IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 19, Issue 4, Ver. VI (Jul.-Aug. 2017), PP 57-63
www.iosrjournals.org

Human eating/drinking activity recognition using hand movements to monitor and assist elderly people

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Abstract: *Day by day the aging population is increasing and it has become an important challenging issue of monitoring the elderly person's daily activities like eating and drinking to assist in maintaining the nutritional and fluid levels as prescribed by the schedule from the physician or care takers. On this context, a system that recognizes vision based eating/drinking activities of elderly people to prevent from dehydration and malnutrition has become very much essential especially in developed societies. In this paper, first human face and hand poses are segmented using skin segmentation, find a mid-point on the face, track the hand posture to get the two extreme points and using these two points and a mid-point on the face determine the area of the triangle. Analyze the area of the triangle for every frame in a video to recognize and classify the human eating/drinking activities using simple rule based classification method without using any sensors on different parts of the elderly person. The proposed work uses 2d coordinate geometry to track the hand part and does not use any datasets, contours or convex hull which consumes lot of computational cost.*

Keywords – *Eating Activity, Drinking Activity, elderly people, hand movement, activity recognition.*

I. Introduction

In the most recent years the requirement for developing an efficient approaches for monitoring elderly people's eating/drinking activities has become an important aspect. The objective is to help elderly people who are in the last phases of their autonomous living period (e.g., individuals in the early phase of dementia [1]), attempting to drag out their free living period. To this end, human focused interfaces and strategies following a human-centric approach ought to be created, so as to monitor eating/drinking activities of elderly people in a savvy home condition [2]. Such strategies could perceive a few Activities of Daily Living (ADLs) of elderly people [3, 4] and can be engaged to recognize eating/drinking activity of these special people. The identification of eating and drinking irregularities of people of any age is a fundamental means for surviving and achieving great wellbeing consistently. In spite of the fact that, nourishment issues concern individuals of any age, elderly people, especially those suffering from dementia, are more disposed to it [5]. The identification of eating/drinking exercises can help in planning the dietary menu arrangement, or re-plan if there would arise an occurrence of deviations from the arrangement [6].

At first, considers on dietary patterns have been led principally in view of meetings [7]. Then again, endeavors to screen eating and drinking conduct of patients or elderly individuals have likewise been performed. A classification of techniques going for eating and drinking movement location explains information obtained by encompassing [8, 9] or body worn (more obtrusive) sensors [10, 11]. The techniques belong to this classification require different body worn sensors so as to collect human activity like movements of arm, swallowing or chewing which reveals intake activity of fluid or food. Surrounding sensors provide data regarding the location of the person people's area (dining, kitchen room and so forth.) and could be utilized as a part of mix with other, more exact, systems. A combination of wearable and ambient sensors were proposed to perceive ADLs of elderly person [12, 13, 14]. The significant disservice of the sensor-based ADLs acknowledgment approach is that it sets confinements on the operation situation and requires individual participation. That is, the individual under thought should consent to have physical contact with sensors. This creates a few issues that ought to be considered [15]. It is obvious that more seasoned individuals are not acclimated with such hardware. This reality results to non-collaboration because of dread. Indeed, even in the situations where a more established individual consents to collaborate, he/she may neglect to wear or make poor utilization of it. An option, less intrusive, approach abuses visual data caught by cameras. Notwithstanding, keeping in mind the end goal to consider the imperviousness to video perception by more seasoned people that have security concerns, Privacy Preserving conduct of the people in the kitchen and the lounge area. An idea of home wellbeing observing is likewise exhibited in [17]. Wellbeing parameters are naturally observed at home without aggravating every day exercises. Moreover, a pilot extend observing practical wellbeing status of the elderly at home by constantly recording parameters of day by day living touchy to changes in wellbeing is accounted for in [18]. So as to recognize nourishment utilization, a technique that consequently identifies biting occasions in reconnaissance recordings of a man is introduced in [19]. Another work with arrangements of human occasions discovery in a video succession and can be reached out in eating/drinking movement acknowledgment is exhibited in [20]. A framework abusing data originating from cameras and amplifiers intended to be "tape on and overlook" gadgets, is depicted in [21] for ADLs acknowledgment. In the field of general action acknowledgment, there are considers that in spite of the fact that don't specifically address the eating and drinking movement acknowledgment issue, they handle other related errands, similar to feast readiness, collaborations with mugs, cutlery (e.g. 'get a handle on a glass', 'touch a fork'), acknowledgment of items and activities, and so on [22, 23]. Another way to deal with eating/drinking action acknowledgment depends on a general human activity acknowledgment approach [24]. Human face and hands are recognized [25, 26] and tracked over time [27, 28], while taking care of impediments [29]. At that point, the distinguished and followed facial areas and potentially facial historic points [30] and are utilized to perform eating and drinking action acknowledgment, in this way accomplishing great execution [24]. Other than its utilization in the home of elderly individuals, eating/drinking action acknowledgment assumes an essential part in different areas also, outstandingly in rumination and masseter myalgia thinks about [31, 32], and in addition on account of head and oral cavity irregularities, e.g. clefts [33] or changes because of maturing [34] that affect rumination, in relationship with different scatters [35]. In this paper, we depict the human focused interface specifications, research and usage for a PC vision-based sustenance help framework. We consider as target gathering of our investigation more established people that are in the early phase of dementia and suffer by gentle memory misfortune. Two difficult issues that the patients with early dementia confront are starving and drying out. This is because of a few reasons, for example, nerve weakening, loss of feeling of notice, apraxia (loss of the capacity or will to execute or do learned deliberate developments), and so forth. Specifically, we explore the situation of helped living in a keen home condition giving a few "canny functionalities", like PC vision-based programmed eating and drinking movement location, programmed correspondence with relatives or doctors in the event of unusual nourishment action, and so forth.

