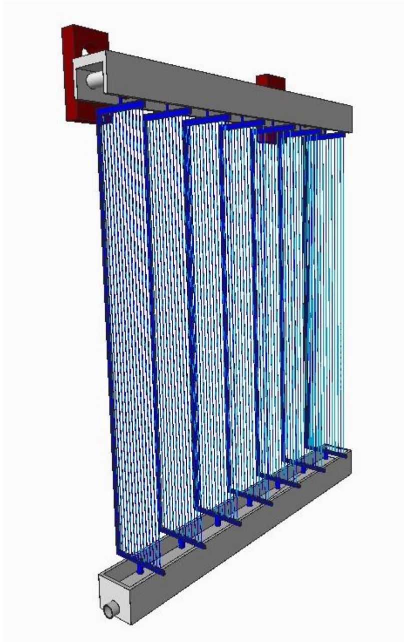

Fig. 1. Complete 3D Rendering of WinDew Estimated Design

2. Problem/Issue

Clean water stock is vital to daily survival either in urban or rural areas. Ensuring it will help to overcome water scarcity. Most people rely on tap water to obtain water, but tap water is not always available throughout every season in some developing countries. A functional and relatively cheap water collector is vital for daily usage throughout water shortage.

Water collection methods vary from time to time. From the conventional ways such as using rivers or lakes as main water supply, until we can extract water from thin air. Atmospheric Water Generator (AWG) machines such as the Watergen mainly form drinkable water from air humidity. It will always supply water as long as the humidity is enough, but its price is relatively high for most consumers in developing countries. For example, the Watergen Genny costs about $2,500 per unit. It generates about 8 gallons (±30 litres) of drinkable water per day. So the water cost is calculated around $83/litre (not including electricity and maintenance cost). Fog collection using fog net/fence such as the CloudFisher is one of the other ways to obtain clean water. It is simple, doesn't need electricity, and is pretty cheap relative to Watergen's water cost per litre. A completely built CloudFisher can produce up to 528 litre of clean water per fog day. With per unit cost at $7,500, the water cost is around $14/litre. Since it doesn't need electricity and has low maintenance problems, this has proved that water produced using a fog collection system is far cheaper than AWG (the costs above are calculated for one time usage in total of 1 day effective production). However, it uses a quite large ground area to generate water. This limits the usage only in rural areas where there are not too many buildings in place.

3. Solution

The problems above stated that a simple, low cost, relatively small size, and effective water collection system is needed. WinDew is just the best item yet to solve this problem. With its innovatively unique fiber, it is hoped that it could produce roughly the same amount or even exceed that of the CloudFisher water collection rate (WCR) at 22 litre/m^{2}day or about 0.916 litre/m^{2}hour (numbers are given with respect to effective fog day or 24 hour). If these numbers are gained, then it will surely help to produce water for daily usage.

WinDew works as simple as a regular fog harvester, by capturing fog that passes it and then the water streams to a collective manifold. Also it is necessary to make it smaller to be able to fit in urban areas. This inspired us to integrate this water collection system to the building's window blind arrangements. It will enable water production, and area usage efficiently in urban cities.

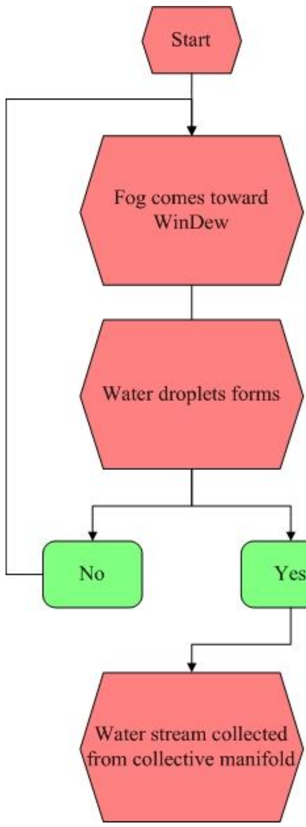

Fig. 2. Expected Work Schematics of A Fully Working WinDew

4. Method

WinDew works solely based on liquid to solid adhesive physics properties, since most fog contains tiny yet microscopic water droplets. These hydrophobic and hydrophilic properties significantly increase WCR because of the variance between surface energy and water contact angle combined.

