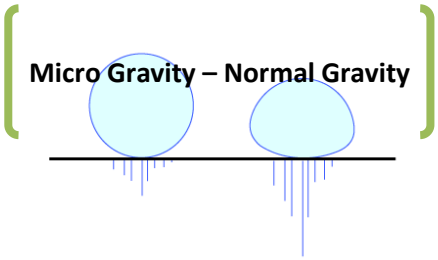
Quick report on
A Study of Water Drops Spreading in Textiles under Microgravity Condition

Abstract

From the previous studying about a movement of the macro fluid in textiles surface, the experiment are mostly considering in the normal gravity conditions and the other factors would be participate in the result of the experiment. But under a microgravity condition, we can create an experiment to compare the result with the normal gravity's to eliminate the gravitational factors such as mass load, hydrostatic pressure and the other gravity-causes factors.

By relying on an inspecting of propagation, spreading, movement and absorption of the water on the textiles surface tracking by the high speed video camera, we can do an experiment to test the textiles properties such as capillarity or the other inter-molecule interaction in the normal gravity and in the microgravity also. The experiment setup will drop the water onto the fabric surface samples and track the information by using the high speed video camera and Diode laser point to the water drop to makes the scattering lights for distinguish between water surface and the black background.



The result will be analyze and conclude to the difference of the inter-molecular interaction in the different substrate. And it also provides information about the result of the microgravity condition that effected to the water drops and the water-textiles physics model. And it should be a fundamental model for the ongoing textiles in the space development.

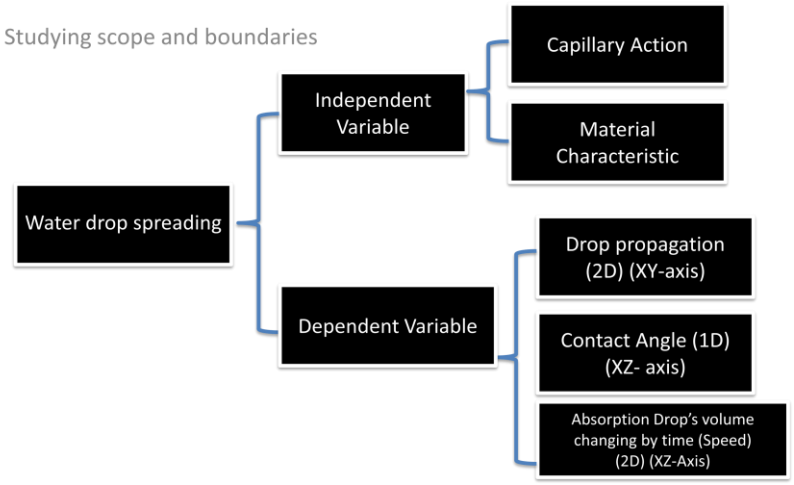
Objective

1. To make better understandings in the behavior of water drops spreading in textiles under microgravity condition.
2. The result implies fluid transport pattern under microgravity which shows the role playing of gravitation in water seeping.
3. To study the pattern of water drops spreading in textiles under microgravity condition.
4. The knowledge from the study can be applied to some space technologies such as the design of fluid transport controlling system for experimental apparatus, space textiles technology, etc.
5. To compare the water uptake of textiles in difference gravity condition.
6. Get a great opportunity to improve research skill and experience.

Experiment members

- Wares Chancharoen [experiment conductor]
- Jakrapop Wongwiwat [onboard experimenter]
- Wasin Tuchinda [onboard experimenter]
- Pongsakorn Polchankajorn [technology support and post-processing]

Procedure and set-up



Strategy and Experiment

- Technical Analysis

The analysis is based on videos we recorded by two of camcorders. One for the spreading tracking (specimen plane) and one for contact angle tracking which stays perpendicular to the specimen plane. Videos from these two camcorders will be prepared in our own image processing software and interpret into the numerical data in order to analysis.