II. DESCRIPTION ABOUT THE SYSTEM

2.1. OBJECTIVE OF THE SYSTEM

Our principle objective is to help free living of more elderly people to the extent that this would be possible in their own particular homes. A framework that naturally identifies and perceives eating and drinking action utilizing video handling procedures would incredibly add to drawing out free living of elderly living people in a non-obtrusive manner. Such a framework can be engaged to screen specific districts of the brilliant home and for pre-specified time interims, comparing to supper periods, keeping in mind the end goal to regard the protection of the more established people. We consider the dining table height such that the hand part is clearly visible and the table would not obstruct the hand part. The human eating/drinking activity monitoring system supportive network ought to have the accompanying functionalities/properties:

- Start the operation when the person’s appearance is detected .
- Detect the activity and classify eating/drinking actions.
- Monitoring the activities of eating/drinking at pre-specified interval of time.
- Ability to remind the elderly person in case if he/she forget to take fluid/food at right time.
- Ability to report the care takers/physician in case if he/she forget to take fluid/food at right time.

Keeping in mind the end goal to acquire the required visual data, one or various cameras ought to be set such that they can capture the individual's upper body area amid a feast. In our present work, we consider one camera mounted at a distance of 1 meter apart from the chair and of 30−50cm above the edge of eating table, with the goal that the upper body part that is above the wrist parts would clearly visible. The camera, lighting, table and chair arrangement is as shown in Figure 1.

2.2. DETECTION OF HUMAN APPEARANCE

Keeping in mind the end goal to recognize the presence of a man sitting on the dining table chair human body [36, 37], or detection of face [38, 25, 26] methods can be used. In the first case, the human body shape (specifically the state of the individual's head and shoulders), typically spoken to by the state of its form utilizing shape descriptors, similar to the Histogram of Oriented Gradient (HOG) [39], is looked in each info video outline at various areas and scales with a specific end goal to give conceivable video outline areas having a place with the human body. In the second case, confront identification strategies are connected at different video outline areas and scales to give conceivable human face video outline areas. Haar-like elements joined with a course of classifiers have been generally utilized to this end [38]. Misusing the way that in our application situation the individual's face ought to be constantly noticeable amid a dinner, we have picked confront identification for individual appearance location. Keeping in mind the end goal to dispose of foundation areas having shape like the human face (false positives), we likewise abuse the shading properties of the human skin [40]. To speed up the process of localization of face we restrict the detection area of face at a bounding box having a size double the extent of the individual's face, as shown in Figure 2.