Since there is yet to be any study relating to epoxy resin WCR for fog harvesting, we intended to make a smaller sized prototype to calculate the WCR results. The experiment will be held in a controlled environment with the fog velocity and fog density as the independent variable. This prototype has 5 pieces $width \times height$: 6x30 cm of slats that forms a 30x30 cm of full coverage area. Our team predicted that the methods used could produce up to or even surpass 0.90 litre/m²hour.

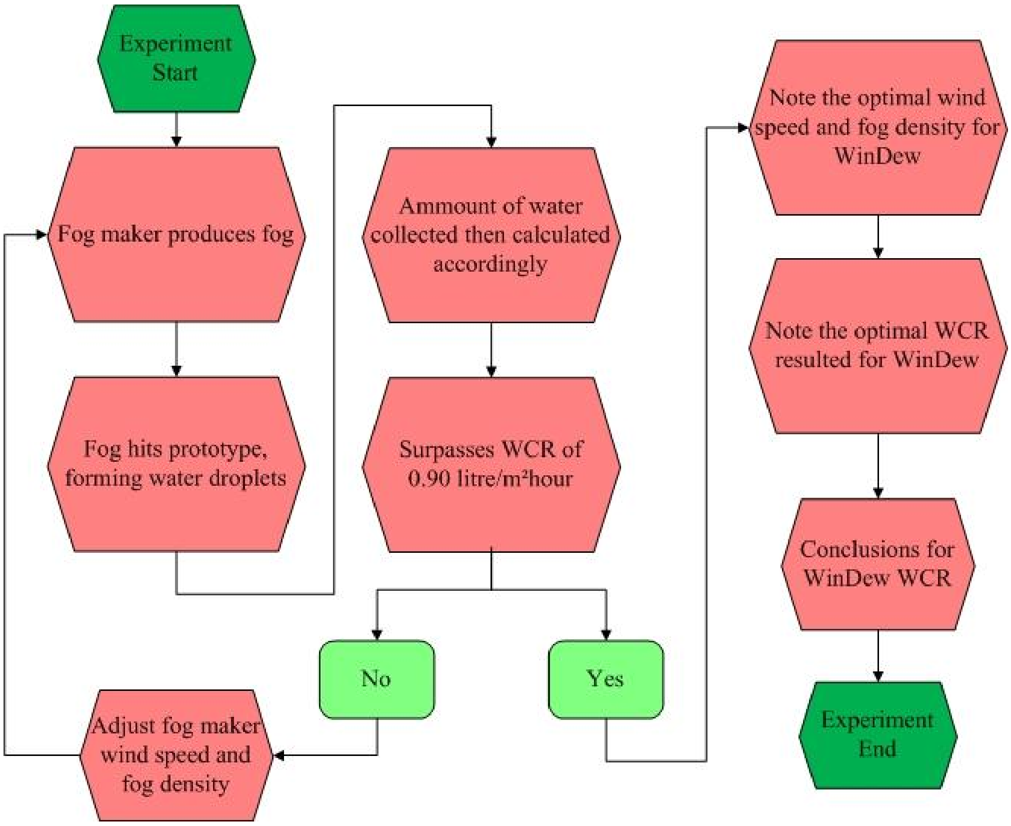

Fig. 3. Prototype Experiment Work Flow

5. Innovative Aspect

In order for WinDew to work efficiently in capturing water vapor, we created a unique fiber/wire part that has hydrophilic and hydrophobic properties. The reason we use these two hydra-properties is so that we can increase water vapor capture ability. These unique wetting patterns are found in Namib-Desert beetle, where its body surface has papilla patterns of hydrophilic and hydrophobic characteristics to maximize water capture efficiency from fog

