BusBot: A Stain Learning Approach

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***Abstract*— In this paper we decided to investigate the application of robotics to the domestic chore of using a sponge to wipe down a table after a meal. We divided the problem into two main components; stain identification and cleaning kinematics. For the stain identification sub-problem we mainly focused on developing algorithms that would enable a robot to correctly identify stains. We first developed and experimented with a series of methods to extract features from stains in images. To increase accuracy we then use machine learning techniques to classify stained sections on images. Resulting tests of the machine learning classification of stains suggests that the utilizes thing but stuff still occurs.**

I. Motivation

While domestic applications of robots have been highlighted in popular culture practically applying robotics to accurately perform household tasks remains an open and interesting problem. In this paper we investigate the application of robots to a particular household task, specifically the task of using a sponge to wipe down a table after a meal.

II. Related Work

RELATED

III. Approach

We divided the problem into two main components; stain identification and cleaning kinematics. For the stain identification sub-problem we mainly focused on developing algorithms that would enable a robot to correctly identify stains. First, we clearly established our definition of a "stain" as a discoloration produced by foreign matter having penetrated into or chemically reacted with a material. The most important property of these stains is the discoloration of the stained area from the background texture color.

A. Image Segmentation

Our initial approach towards stain detection used the Watershed image segmentation algorithm. Specifically, watershed by flooding [1] was utilized. The segmentation process initially erodes the image to obtain seed points, which are defined as pixels whose values are close to their neighbors. The watershed algorithm is then run on the seed points to obtain a segmentation. The watershed algorithm was initially chosen because of its speed and ability to clearly segment trivial test cases.

B. Average Window Approach

One of the most important reasons why Watershed segmentation was abandoned was due to the algorithm's inability to ignore background textures. As a result an alternative method was created. The new method segments the image into square windows and compares each window with the average window value. Windows with a value difference greater than a threshold are classified as a stain.

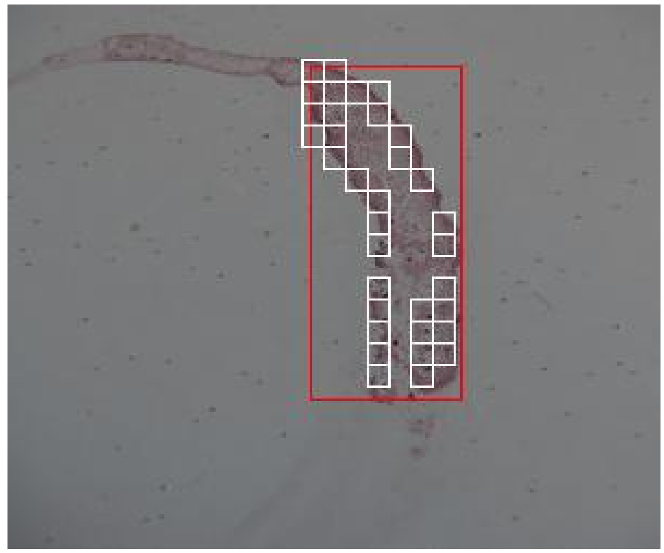

Fig. 1. Window-based

C. Learning Features

SVM features were determined on a per channel basis for all three color channels. For each channel the difference between the window and average, mean and mode value were used as features. In addition the variation of values within the window as well as the edginess of the window were also used as features. The variation of values was used because stains might be monocolored as compared to the background texture pattern, due to the properties of the stain substance.

IV. Results and Discussion

A. Segmentation

Several disadvantages were discovered through experimentation with the Watershed segmentation. It was difficult to determine which segmented portion of the mask was a stain. The watershed segmentation approach was unable to handle patterned backgrounds or textures such as wood, as figures 3 and 4 demonstrate. In addition it is hard to modify and improve the the algorithm besides through pre and post processing.

B. Dataset

The dataset used contains about 70 images, which together contain roughly 70,000 training examples. The distribution of positive and negative examples is roughly evenly split as

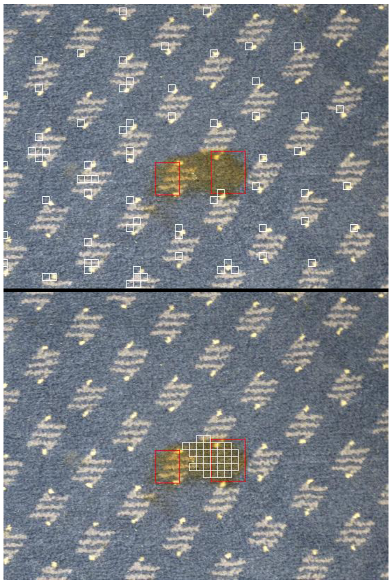

Fig. 2. Comparison of window feature detection (left) and SVM detection (right)