2.3. REPRESENTATION OF EATING/DRINKING ACTIVITIES

Monitoring of the elderly person’s eating/drinking activity is started once the person’s face is detected first time. The goal, at this stage, is to perceive the individual's activities, i.e., his/her elementary hand movements pattern to recognize eating/drinking activity. Using the hand palm posture classify the eating/drinking activity. Activities are normally portrayed by utilizing either highlights in light of movement data and optical flow [41, 42], or highlights contrived basically for activity portrayal [43, 23]. In spite of the fact that the utilization of such elements prompts palatable activity acknowledgment comes about, their calculation is costly. In this way, keeping in mind the end goal to accomplish continuous operation, the utilization of less difficult activity portrayals is required. Investigations of Neurobiology [44] have presumed that the human cerebrum can see activities by watching just the human body configurations (stances or stances) amid activity execution. In this way, activities can be depicted as arrangements of back to back human body postures, as far as human body outlines [45, 46]. In this work, a triangle is drawn using three points (two extreme points on the hand posture as a base and a reference point on the face part which is a mid-point on the face).

Determine the area of the triangle using our new formula (1) for every fourth frame for one iteration starting from the frame in which the hand with palm part appears with in the two threshold levels and moving towards the threshold level2 in eating/drinking activity video as in fig 4 and its stick figure representation is shown in fig 3. Human body posture pictures are made by applying skin shading division methods to the shading video outlines [47]. Exploratory investigations have presumed that the skin shade of Caucasian individuals has a few properties [40]. Specifically, it has been demonstrated that the shading estimations of the human skin lie in a known locale of the HSV colour space, i.e., $0 < H < 0.1$, $0.23 < S < 0.68$ and $V > 0.27$.

2.4. FEATURE EXTRACTION

Find the hand posture of the binary human body image frame by scanning from top to bottom within the two threshold area to get the two extreme points (Ax, Ay) and (Bx, By) on the hand posture as shown in figure 4. These two points are used as a base of the triangle. Mark the centre point (Cx, Cy) of the bounding box drawn over the face, used as a third point of the triangle as in the fig 4.

The area of triangle drawn using hand part as base and the reference point on the face as a third point of the triangle and palm postures are the most important features used in this work. These two features are used to recognize and classify eating/drinking activity. The area of the triangle is determined by using our new formula as given in equation (1) below:

$$At= \frac{1}{2}(\,|(Ax - Cx)| * |(By-Cy)| + |(Bx - Cx)| * |(Ay - Cy)|\,) \quad (1)$$

Where, At: Area of triangle, (Ax,Ay),(Bx,By) and (Cx,Cy) are the coordinates of 3 vertices of triangle. The two coordinates (Ax,Ay) and (Cx,Cy) are the two extreme points tracked over the hand part and (Bx,By) is a reference point on the face part as explained above and shown in fig 3.

III. EATING/DRINKING ACTIVITY RECOGNITION

Let us assume that an action video, i.e., a video depicting an elementary hand movement pattern, is formed by Nt video frames. These video frames are pre-processed by applying the above described process in order to produce Nt binary posture images.

A rule-based approach is implemented to recognize eating/drinking activities using hand postures in the input image. The rules are defined as follows:

Let A be an array, i.e. A€RN, I = 1,…., Nt, where N is an area of triangle drawn on every fourth frame for one iteration starting from the frame in which the hand with palm part appears with in the two threshold levels and moving towards the threshold level2 in eating/drinking activity video using the method and the formula as explained above.

Ati be the area of triangle of ith frame.

Ain be the count of increasing area of triangle values of an array A.

Ade be the count of decreasing area of triangle values of an array A.

Acmin be the minimum constant area of triangle value of an array A. I.e. minimum value is 10.

Acmax be the maximum constant area of triangle value of an array A. I.e. maximum value is 200.

Fc() be a comparing function, returns the subtraction of second value from the first value.

Rule1: While hand part appears within the two threshold levels, compare the areas of the triangle of the current frame and its fourth frame. Compare this for every hand actions that appears with in the two threshold levels for ever iteration of the eating/drinking activities.

