**Literature survey**

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| *Title/Authors* | *Principle* | *Key-points* | *Applications* | *Remarks/Ob* | *References* |
| Computer vision detection of peel defects in citrus by means of region oriented segmentation algorithm.  J. Blasco,  N. Aleixos ,  E. Molto | An inspection chamber was mounted over commercial conveyor, with CCD camera, provided the video should be RGB coordinates to segment the regions that represents sound peel, defects and stem along with external defectsC:\Users\Arvind\Documents\papersswt\Orange img processing reference\peel.JPG | Small defects were analyzed using smaller neighborhood window of 3x3 and large neighborhood of 5x5 pixels. These values were used to establish a homogeneity threshold by  is avg. homogeneity is std. deviation and is constant (0.6)  Estimation of color difference was done by | The algorithm being developed has been tested successfully in different species of citrus, as mandarins and oranges, with different colors and sizes. Probably, it could also work properly with other fruits having a single skin color affected by similar type of defects, as some varieties of peaches or apples. | Algorithm succeeded in segmenting correctly 94% of defects and stem present in image without introducing changes in configuration.  The segmentation algorithm proposed does not distinguish between the stems and the type of defect. | Blasco, J., N. Aleixos, and E. Molto. "Computer vision detection of peel defects in citrus by means of a region oriented segmentation algorithm." Journal of Food Engineering 81.3 (2007): 535-543. |
| Estimate Ripeness Level of fruits Using RGB Color Space and Fuzzy Logic Technique  Meenu Dhawal, V.K.Banga | Intensities of RGB images was calculated and compared to pre-defined intensity levels to define the ripeness level of apple  r(i)>a  g(i)<b  b(i)<c  Where, r(i),g(i),b(i) are respective intensities and a=80 b=83 and c=95 are found on experimental basis. | Segmentation was carried out on M\*N\*3 array of pixels to define the relation among the primary color objects. Individual mean of RGB layers to calculate range for ripeness and accordingly the input and output for fuzzy membership function editor was defined.  C:\Users\Arvind\Documents\papersswt\Orange img processing reference\rgb.JPG | This approach can be used to detect the ripeness level of fruits, vegetables and in medical field to find different stages of diseases in human body on the basis of color. | The developed algorithm can operate directly on RGB color space without the need of color space transformation. By changing the values of a, b and c it can be applied on other similar applications.  In some cases range of ripeness do not give accurate results due to overlapped regions in red green and blue mean values | Dadwal, Meenu, and V. K. Banga. "Estimate Ripeness Level of fruits Using RGB Color Space and Fuzzy Logic Technique." *International Journal of Engineering and Advanced Technology* 2.1 (2012): 225-229. |
| A Survey of Computer Vision Methods for Locating  Fruit on Trees  A.R. Jimenez,  R. Ceres,  J.L. Pons | 3D-position is directly obtained in the sensor spherical coordinate system which could be transformed to the robot Cartesian coordinate system to place a robotic gripper to detect the fruit. | The survey stated that images are one form of three types: Intensity, Spectral, range. But the problem includes shadows, no depth information, Confusing regions which could be replaced by range sensors. | Can be used to locate position of any fruit on the tree. | The rocking motion or oscillation of fruits in a tree due to wind streams creates time-variant graph. | Jimenez, A. R., R. Ceres, and J. L. Pons. "A survey of computer vision methods for locating fruit on trees." Transactions of the ASAE-American Society of Agricultural Engineers 43.6 (2000): 1911-1920. |
| Learning techniques used in computer vision for food  quality evaluation: a review  Cheng-Jin Du, Da-Wen Sun | **ANN** was trained for classification of various food products.  Segmentation based on Bayesian theorem and multi-normal frequency distribution is used to find defects so that probability distribution class can be determined.  **Fuzzy logic** classifier with four-level hierarchy and k-neighborhood, **Decision tree**- based on thresholdC:\Users\Arvind\Documents\papersswt\Orange img processing reference\decision tree.JPG  **Genetic Algorithm-** Feature selection to find subset of informative variables | SL is better for feature selection and segmentation.  *Grains*-morphology *Fruits*- Bayesian Discriminant model    *Vegetables-*Fisher’s linear model, Discriminant model, Bayesian filter, X-ray imaging | **1}Fuzzy logic**:  *Apple*:-sorting based on water-core severity  *Tomato*:-Mapping various fuzzy consumer aspects to overall quality classes  *Crusting sausage* :- Evaluating sensory properties  *Fish products* :-Automated grading  *Pizza*:- Classification  **2}Decision tree:**  *Beef:-*Predicting meat yield & meat quality grade  Chicory*:-*Image segmentation  3}**Genetic algorithm:**  *Seed species:* Feature selection | SL performs worst for non-Gaussian features.    Decision tree is an explicit model and easily to be understood, but it is a method for approximating discrete-valued target functions.  Fuzzy classifier provides 92% accuracy for pizza. | Du, Cheng-Jin, and Da-Wen Sun. "Learning techniques used in computer vision for food quality evaluation: a review." Journal of Food Engineering 72.1 (2006): 39-55. |