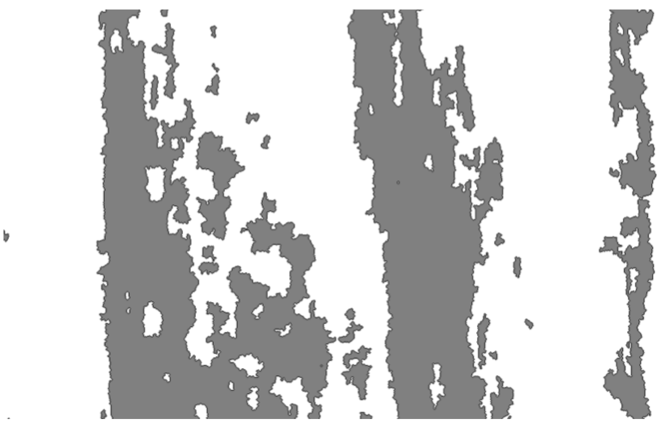

Fig. 3. Segmentation fail

Fig. 4. Segmentation fail

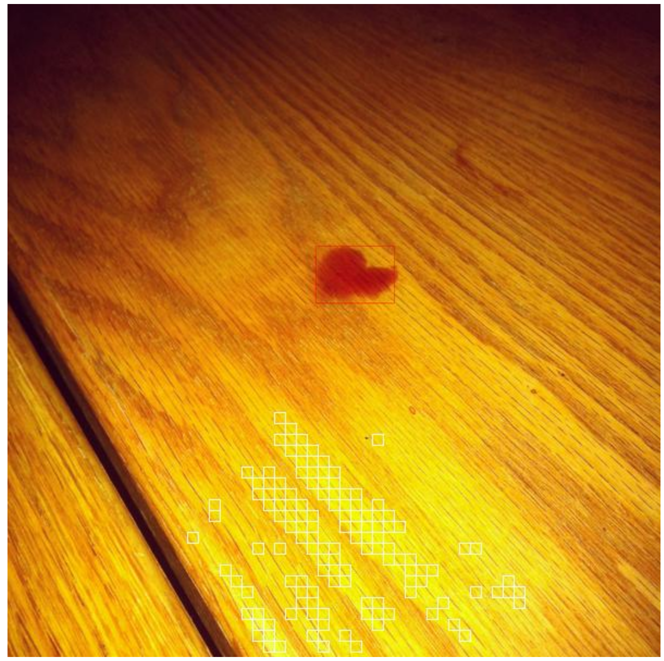

Fig. 6. Window-based

well. The window size is 10x10 for the examples used in this paper.

C. Future Work

Through

V. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word acknowledgment in America is without an e after the g. Avoid the stilted expression, One of us (R. B. G.) thanks . . . Instead, try R. B. G. thanks. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

REFERENCES

[1] Serge Beucher and Christian Lantujoul. Use of Watersheds in Contour Detection. In International workshop on image processing, real-time edge and motion detection (1979).

[2] Abid, K. (2012, July 11). stackoverflow Retrieved from http://stackoverflow.com/questions/11294859/how-to-define-the-markers-for-watershed-in-opencv/11438165

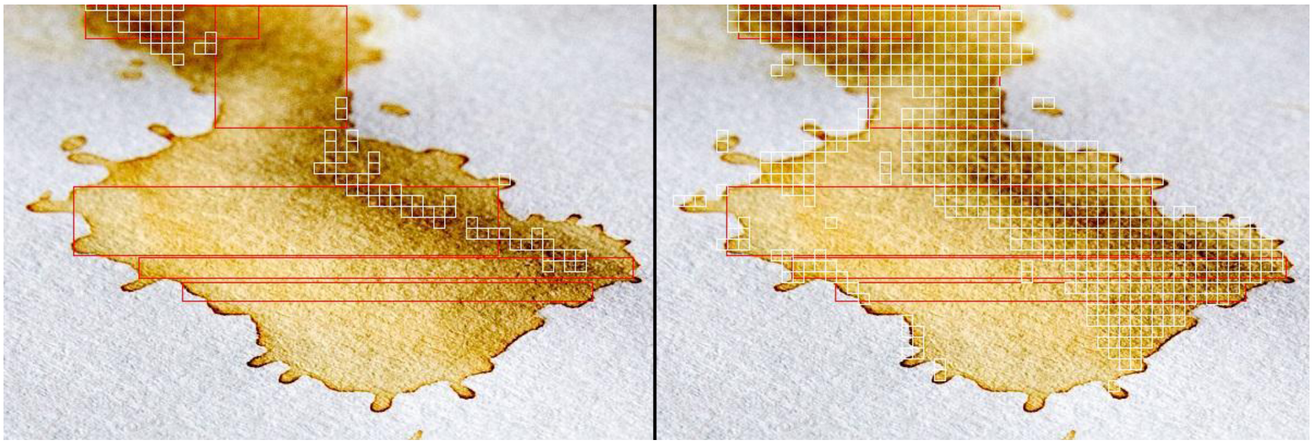

Fig. 5. Comparison of window feature detection (left) and SVM detection (right)