Smart Phone Camera based Weighing Scale for Kitchens in Household Applications

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Abstract: Measurement of physical variables is the most important task in manufacturing, production and trading of each and every produce. E.g. our clothes cannot be stitched properly without taking bodily measurements by a tailor. Household furniture if produced oversize cannot be brought inside homes if the measurement’s of door at entry was not considered in prior. Kitchen food cooked by every fellow Indian sisters, mothers, and daughters can produce some mouthwatering tastes, only if all cooking ingredients were mixed in the right proportion’s, else many have experienced the odds, with special attention to salt, sugar, chilli powder, turmeric powder, and other spices. Cooking food is an art and science both and the ingredients to be added in proportion are measured in prior using tools such as measuring spoons, cups and sometimes using weighing scales. Often measurements are carried with confidence of eyes and hands without use of tools, with special attention if one does not have a measuring tool. Not many have access to measuring scales in our society. However it is estimated that 60 % of people in India have access to Smart Phones. Modern Smart Phones are built using at least a 10’s of sensors, among which the Camera is the most popular. A modest weight measuring device can be developed based on very simple algorithms from the wide spectrum of image processing tools. This paper attempts to discuss the use of smart phones to quantify (estimate) the weight of at least one cooking ingredient used in every household. The same device can be used to estimate to identify the quality of the same ingredient in terms of size, color, nutrition, etc.

Keywords: Smart Phone, Weight Sensor, Image Processing, Weighing Scale, Smart Sensors, Algorithms.

1. INTRODUCTION

Measurement of physical variables is the most important task in manufacturing, production and trading of each and every produce. E.g. our clothes cannot be stitched properly without taking bodily measurements by a tailor. Household furniture if produced oversize cannot be brought inside homes if the measurement’s of door at entry was not considered in prior. Kitchen food cooked by every fellow Indian sisters, mothers, and daughters can produce some mouthwatering tastes, only if all cooking ingredients were mixed in the right proportion’s, else many have experienced the odds, with special attention to salt, sugar, chilly powder, turmeric powder, and other spices. Cooking food is an art and science both and the ingredients to be added in proportion are measured in prior using tools such as measuring spoons, cups and sometimes using weighing scales. Often measurements are carried with
confidence of eyes and hands without use of tools, with special attention if one does not have a measuring tool. Not many have access to measuring scales in our society. However it is estimated that 60% of people in India have access to Smart Phones. Modern Smart Phones are built using at least a 10's of sensors, among which the Camera is the most popular. We had developed system to identify the particle size, color and weight of mustard seeds by using image processing. Texture analysis and color analysis methods are used in this system. For taking images of different samples mobile phone camera is used with high resolution, at pre determine height, light and customized environment. We used small size and big size black color mustard seeds, yellow color mustard seeds. Different recipes were taken for photographs.

Researcher depicts[1] that a color digital image processing workstation developed to evaluate instrumentally the colour of specific cereal grains and other objects recognized within digital images. A Saticon-type video camera used for video digitization of digital colour images to produce the RGB (red, green, blue) signals. They used a low-cost microcomputer-frame grabber system to control digitization, to perform image segmentation and to extract colour features. To measure morphology characteristics of a range of cereal grains, digital image analysis of monochrome images has been applied. The size, shape and texture features determined from monochrome images which can be amplified by colour data extracted from the video signals produced by colour television cameras. For grading colour is the most important grain feature and useful visual characteristic of cereal grain colour perception by human eye is difficult which may vary with different human inspectors. Comparatively, in electronic imaging system colour perception is objective and reproducible. Therefore image processing is used to evaluate quality of a range of agricultural products including wheat, mustard seeds and fruits etc.

Maiti A et al.[2] described a new method for estimating the weight-wise particle sieve-size distribution using digital image processing. Comparison to mechanical sieving is used to quantify particle size in industries; it is time consuming and has its restrictions. The method gives a speedy and easy way to estimate particle size; it produces accuracy up to 99% weight-wise particle size distribution. For computation of particle size various particle shape parameters like major axis, minor axis, enclosing bounding box and equivalent diameter are used. The particle sieve-size and shape parameters are determine using regression analysis and gradation curves.

