International Journal of Advances in Image Processing Techniques– IJIPT
Volume 2: Issue 1 [ISSN : 2372-3998]
Publication Date : 30 April, 2015

Capturing Features for Height Computation Derived With Gaussian Mixture Model

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***Abstract*—Height is a biometric trait which is considered as one of the important parameters for the identification of a person and nutritional status. This study generally aimed to obtain the height of a person through experimental approach utilizing computer vision. The web cam captures group of students into a single image. Canny edge detection is applied for image segmentation and Gaussian Mixture Model (GMM) for background subtraction. Segmented images were evaluated to identify the ideal number of students from a controlled environment lessening computer vision constraints. Data collected from the experiment were subjected to one-way ANOVA and T-Test to analyze the difference between prototype derived height from a captured image and actual height of the student. The prototype was developed using OpenCV library integrated to C# available in Microsoft Studio 2010.**

***Index Terms*— background subtraction, Gaussian Mixture Model, Canny Edge Detection, height derivation**

I. INTRODUCTION

Through the years several studies on image analysis applied to different field of human activities and biometric traits were conducted. It shows significant results to attest that computer vision is capable to perform analysis on captured images or video [1]. Biometric traits differentiate a person uniquely and provide important parameters for the identification of a person and nutritional status [3]. Biometric traits can be skin color, weight or height of the person [2]. Some of these traits are used to analyze personal health characteristics especially on nutritional status of a child.

Image segmentation can be used to partition an image into a set of disjoint regions [10] to provide features extraction for image processing and image analysis [4][5][6][7]. This study developed a prototype able to segment each student from a captured image and identify their individual height from a controlled environment lessening computer vision constraints [2].

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II. RESEARCH DESIGN

Initially, this study identified the appropriate angle and distance of the students from the web camera to determine the number of students that can fit on a single frame. Incorporated on the web camera manual configuration is the consideration that each student's image can be extracted perfectly from each other after the image segmentation. Each captured image requires an effective image segmentation algorithm and background subtraction algorithm to segment foreground and background objects.

Height measurement was done manually by positioning the student's back against the wall where a tape measure is attached. The edges from the captured image must be identified, which is the fundamental basis of height measurement [9].

Web camera was used to capture students on a single frame. The captured image was cropped to 4 new images using Grabcut algorithm [12]. Each cropped image was subjected to image segmentation through canny edge detection technique [10]. The image segmentation technique was able to segment different objects from the cropped image but successful extraction of the desired objects background subtraction [8] was done using Gaussian Mixture Model (GMM), which separated foreground objects from background objects. A controlled environment setting was identified to reduce computer vision issues and possibility of extracting undesired objects.

Image segmentation algorithm and background subtraction algorithm were incorporated to prototype design using OpenCV library integrated to C# available in Microsoft Studio 2010.

III. METHODOLOGY

A quantitative experimental research design through Posttest Only Control Group design was used in this study. The control group used was the traditional height measurement while the students' height derivation was used as the experimental group. During controlled test, the students' heights were measured through traditional methods using a tape measure attached to the wall and perpendicularly aligned to the floor. During experimental testing, student was randomly arranged to different grade level to assess the consistency of the derived height. Each student's arrangement was exposed to two types of light condition. A total of 240 images were collected from the experiment.

Convenient sampling was used to identify the locale of the study. A sample size of 30 [11] students out of 1,288 were selected; 5 each from Kinder and Grade 1 levels, and 4 each from Grade 2 to Grade 6.

The study used a low cost web camera attached to personal computer with technical specifications as stated in Table 1.0 and was manually configured to identify the appropriate angle and distance from the subjects.

Table 1.0
Spectacle Web Camera Specifications

Resolution: 1300K Pixels in hardware
Max: 1280x960, 640x480 can reach 30fps/sec
Lens: 2-layer glass lens, shimmering inducing
Video Format: Microsoft AVI
Video Stream Rate: 30fps (CIF) and 30Fps (VGA)
Color Depth: 24Bit True color
Plug and play
Supports Windows Vista/XP/2000/Windows 7/8

A white cloth was used to cover any existing object that will affect image segmentation. Through trial and error approach, the proper distance of the students from the web camera and the maximum number of students to fit in the web camera frame constrained by the limited space of clinic dimension were determined. Testing yielded web camera distance of 148 inches and an inclination of 45^0 to capture a maximum number of 4 students giving enough space between students to segment them properly. Each group of students had undergone two lighting conditions as shown in Figure 1.0 by switching the lights on and off.