Experimental instructions

Onground and Onboard instructions

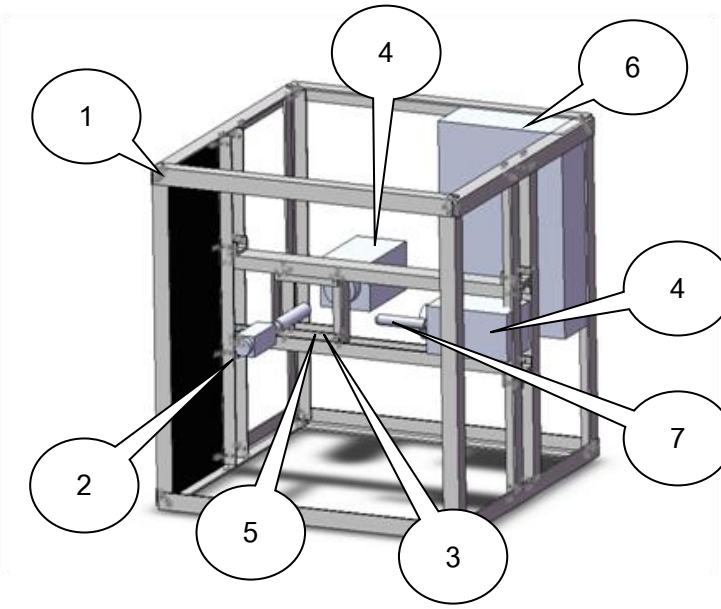
1. Making the frame for hold two high speed video cameras, nozzle and textiles fixtures.
2. Put the textiles into textile fixtures.
3. Set up nozzle with the aluminum frame and measure a position between nozzle and textiles.
4. Inject liquid from nozzle.
5. The data is collected by a high speed video camera for analysis.

Method and Analysis

1. Drop the water to the textiles until saturated point of water in textiles. (Specify the environment condition such as temperature, pressure and gravitation.)
2. Use the image processing technique to track the spreading of water drop and contact angles in numerical format into spreadsheets.

3. Compare the results of the reference on board with the results of the reference on earth (normal gravity) according to these criterions.
    a. Differentiations in **range of spreading** between each gravitational situations and specimens.
    b. Differentiations in **speed of spreading** between each gravitational situations and specimens.
    c. Differentiations in contact angle (absorption rate) changing speed of the drop between each gravitational situations and specimens.

Experiment Setup



Component:

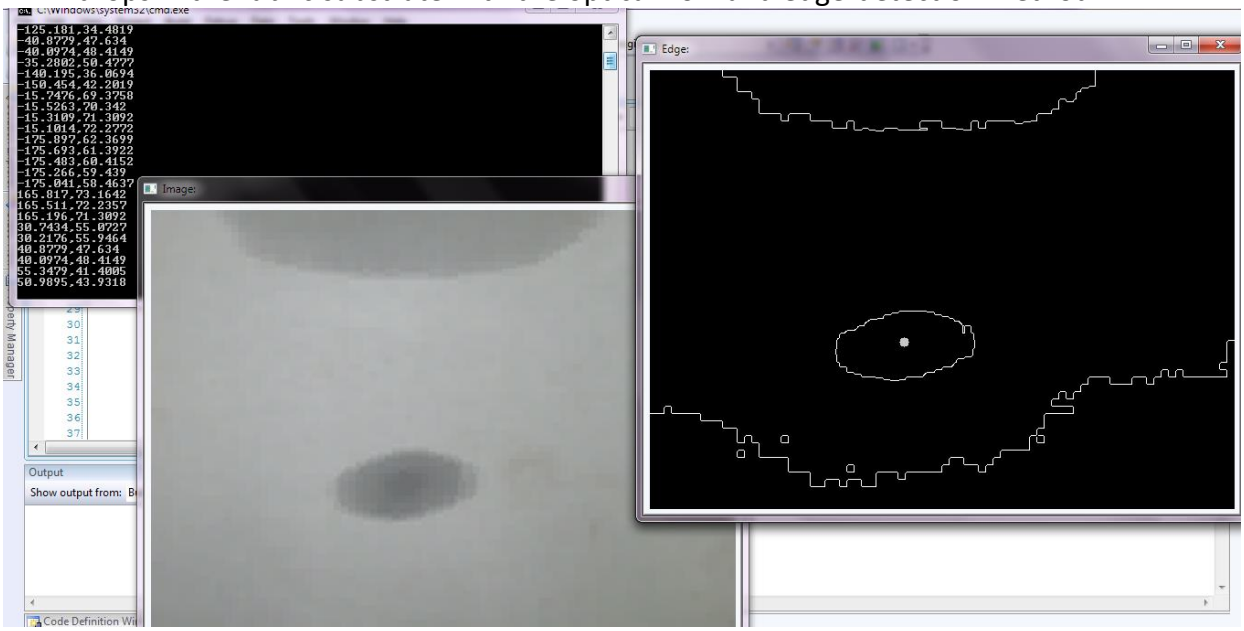
1. Aluminium frame
2. Nozzle & Syringe **
3. Textiles (size 10 × 10 cm)
4. High speed video camera
5. Textiles fixtures (size 10 × 10 cm)
6. Microcontroller and accelerometer
7. Diode laser (battery build in)
8. Leakage control box