Ahmad I. et.al.[3] Depicts that indication related with fungal destruction, viral diseases, and immature soybean seeds were categorized using image processing techniques. For inspection and grading a red, green and blue (RGB) color feature based multivariate decision model differentiated between asymptomatic and symptomatic seeds. The color analysis gives discrete color differences between the asymptomatic and symptomatic seeds. For describing the seed symptoms a model consist of six color features in addition to averages, minimums, and variances for RGB pixel values was developed. The color analysis indicated that color alone did not adequately describe some of the differences among symptoms. Accuracy of 88% was accomplished using a linear discriminate function with unequal priors for asymptomatic and symptomatic seeds. The investigation was effective in evolving a color classifier and a knowledge domain established on color for upcoming development of intelligent computerized grain grading systems.

Pandit A. et.al. [4] illustrates literature review on object counting using image processing. Object counting using image processing techniques are helpful and reduce the time of counting effectively. For object counting appropriate recognition of object plays very important role. Camera used, size of objects, object touching or non-touching and illumination conditions these are the factors affecting the accuracy of the algorithm.

2. FRAMEWORK

Figure 1 gives generalize block diagram of proposed work:
Figure 1. Generalized block diagram.

We create a studio to capture images of mustard seeds. The purpose of the creation of a studio is to control the distance between the image sensor and a sample constant as well as to maintain fixed illumination within the environment, so the studio consist of box made from cardboard with dimensions are length 43cm, breadth 35cm, height 34cm. The top portion of box has opening to place a smart phone and allow the user to capture image at the same time the bottom portion has a slit to slide the sample cup or plate and place it at a fixed position before capturing the image to create a controlled illumination a LED light bulb is placed inside the studio such that it illuminates the sample surface at max without creating any shadow effect in the image capture (Or butter paper kept on flash light of mobile which is used for capturing image.) In addition to this the studio is colored black so that minimum diffuse reflectance phenomena occur at its least. OPPO F15 mobile phone is used for image capturing. Lid of storage bottle which had white surface from inside and edge of it is red in color. The details specifications regarding the camera and bulb are given in table 1.

Table 1. Specifications of camera, bulb and plate are given in following table

| Mobile Camera     | Bulb                        | Plate                        |
|-------------------|-----------------------------|------------------------------|
| OPPO F15, ColorOS version- V7.1 | Philips CFL bulb            | Weight – 10 gram            |
| Processor – Octa core| Wattage – 8 watt.           | Diameter - 8.5cm            |
| Version – Baseband and kernel| Voltage range – 220V-240V, | Radius – 4.25cm             |
| Android version – 10 | Frequency -50 Hz            |                              |

About the samples:
In this study we used mustard seeds with following characteristics:
- We used two varieties of mustard seeds with three variations and also one silver sugar ball.
- The first is black and other is yellow within the black two sizes one is small and other is big.
- The bigger mustard have diameter of 0.184 cm.
- The smaller mustard had diameter of 0.086 cm. on average basis.
- The mustard seed were also weight and it was observe that approximately 10 big mustard had a 0.056 gram and 20 small mustard had 0.32gram

Experiment and data collection:
Image data was collected on mustard seed placed in the sample in the studio with constant parameter. The specifications of experiment are listed below:

Table 2. Information about samples.

| Sr. No. | Type of sample                  | Weight 1 (gm) | Weight 2 (gm) | Weight 3 (gm) |
|---------|---------------------------------|---------------|---------------|---------------|
| 1       | Big black (Bb) mustard seeds    | 2             | 4             | 6             |
| 2       | Big yellow (Yb) mustard seeds   | 2             | 4             | 6             |
| 3       | Big black yellow (BYb) mustard seeds | 2          | 4             | 6             |
| 4       | Big Silver (Sb) sugar balls     | 2             | 4             | 6             |

From above table 2 it is clear that 12 images were captured and stored on google drive so that we
don’t lose data. The detail custom setup to capture the images is shown in figure 2.