Students stepped on a plain white cloth to separate their shoes from any objects on the floor and to control the background color or objects that might affect image segmentation process since the school clinic was painted with different color schemes as illustrated in Figure 1.0.

a b

Figure 1.0. Noise conditions. Image (a) represents an image without noise while (b) shows an image with noise.

Prototype height derivation used the bookshelf located at the left-hand side of the picture as the reference object in estimating the student's height from segmented image.

IV. RESULTS AND CONCLUSION

Images had undergone various stages of segmentation as shown in Figure 2.0. The study used segmentation rating of 0% (miss) or 100% (hit). Image segmentation performance was done manually guided by images in Figure 3.0. Each segmented image was tested for 10 trials.

a b c

Figure 2.0 Segmentation stages. (a) GMM Background subtraction. (b) Canny Edge Detection and (c) Cropped student image using Grabcut algorithm.

a b c d

Figure 3.0. Sample segmented images. (a) shows a properly segmented image while (b) is an example of

a not properly segmented image. (a) and (b) are both taken without noise condition. Images (c) and (d) depict a properly segmented image and an improperly segmented image with noise condition, respectively.

The image segmentation results by the experiment are recorded in Tables 2.0 and 3.0, without noise and with noise, respectively.

Table 2.0
Segmentation Results (without noise)

Grade	Image	Test Set 1	Test Set2	Test Set 3	Test Set 4
Kinder	1	0%	0%	3%	10%
	2	0%	0%	0%	45%
	3	0%	0%	0%	38%
	4	0%	0%	13%	25%
	5	0%	0%	0%	25%
Grade 1	1	100%	100%	100%	80%
	2	100%	65%	73%	73%
	3	100%	100%	53%	50%
	4	100%	100%	100%	50%
	5	100%	100%	100%	73%
Grade 2	1	100%	100%	23%	53%
	2	100%	100%	67%	28%
	3	100%	100%	67%	53%
	4	100%	100%	33%	70%
Grade 3	1	0%	60%	67%	0%
	2	100%	55%	0%	0%
	3	100%	55%	33%	0%
	4	10%	0%	33%	0%
Grade 4	1	90%	50%	33%	83%
	2	70%	70%	67%	68%
	3	0%	0%	33%	70%
	4	0%	50%	37%	75%
Grade 5	1	0%	50%	33%	43%
	2	100%	75%	33%	40%
	3	100%	75%	63%	30%
	4	30%	50%	20%	25%
Grade 6	1	100%	100%	90%	45%
	2	100%	100%	83%	55%
	3	10%	70%	57%	50%
	4	100%	70%	60%	40%

Table 3.0
Segmentation Results (with noise)

Grade	Image	Test Set 1	Test Set2	Test Set 3	Test Set 4
Kinder	1	0%	0%	17%	48%
	2	0%	45%	33%	25%
	3	0%	90%	67%	28%
	4	0%	50%	67%	0%
	5	0%	0%	33%	23%
Grade 1	1	100%	100%	100%	75%
	2	100%	100%	100%	75%
	3	100%	100%	100%	75%
	4	100%	100%	100%	75%
	5	100%	100%	37%	100%
Grade 2	1	100%	100%	67%	50%
	2	100%	55%	67%	50%
	3	100%	100%	67%	75%
	4	100%	100%	67%	50%
Grade 3	1	100%	55%	97%	0%
	2	100%	95%	67%	0%
	3	100%	100%	67%	0%
	4	100%	100%	67%	25%
Grade 4	1	0%	0%	0%	0%
	2	0%	0%	0%	0%
	3	0%	0%	0%	0%
	4	0%	0%	0%	0%
Grade 5	1	0%	100%	67%	50%
	2	0%	100%	33%	15%
	3	0%	100%	67%	50%
	4	100%	50%	67%	50%
Grade 6	1	0%	50%	33%	75%
	2	0%	0%	3%	75%
	3	0%	5%	33%	75%
	4	0%	45%	33%	48%

Prototype image segmentation performance with noise depicted in Table 2.0 and without noise reflected in Table 3.0 show segmentation performance variation ranging from 0 to 41 centimeters after Grabcut algorithm extraction of each student from a single captured image.