** The bottom of syringe part must be seal for block the water.

Data Collection and Analysis

1. **Water drop's propagation tracking**

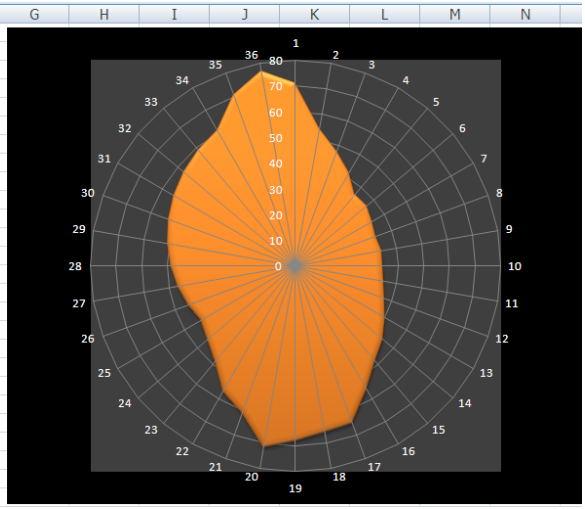
    By using the computer image processing, we can tracking the propagation of drops in the fabric substrate with the optical flow and edge-detection method.



(This picture is from our image processing program that turns raw image from digital camera into the polar co-ordinate information.)

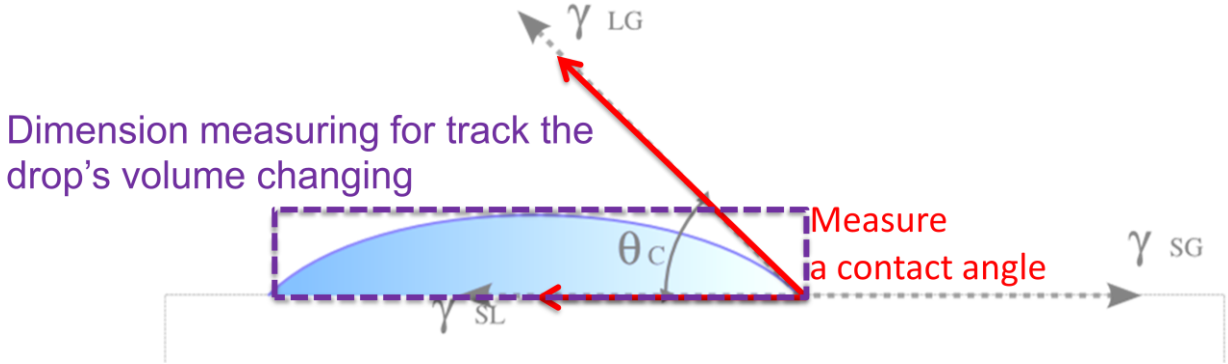
Since we have image information of drop's propagation in 2D-plane, therefore we'll evaluate the distance, velocities, and acceleration of propagation by numerical method.