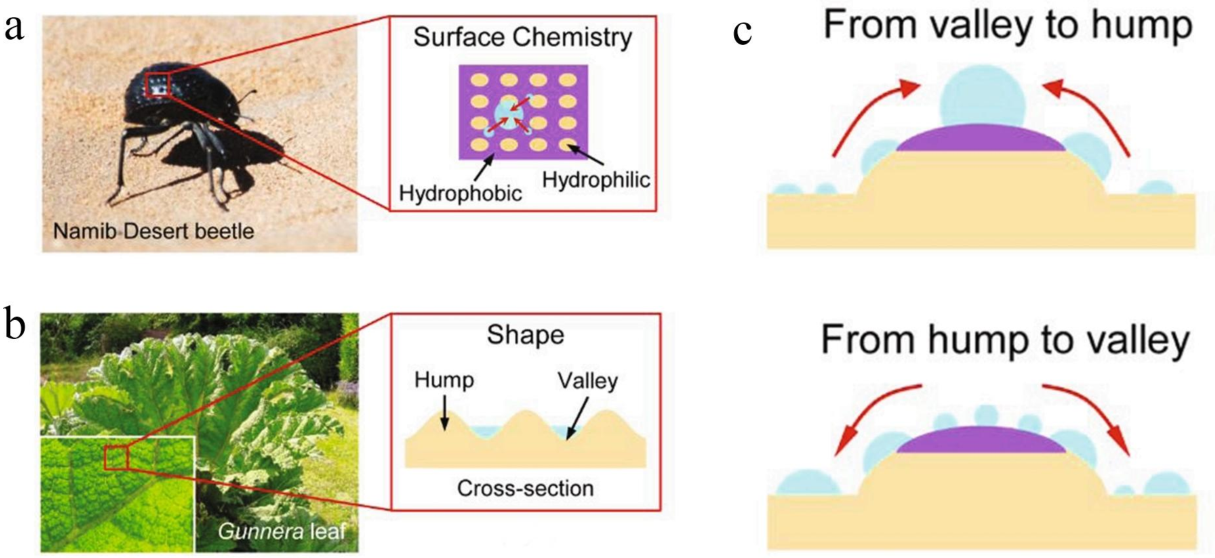

Fig. 4. Applied Bio-Inspired Design. (a) Namib-Desert beetle hydrophilic and hydrophobic surface properties. (b) Gunnera leaf asymmetric contour of humps and valleys. (c) Valley to hump and hump to valley water transport schematics based on different surface wettability.

A single fiber consists of 2 stainless steel 304 (SS304) each 1 mm and 0.8 mm in diameter wire. The 0.8 mm SS304 wire acts as the main structure of the fiber, and is coated with epoxy resin respectively so that the final wire diameter is expected to be 1 mm in total. This coating creates hydrophobic characteristics due to epoxy resin surface properties. Meanwhile, the 1 mm SS304 wire acts as wrapping around the main wire. The wrapping wire itself has hydrophilic properties. We intend to mimic the Gunnera leaf's humps and valleys pattern to enhance fog harvesting ability. The fiber uses valley to hump water transport to enable droplet stacking so that the formed water droplets can go straight down to manifold. This minimized the quantity of clogged water drops that can evaporate back to air, reducing WCR.

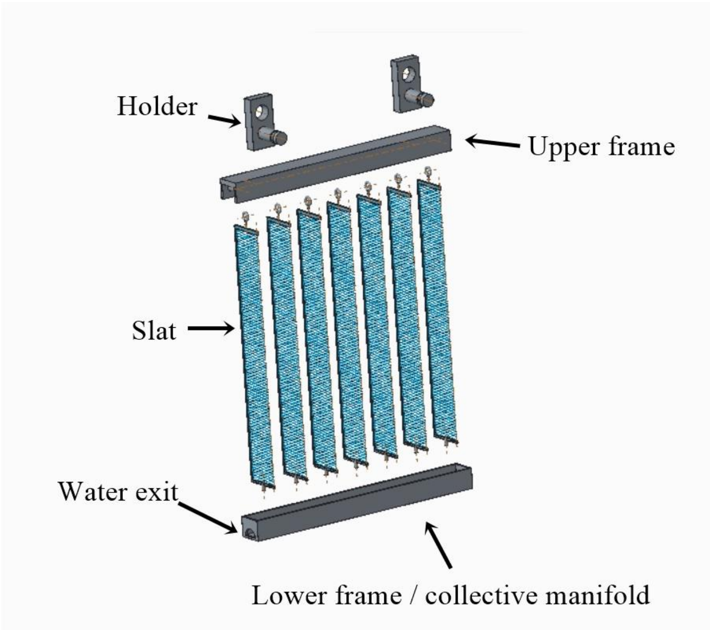

Fig. 5. Exploded View of WinDew

The 2 wires combined accordingly to form a fiber component as seen in figure … . The wrapping wire gives the humpy terrain over the valley (the main wire). With the valley to hump water transport, stacked water droplets should be streaming down easily via the main wire. These fibers are then placed vertically one by one, forming a slat structure. Each slat contains two fiber layers, with each fiber layer containing 2 mm wide of fiber (1 mm + 1 mm) and 1 mm wide of empty space continuing pattern. Which results in 3 mm wide of fiber + empty space (gap) in total. The back layer of fiber is placed in alternating parallel with the front layer with a distance of 1 mm. This alternating layer results in a bigger area covered by the fiber, and fulfills the requirements of blocking sunlight that is needed for window blind.