Fc(Ati , Ati+4) ---->	>0, in decreasing order i.e. hand is moving towards the threshold level2, A_{de}++
	<0, in increasing order i.e. hand is moving towards the threshold level1, A_{in}++
	Otherwise, values are constant i.e. hand is either at mouth or at the plate.

Rule 2: Classify eating/drinking activities by using the values recorded in the array A for one cycle of the activity. I.e. the hand starts moving from the threshold level1 towards the threshold level2.

Since the similar hand posture at the mouth appears repeatedly in drinking activity than eating activity. So compare the number of minimum values with number of decreasing values in A. Since the hand posture remains at the mouth for longer time compared to the time taken by the hand movements from threshold level1 to threshold level2 in drinking activity, compare the number of frames with the triangle area in decreasing order and number of frames with triangle area above the threshold level which is considered minimum triangle area of value as ten.

Fc(Acmin , Ade) ----->	>0, Drinking activity
	Otherwise, Eating activity

Rule 3: To confirm the drinking activity draw a bounding box on palm from the wrist point [49] to the tall fingertip and analyze the alignment of the fingertips holding the water bottle. In this case all the four fingers are visible when hand posture is near the threshold level2. Where as in eating activity, visibility of number of finger is one. So draw a vertical line at a point 80% width of the palm length from the wrist point as in fig 5. Over this line, from top to bottom count the number of white and black pixels. If the black pixels count is greater than the white pixels count then the activity is recognized as eating activity otherwise it is drinking activity. Use rule3 if drinking activity is detected in rule2.

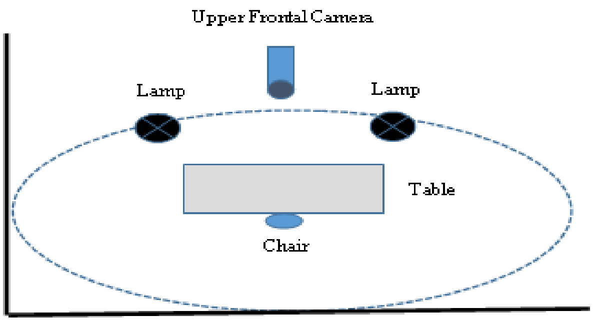

Fig 1 Camera and Lighting Arrangement at the dining table.

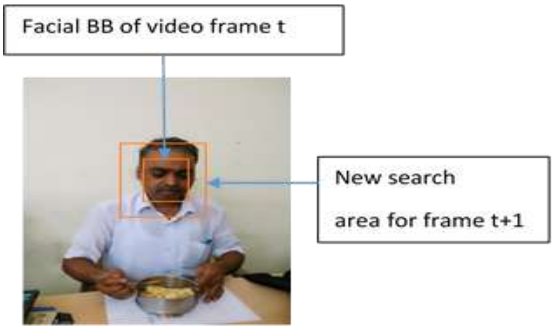

Fig 2. A new search area of Face detection for quick operation.

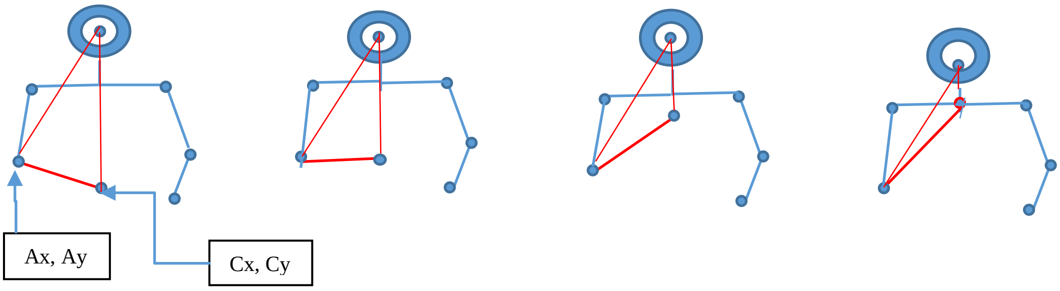

Fig 3: Representation of hand postures involved in eating/drinking activity, and a triangles drawn with a two extreme points on the hand postures as a base and the reference point on the face as a third point of the triangle

Threshold Level2
Threshold Level1

Fig 4: Sequence of frames representing drinking and eating actions

(a) (b) (c) (d)

Fig 5: a) and c) Bounding box drawn using wrist point and fingertip, b) and d) palm part is segmented at wrist point and a line is drawn to classify eating/drinking activity.