	A	B	C	D	E	F
1	degree/frame	208	238	268	298	328
2	-180	70.827	70.8635	83.4511	94.4758	105.537
3	-170	54.0695	58.3828	65.5771	67.032	105.537
4	-160	47.2112	54.432	55.9046	56.5224	60.0508
5	-150	41.7779	43.4469	48.219	52.5371	51.8025
6	-140	36.0809	40.9088	44.648	45.8174	47.3536
7	-130	36.2508	40.155	41.0805	42.3127	44.7055
8	-120	34.5205	38.0903	38.5655	40.6916	40.7239
9	-110	33.3436	37.2805	39.3506	39.3506	40.3871
10	-100	34.1598	37.174	39.1823	39.1823	42.1942
11	-90	34.089	37.0961	39.1002	42.0907	42.1057
12	-80	34.9843	38.4625	42.5141	43.2143	43.2143
13	-70	36.9827	41.3319	43.9391	45.6802	45.6802
14	-60	40.4077	43.7846	45.9253	47.6899	48.7271
15	-50	44.5843	46.6963	51.3426	54.0441	55.3946
16	-40	48.4566	54.9857	60.6099	63.0722	64.6879
17	-30	55.5935	63.7873	69.551	71.4602	74.1555
18	-20	65.0755	72.4307	79.4644	79.4644	79.4644
19	-10	65.6818	135.811	136.678	87.8912	87.8912
20	0	68.0703	79.1774	86.9727	88.0077	88.0077
21	10	71.6121	75.7743	78.6309	84.3922	84.3922
22	20	60.7757	70.6654	75.3075	76.5497	76.8075
23	30	56.3212	58.4061	63.977	66.7498	66.7498
24	40	48.5165	52.9525	54.9857	56.604	56.604
25	50	44.5843	47.8921	52.3355	67.6283	52.1943
26	60	42.3469	46.0197	62.8026	81.1539	62.6332



(This picture shows the numerical analysis by plotting the polar co-ordinate information in the spreadsheet.)

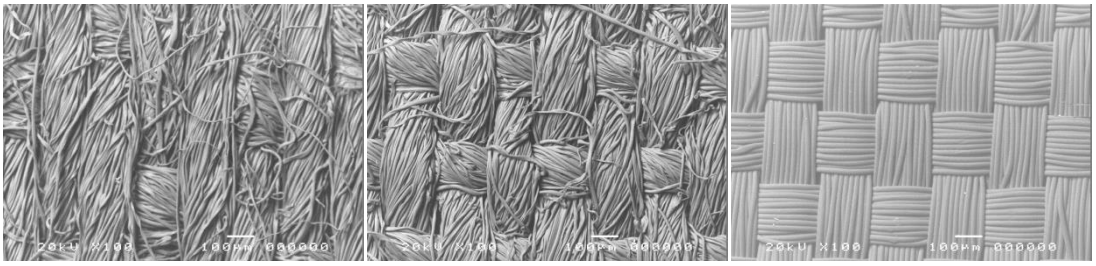
2. Contact Angle changing speed (Absorption rate)



Because the side camera was designed to tracks the side view of the drops. Therefore we can evaluate a contact angle of the drop that change by the wetting of the surfaces. Or even the volumes of the drop that changes by the times that we can calculate back to the rate of water-uptaking of the surfaces.