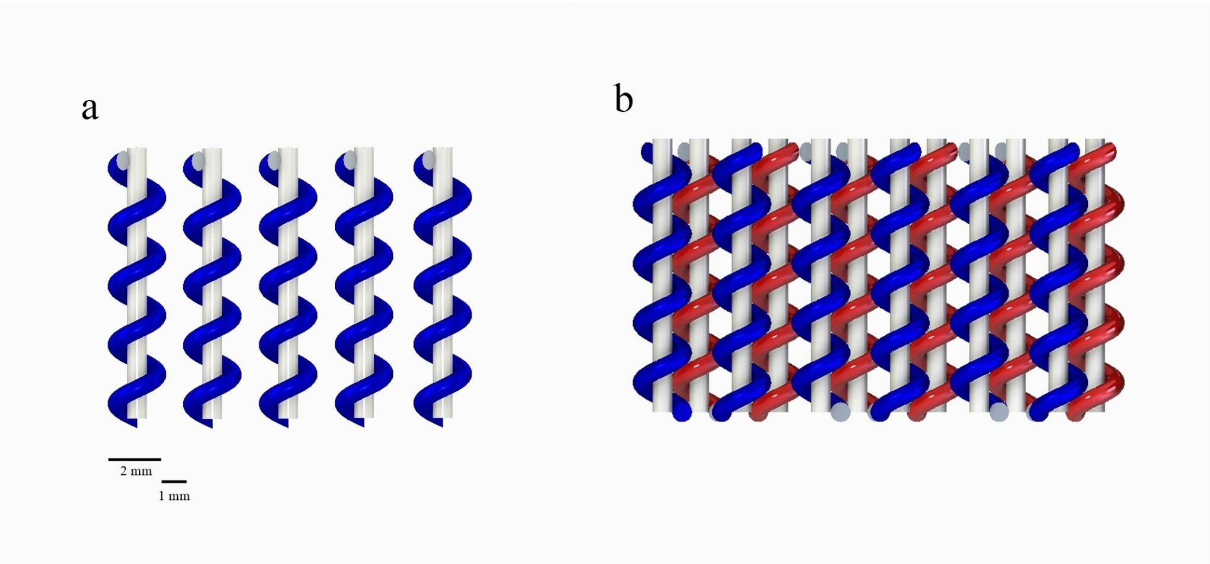

Fig. 6. (a) Single layer fiber that consists of 2 mm width of fiber and 1 mm width of gap. (b) Double layer of fiber with the back layer alternating with its front layer

Similar products like the CloudFisher uses German FogHa-Tin mesh, and is used only for fog collection. WinDew fiber composition has unique hydra-properties, and is also used as window blind to shade sunlight. Since the WinDew is built relatively in small size so it can fit to buildings window size, it uses much smaller ground area.