IV. EXPERIMENTAL RESULTS

The proposed human eating/drinking activity recognition method is tested using MATLAB s/w on a Personal laptop with Intel-core i3 4th generation, 2.30 GHz CPU and 2GB of RAM. The system starts monitoring whenever the elderly person uses the dining table by sitting on the chair for eating a meal or drinking fluids as the camera detects the person face clearly. The system records the time of eating and drinking activities and compares with the sessions as prescribed in the table2. The system also reminds the person whenever he/she misses a meal or taking fluids as per the schedule. If the person continues the habit of having a meal or fluids at abnormal time or missing a meal or intake of fluids, then the system informs the care takers. The dining room is set up with a dining table, a camera with 640×480 pixels resolution at a frame rate of 20 frames per second, equipped with two lamps of 600 watts each, with constant background and constant illumination.

In order to extract face and hand parts use skin colour segmentation method and these video frames are converted to HSV colour space. To get binary images, pixels having values equal to the person's skin colour are set to a value one and the remaining pixels are set as zero.

A rule based classification method as explained above is used to classify the eating/drinking activities. While eating/drinking activity if the wrist part of hand appears above the threshold1 and below the threshold2 of the current frame i then the next frame to be considered is i+4th frame. I.e. every fourth frame is enough to be considered for analysis when wrist part of hand appears within the two thresholds to speed up the analysis of eating/drinking activities. The graph shown in fig depicts the eating and drinking activities. The graph shows clearly, the area of triangle drawn using the two extreme points on the hand part and a reference point on the face as a third point as explained above gradually decreases, remained constant and gradually increases depicts the hand movements within the two thresholds. It is observed from the graph that the area of triangle gradually decreases and reaches constant value stays maximum for maximum duration as per the rule 2 this is classified as drinking activity by confirming the hand palm posture according to the rule3. Table1 shows the confusion matrix for three activities. Table 3 shows human eating/drinking activity classification rates. A graph on eating/drinking activity is shown in fig 6, since the hand posture remains at the mouth for longer time compared to the time taken by the hand movements from threshold level1 to threshold level2 in drinking activity.

Fig 6 shows a chart of hand movements in eating and drinking activities

Table 1: Confusion matrix for three activities

	Eating	Drinking	Apraxia
Eating	0.98	0.01	0.01
Drinking	0.0	1	0.0
Apraxia	0.01	0.0	0.99

Table 2. Scheduled meal and fluid intake time sessions

<table>
<tr><th>Meal Type</th><th>Session</th><th>Regular fluid intake</th><th>Session</th></tr>
<tr><td rowspan="3">Breakfast</td><td rowspan="3">8:30 - 10:00</td><td>Prior Breakfast</td><td>6:00-8:00</td></tr>
<tr><td rowspan="2">Prior Lunch</td><td>10:30-11:00</td></tr>
<tr><td>11:30-12:00</td></tr>
<tr><td rowspan="3">Lunch</td><td rowspan="3">12:30 – 14:00</td><td rowspan="3">Post Lunch</td><td>14:30-15:00</td></tr>
<tr><td>15:30-16:00</td></tr>
<tr><td>17:00-18:00</td></tr>
<tr><td>Dinner</td><td>19:30 – 21:00</td><td>Post Dinner</td><td>21:30-22:00</td></tr>
</table>

Table 3: shows human eating/drinking activity classification rates

Activity	No of iterations of hand movements	Rate (%)
Eating	22	89%
Drinking(during eating)	4	92%
Drinking(not during eating)	8	91%
Apraxia	3	81%

V. CONCLUSION

This work monitors the elderly person's eating and drinking activities by using simple rule based classifiers at very affordable computational cost as compared to other sensor based recognition methods which requires sensors to be worn on different body parts and users are forced to wear these sensors. Use of two threshold levels have boosted the analysis by avoiding the overlapping of palm over face part in the activities. This work deals with intelligent functions that monitors the elderly person's eating and drinking activities at a regular prescribed schedule to assist the user from malnutrition.