Specimens

1. Bleached and powder washed 100% cotton
2. Fat bleached 100% Fabricated Rayon
3. Satin (Surface-modified cotton with acetate treatment)
4. Artificial fabricated Nylon
5. 100% Natural Silk
6. 100% Natural Silk with modified surface (Hydrophobic coating)



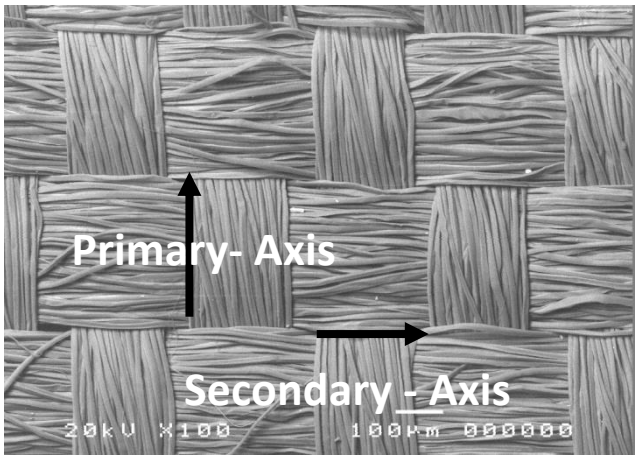
(Example of SEM images of specimen no.3,1,4 by order)

Result and Discussion

For now, the result needs to be processed by the image processing technique in order to get the numerical analysis of observing parameters such as spreading or contact angle that we've mentioned above.

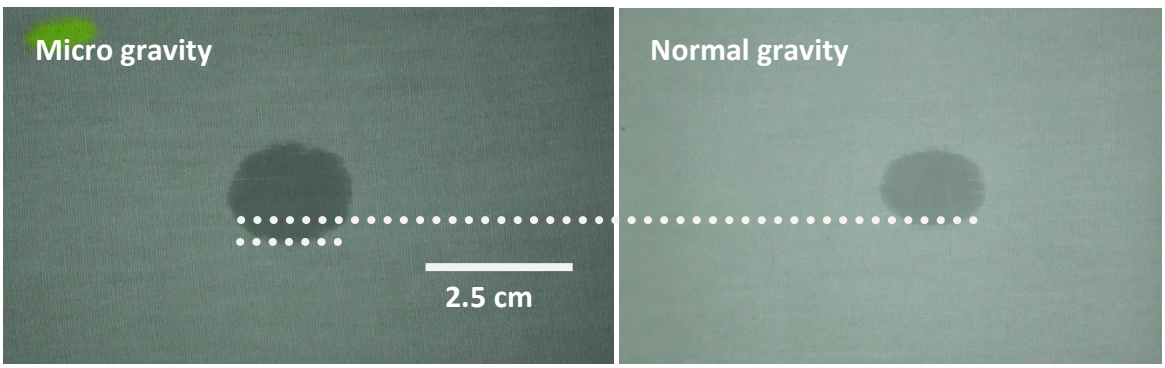
Fortunately, our result videos obviously show the differences in spreading and wetting speed that we can see it by naked eye.

First, the speed of spreading and changing of the wetting is quite slower when the dropping conducts in the microgravity



Second, from our studies of water spreading in normal gravity, structural differences in each axis of textiles cause the difference of capillary pressure in each axis. Because of the fabrication process, primary and secondary axes have a different width hence it directly affects to the capillary pressure and spreading speed.

Surprisingly, the microgravity situation gave us interesting results, the difference in speed of wetting in each axis are less than under normal gravity in every specimens.



Remarks: Our hypothesis predicted about the disappearing of hydrostatic pressure of the water drop. So we're analyzing the information we obtained to confirm the correlation about how it works and how much it interfere the normal seeping phenomenon in each conditions and specimens.

Conclusion

The equipment worked properly and reached the objective we meant. And the experiment's results conducted themselves according to our hypothesis and proof the physical model.

The results even show the interesting points in the seeping phenomenon about the domination of gravitation involved in this phenomenon. And we needed to continue the analysis in order to get the final result we've expected.

Acknowledgement

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