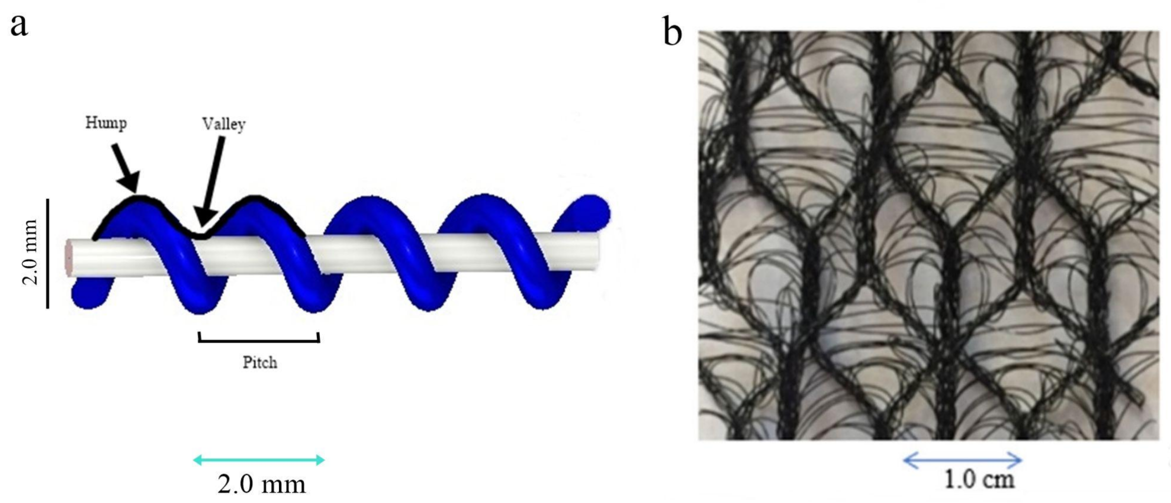

Fig. 7. Fiber Structure Comparison. (a) WinDew single fiber thread. (b) German FogHa-Tin mesh used on CloudFisher

6. Applicability

A building is more likely to have at least a window in place for either lighting or sight seeing. So the WinDew is surely to have a pretty large consumer in urban areas. The downside of WinDew is that if not too much fog or even no fog are formed, this device may not or will not produce water as expected.

Implementation of the project is highly dependent on window building size. Since it will vary from small to large, we will gather as much information needed from consumers before designing the proper WinDew final size. We will also try to collaborate with some vertical window blind manufacturers in effort to make more improvements to this system. It is possible that later in the future, only the slats that are needed to be changed in order for existing vertical window blind to produce water from fog.

7. Estimated Cost and Project Time Planning

Time Planning

No.	Project	Date
1	Search for tools and materials	14 - 18 July

2	Make full design and size for WinDew - Blind	14 - 16 July
3	Make upper rail WinDew - Blind	16 - 18 July
4	Make cable nets	18 - 22 July
5	Make holder and upper frame	18 - 24 July
6	Make lower PVC	24 - 26 July
7	Make slats for WinDew - Blind	26 - 28 July
8	İnstall cables net on slats WinDew - Blind	28 - 2 August
9	Combine slats on the upper rail of WinDew - Blind and combine the lower PVC	2 August - 8 August
10	make hole on one side of the bottom shelter	9 August
11	Testing prototype WinDew - Blind	10 August - 15 August
12	Prototype completed	15 August

Estimated Budget

Items	Quantity	Unit Price (USD)	Total Price (USD)
Full Set Frame Head Rail	2 pcs	45.48	90.96
Stainless Steel Wire 0,8mm	4 lb	27.99	55.98
Stainless Steel Wire 1mm	4 lb	27.99	55.98
Epoxy Resin fluid	2 pcs	39.99	79.98
PVC Hollow Rectangular Bar	4 pcs	23.03	92.12
Square Tubing Plug Cap	4 pcs	6.99	27.96
Custom Upper Frame and Lower Frame	10 part	3.7	37

Wrapping Cable Machine	2 Mchn	34.47	68.94
Acrylic Latex Brush on Paint	2 can	19.99	39.98
Fog Machine	1 Mchn	68,94	68.94
		Total USD	617.84

8. Target Audience of the Project Idea (Users)

This product is best suited for foggy urban areas, such as San Francisco, Ankara, and many more. But also supposed to help overcome water scarcity in most developing countries. Thick fog usually forms in the west coast of Namibia, Swakopmund. With many of its buildings has windows installed, it is possible for WinDew to operate in such city

9. Risks

Consequences	Fail Probability			
	0-25%	25-50%	50-75%	75-100%
Small disturbance	Stain occurance	Railing system damaged	Water path clogging by debris	-
Mild disturbance	Broken fiber	-		-
Great disturbance	Broken frame	-	Environmental change	Environmental change
Product will not function	Fog does not form	Fog does not form	Fog does not form	Fog does not form

WinDew water production per day will mainly be affected by the results of WCR from prototype experiment, and fog quantity during collection. If the WCR results do not equal or exceed the WCR target, it is possible to use other similar hydrophobic coating in order to raise WCR results.

10. Resources

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L. Zhong et al. (2018). Journal of Colloid and Interface Science. *Understanding how surface chemistry and topography enhance fog harvesting based on the superwetting surface with patterned hemispherical bulges.*

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Y. Fu et al. (2010) Colloids and Surfaces A: Physicochemical and Engineering Aspects *Wetting characteristics of epoxy resins modified by graphitic nanofibers with different functional groups*