Future Scope: The system shall able to monitor the type of food, calculate the intake calories, vitamins, minerals, fluids and number of time the user has consumed the meal or fluid to assist the elderly person to maintain nutritional and fluid intake. For better recognition of eating/drinking postures use one more camera at the top of the hand.

REFERENCES

[1] J. Vogt, K. Luyten, J.V. den Bergh, K. Coninx and A. Meier, Putting dementia into context: a selective literature review of assistive applications for users with dementia and their caregivers, International Conference on Human-Centered Software Engineering, pp. 181-198, 2012.

[2] D. Vergados, A. Alevizos, A. Mariolis and M. Caragiozidis, Intelligent services for assisting independent living of elderly people at home, International Conference on Pervasive Technologies Related to Assistive Environments, vol. 97, pp. 1-4, 2008.

[3] Z. Lin, A. R. Hanson, L. J. Osterweil and A. Wise, Precise process definitions for activities of daily living: a basis for real-time monitoring and hazard detection, Workshop on Software Engineering in Health Care, pp. 13-16, 2011.

[4] C.A. Frantzidis and P.D. Bamidis, Description and future trends of ICT solutions offered towards independent living: the case of LLM project, International Conference on Pervasive Technologies Related to Assistive Environments, vol. 59, pp. 1-8, 2009.

[5] R. Watson, Measuring feeding difficulty in patients with dementia: perspectives and problems, Journal of Advanced Nursing, vol.18, no. 1, pp. 25-31, 1993.

[6] S.A. Noah, S.N. Abdullah, S. Shahar, H. Abdul-Hamid, N. Khairudin, M. Yusoff, S. Shahar, R. Ghazali, N. Mohd-Yusoff, N.S. Shafii and Z. Abdul-Manaf, DietPal: a Web-based dietary menugenerating and management system, Journal of Medical Internet Research, vol. 5, no. 3, 2003.

[7] C.H. Morris, R.A. Hope and C.G. Fairburn, Eating habits in dementia: a descriptive study, The British Journal of Psychiatry, vol. 154, pp. 801-806, 1989.

[8] K. Sim, G.E. Yap, C. Phua, J. Biswas, A.A.P. Wai, A. Tolstikov, W. Huang and P. Yap, Improving the accuracy of erroneous plan recognition system for activities of daily living, International Conference on e-Health Networking Applications and Services, pp. 28-25, 2010.

[9] N.M. Gil, N.A. Hine, J.L. Arnott, J. Hanson, R.G. Curry, T. Amaral and D. Osipovic, Data visualisation and data mining technology for supporting care for older people, International ACM SIGACCESS conference on Computers and accessibility, pp. 139-146, 2007.

[10] O. Amft and G. Troster, On-body sensing solutions for automatic dietary monitoring, IEEE Pervasive Computing, vol. 8, no. 2, pp.62-70, 2009.

[11] O. Amft and G. Troster, Recognition of dietary activity events using on-body sensors, Artificial Intelligence in Medicine, vol. 42, no. 2, pp. 121-136, 2008.

[12] A. Fleury, M. Vacher and N. Noury, SVM-based multimodal classification of activities of daily living in health smart homes: Sensors, algorithms, and first experimental results, IEEE Trans. on Information Technology in Biomedicine, vol. 14, no. 2, pp. 174-283, 2010.

[13] C. Phua, V.F. Foo, J. Biswas, A. Tolstikov, A.P.W. Aung, J. Maniyeri, W. Huang, M.H. That, D. Xu and A.W. Chu, 2-layer erroneous-plan recognition for dementia patients in smart homes, IEEE International Conference on e-Health Networking, Applications and Services, pp. 21-28, 2009.

[14] V. Di Lecce, C. Guaragnella, T. d'Orazio and R. Dario, Smart Postural Monitor for Elderly People, 19th IMEKO TC 4 Symposium and 17th IWADC Workshop Advances in Instrumentation and Sensors Interoperability, 2013.