| Fruits Sorting and Grading using Fuzzy Logic  Harshavardhan G. Naganur, Sanjeev S. Sannakki, Vijay S Rajpurohit, Arunkumar R | Boundary feature of fruits are extracted. The fuzzy logic consisting of: C:\Users\Arvind\Documents\papersswt\Orange img processing reference\fuzzy.JPG  The color features red, green, yellow and geometric feature minor axis has been used to classify the samples. Extracted features are given as input to fuzzy system and defuzzification results as output. Geometric features as area, major axis length are used to grade fruits. | Modules performing different operations are:  C:\Users\Arvind\Documents\papersswt\Orange img processing reference\fruit_grading.JPG  a}Image Capture  b}Boundary extraction  c}Geometric feature extraction :- area, major axis and minor axis are extracted.  d}Color features extraction : corresponding RGB pixel value is calculated  e}Classify the samples: Mamdani-type inference defined in fuzzy toolbox is used  f}Grade the sample | Variety of fruits can be sorted and graded. This type of system can also be employed in Agriculture Produce Marketing Corporation etc. | The fruits with same color ex. Tomato and apple which have nearly same size and color are difficult to classify. Also requires uniform background. | Naganur, Harshavardhan G., et al. "Fruits Sorting and Grading using Fuzzy Logic." International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) 1.6 (2012): pp-117. |
| Non-destructive freeze damage detection in oranges using machine  vision and ultraviolet fluorescence  D.C. Slaughter , D.M. Obenland , J.F. Thompson, M.L. Arpaia ,  D.A. Margosan | Long wave UV light is used to identify a fine pattern of 1-2 mm bright yellow dots on the surface of orange (freeze damage).  C:\Users\Arvind\Documents\papersswt\Orange img processing reference\literature\vision\yellow_spot1.JPG  365 nm UV light illumination, Blak-ray, model as light source was used and fruits were then evaluated for freeze damage using official segment cut. | The UV fluorescence of freeze had a unique high contrast compared to undamaged peel tissue.  C:\Users\Arvind\Documents\papersswt\Orange img processing reference\literature\vision\yello-spot2.JPG  Total area of yellow spots in image was determined by transforming image to HSI color space and segmenting hue for gray levels between 35 and 100 and total area of image by segmenting green image of RGB image. Ratio of spot area was then determined and expressed as %.  visual damage score  = 0*.*41 + 0*.*087 × yellow spot area by machine vision  If visual damage score ≤ 0*.*5 then unfrozen*,* else frozen  If yellow spot area *<* 2% then unfrozen*,* else frozen | Suitable for real time inspection of all fruit on citrus packing lines. | UV fluorescence method had classification accuracy of about 70% and accuracy increased to 86% for fruit with no UV fluorescence or for those fruit with moderate to severe levels of freeze damage.  Restricted to citrus with small yellow spots (freeze damage). | Slaughter, D. C., et al. "Non-destructive freeze damage detection in oranges using machine vision and ultraviolet fluorescence." *Postharvest biology and technology* 48.3 (2008): 341-346. |
| Improving quality inspection of food products  by computer vision––a review  Tadhg Brosnan, Da-Wen Sun | Different levels of image processing are highlighted categorizing them into low level, intermediate level and high level.  C:\Users\Arvind\Documents\papersswt\Orange img processing reference\literature\vision\img-processing.JPG | *Low level*: correction of geometric distortion, removal of noise by Averaging and Gaussian filters, gray level and blurring correction.  *Intermediate level*: threshold, edge-based and region based segmentation  Morphological, textural and photometric to perform object recognition.  *High level*: recognition and interpretation using statistical classifiers and multi-layer neural networks. Decision making is knowledge base. | Bakery products, meat and fish, vegetables, fruit, grains, prepared consumer foods (ex. pizza), monitoring of dry sugar granules and powder, medical diagnostic imaging, factory automation, remote sensing, forensics, autonomous vehicle and robot guidance. | It is flexible and non-destructive. Advancements can be made with X-ray, 3-D and color imaging to clarify the details and ensure higher implementations. | Brosnan, Tadhg, and Da-Wen Sun. "Improving quality inspection of food products by computer vision––a review." Journal of Food Engineering 61.1 (2004): 3-16. |
| Non-destructive tests on the prediction of apple fruit flesh  firmness and soluble solids content on tree and in shelf life  Manuela Zude, Bernd Herold, Jean-Michel Roger,  Veronique Bellon-Maurel , Sandra Landahl | Linear multivariate models were built using AIF analysis, VIS and NIR spectrometry. The feasibility of sensor data was accepted to predict the freshness and SSC.  AIF and VIS addresses the fruit flesh firmness and SSC is predicted by NIRS. The obtained information was used to (1)Determination of optimum harvest date  (2)Fruit Quality inspection in shelf life | Stiffness is measured from:  S = f2 \* m2/3  f = first resonance frequency [Hz]  m = fruit mass [g] |  |  | Zude, Manuela, et al. "Non-destructive tests on the prediction of apple fruit flesh firmness and soluble solids content on tree and in shelf life." *Journal of Food Engineering* 77.2 (2006): 254-260. |
| Embedded Electronic Nose and Supporting Software Tool for its Parameter Optimization.  B.A.Botre, D.C.Gharpure, A.D.Shaligram |  |  |  |  | Botre, B. A., D. C. Gharpure, and A. D. Shaligram. "Embedded electronic nose and supporting software tool for its parameter optimization." Sensors and Actuators B: Chemical 146.2 (2010): 453-459. |
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