![Image](figure2.png)

| Mustard Samples | Weighting of mustard samples | The custom made studio |
|-----------------|-------------------------------|------------------------|
| The Sample Holder | Studio inside view with source for illumination | The Sample placed in position |

**Figure 2.** Images while taking samples and experimental setup.

### 3. IMAGE PROCESSING

To perform image processing we have to do some preprocessing technique such as cropping the portion related to sample, holder and resaving it as a new image. Now we can only see the mustard seeds placed in the sample holder so mustard seed is black, yellow the white bottom of lid and red edge of lid.

**Table 3.** Images taken on samples:

| Sr. No | Code | 2 gm | 4 gm | 6 gm |
|--------|------|------|------|------|
| 1      | Bb   | ![Image](2gm_bb.png) | ![Image](4gm_bb.png) | ![Image](6gm_bb.png) |
| Sr.no. | Code | 2 gm | 4 gm | 6 gm |
|-------|------|------|------|------|
| 1     | Bb   | ![Image] | ![Image] | ![Image] |
| 2     | Yb   | ![Image] | ![Image] | ![Image] |
| 3     | BYb  | ![Image] | ![Image] | ![Image] |
| 4     | Sb   | ![Image] | ![Image] | ![Image] |

Table 4. BW images converted on samples:
Here we have two parameters, we compare images from table 3 and table 4 so it is clear that the region inside the circle purposely drawn in red can be analyzed for the number of pixels in black and white and a ratio can be calculated to generate a number which can be probably correlate to the actual weight of the sample image under observation.

| Sr.No. | Seed  | Weight (gm) | Count | Ratio (W:B) |
|--------|-------|-------------|-------|-------------|
| 1      | Bb    | 2           | 163   | 0.76        |
| 2      | Bb    | 4           | 325   | 0.36        |
| 3      | Bb    | 6           | 490   | 0.09        |
| 4      | Yb    | 2           | 172   | 0.97        |
| 5      | Yb    | 4           | 331   | 0.85        |
| 6      | Yb    | 6           | 499   | 0.75        |
| 7      | BYb   | 2           | 168   | 0.93        |
| 8      | BYb   | 4           | 327   | 0.65        |
| 9      | BYb   | 6           | 495   | 0.41        |
| 10     | Sb    | 2           | 22    | 0.99        |
| 11     | Sb    | 4           | 60    | 0.83        |
|        | Sb    | 6           | 96    | 0.70        |

Figure 3: Linear relationship between the weights in gm versus the ration of white to black pixels when calculated within the region of interest as shown in red circles.

Mustard is an important in all area from any industry or daily life, not everyone is carrying weighing scale but everyone has a mobile camera. In this study we can be used mobile camera to estimate the weight of mustard seeds which are used in every household kitchen in India. If the result is satisfactory we can also go with other spices, grains, cereals which are also used in kitchens of India. Eventually we are identifying quality and adulteration and perhaps nutrition contents.

4. RESULTS AND DISCUSSION:

From table no.5 and figure 3 it can be observed that there is linear relationship between the weights in gm versus the ration of white to black pixels when calculated within the region of interest as shown in red circles. The sensitivity (slopes) are very narrow for yellow mustard seeds as well as for the silver colored sugar balls. If one considers the count values in table no.5 then a linear model can be created and the data can be used for calibration purpose.
In this example we have shown a simple way to use a smart phone based camera to capture images on cooking ingredient’s to estimate their weights. In future more algorithms can be applied to the data set to predict the quality of the same ingredient. The nutrition quality can be measured perhaps based on the size, color and texture attributes. The same work can be extended to apply same techniques on n-number of cooking ingredients used in every Indian kitchen’s of every house hold.

5. CONCLUSION:

In this research we have designed a simple setup to capture images on cooking food ingredients such as mustard seeds and silver sugar balls. We used a simple smart phone based camera to acquire the images of samples when placed inside the studio with fixed source of illumination and distance between sensor and sample. The images were captured and saved and then converted into black and white images. Later a ROI was defined such that the area inside the red circle is considered for further investigation. Inside the ROI the number of black vs white pixels were measured using a small program written in octave. The ration W:B was calculated. Finally it was demonstrated that the ration along with the known count can be used to quantify the weight of the sample under investigation. This paper attempts to discuss the use of smart phones to quantify (estimate) the weight of at least one cooking ingredient used in every household. The same device can be used to estimate to identify the quality of the same ingredient in terms of size, color, nutrition, etc.

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