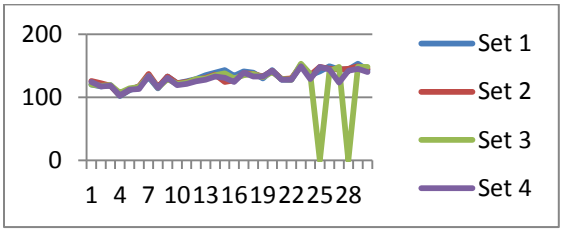

Figure 4.0 Derived Heights of each Students from 4 test sets(without noise)

Table 4.0
Variation among 4 test set readings (without noise)

ANOVA results		
f-value	**p-value**	**Interpretation**
.842	.474	Not Significant

Figure 4.0 shows little height variation on derived heights of the 30 students from 4 test sets. In order to assess whether there is a significant difference between 4 derived heights measurement from each test set, One-way ANOVA was used. Table 4.0 shows that height variation from the experiment is not significant since the p-value is greater than 0.05.

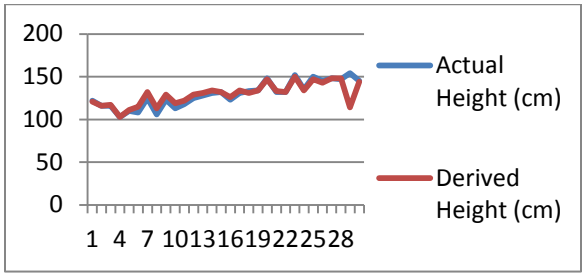

Figure 5.0 Actual Students' Heights against Derived Students' Heights (without noise)

Figure 5.0 shows some variation between actual heights gathered and derived heights of the 30 students.

Table 5.0
T-test Results (without noise)

	Mean	N	Mean Difference	t-value	p-value	Interpretation
Actual Height	129.5000	30	-.03333	-.023	.982	Not Significant
Average of the 4 readings without noise	129.5333	30				

After organizing the values of the test sets, T-test was used to determine if there is a significant difference between the actual heights and derived heights of the 30 students. The result as presented in Table 5.0 shows that the mean difference of the actual heights and derived heights (without noise) is –0.03333 is not significant based on the p-value which is greater than 0.05.

A similar statistical analysis was employed to determine the prototype performance on images exposed to noise condition as shown in Figure 6.0.

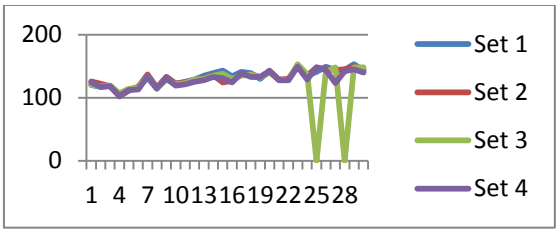

Figure 6.0 Derived Heights of each Students from 4 test sets(with noise)

Table 6.0
Variation among 4 test set readings (with noise)

ANOVA Results		
F-value	**p-value**	**Interpretation**
1.615	.190	Not Significant

Figure 6.0 depicts some variation on derived heights. One-way ANOVA shows that the difference among the 4 derived heights (with noise) as depicted in Table 6.0 is not significant.

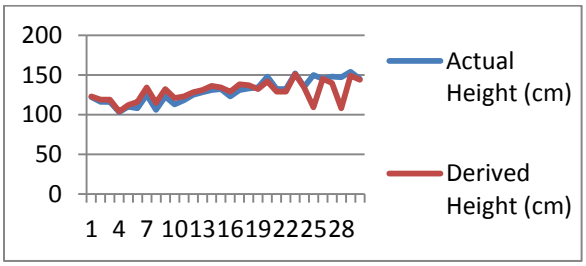

Figure 7.0 Actual Students' Heights against Derived Students' Heights (with noise)

Figure 7.0 shows gaps between actual heights and derived heights of the 30 students when exposed to noise.

Table 7.0
T-test Results (with noise)

	Mean	N	Mean Difference	t-value	p-value	Interpretation
Actual Height	129.5000	30	.80000	.378	.708	Not Significant
Average of the 4 readings with noise	128.7000	30				

The T-test resulted as shown in Table 7.0 shows that the mean difference of the actual heights and derived heights (without noise) of 0.80000 is not significant.

These results imply that the actual height and derived height of the student in both conditions do not differ significantly. These proved that the quality and configuration of the web camera is appropriate

for the study and that the applied image processing algorithms for deriving the height of the students were adequate to yield accurate results. Furthermore, the prototype yields considerable reliability for deriving human height regardless of the number of students and lighting conditions.

V. ACKNOWLEDGMENT

Authors would like to express their sincere gratitude to the financial support given by the College of Computer and Information Science and Malayan Colleges Laguna, Philippines.

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