[15] V. Metsis, Z. Le, Y. Lei and F. Makedon, Towards an evaluation framework for assistive environments, International Conference on Pervasive Technologies Related to Assistive Environments, pp. 1-8, 2008.

[16] M. Ogawa and S. Ochiai and K. Shoji and M. Nishihara and T. Togawa, An attempt of monitoring daily activities at home, International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 786-788, 2000.

[17] T. Togawa, Home health monitoring, Journal of Medical and Dental Sciences, vol. 45, no. 3, pp. 151-160, 1998.

[18] B.G. Celler and E.D. Lisar and W. Earnshaw, Preliminary results of a pilot project on remote monitoring of functional health status in the home, Bridging Disciplines for Biomedicine, pp. 61-64, 1996.

[19] S. Cadavid and M. Abdel-Mottaleb, Exploiting visual quasi-periodicity for automated chewing event detection using active appearance models and support vector machines, International Conference on Pattern Recognition, pp. 1714-1717, 2010.

[20] P. Wu, J.W. Hsieh, J.C. Cheng, S.C. Cheng and S.Y. Tseng, Human smoking event detection using visual interaction clues, International Conference on Pattern Recognition, pp. 4344-4347, 2010.

[21] E. Tapia and S. Intille and K. Larson, Activity recognition in the home using simple and ubiquitous sensors, PERVASIVE, 2nd International Conference, pp. 158-175, 2004.

[22] Q. Fan, R. Bobbitt, Y. Zhai, A. Yanagawa, S. Pankanti and A. Hampapur, Recognition of repetitive sequential human activity, Computer Vision and Pattern Recognition, pp. 943-950, 2009.

[23] H.J. Seo and P. Milanfar, Action recognition from one example, IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 33, no. 5, pp. 867-882, 2011.

[24] A. Iosifidis, E. Marami, A. Tefas and I. Pitas, Eating and drinking activity recognition based on discriminant analysis of fuzzy distances and activity volumes, International Conference on Acoustics, Speech and Signal Processing, pp. 2201-2204, 2012.

[25] G. Stamou, M. Krinidis, N. Nikolaidis and I. Pitas, A monocular system for automatic face detection and tracking, Visual Communications and Image Processing, 2005.

[26] M.M Elmansori and K. Omar, An Enhanced Face Detection Method Using Skin Color and BackPropagation Neural Network, European Journal of Scientific Research, vol. 55, no. 1, p. 80, 2011.

[27] H. Baltzakis, A. Argyros, M. Lourakis and P. Trahanias, Tracking of human hands and faces through probabilistic fusion of multiple visual cues, Computer Vision Systems, pp. 33-42, 2008. [28] O. Zoidi, A. Tefas and I. Pitas, Visual Object Tracking based on Local Steering Kernels and Color Histograms, IEEE Trans. on Circuits and Systems for Video Technology, vol. 23, no. 5, pp. 870-882, 2013.

[28] L. Goldmann, U.J. Monich and T. Sikora, Components and their topology for robust face detection in the presence of partial occlusions, IEEE Transactions on Information Forensics and Security, vol. 2, no. 3, pp. 559-569, 2007.

[29] M. Pateraki, H. Baltzakis, P. Kondaxakis and P. Trahanias, Tracking of facial features to support human-robot interaction, IEEE International Conference on Robotics and Automation, 2009.

[30] C. Anagnostou, S. Psomiadis, A. Pavlides, G. Economou and L. Zouloumis, Protocols of conservative treatment of masseter myalgia, 29th Panhellenic Dental Congress, 2009.

[31] E. Horjales-Araujo, N.B. Finnerup, T.S. Jensen and P. Svensson, Differential effect of visual and gustatory stimuli on experimental jaw muscle pain, European Journal of Pain, vol. 17, no. 6, pp. 811-819, 2013.

[32] S.A. Othman, R. Ahmad, S.M. Asi, N.H. Ismail and Z.A. Rahman, Three-dimensional quantitive evaluation of facial morphology in adults with unilateral cleft lip and palate, and patients without clefts, British Journal of Oral and Maxillofacial Surgery, vol. 52, no. 3, pp. 208-213, 2014.

[33] P. Koruga, M. Baca and M. Schatten, Analysis of craniofacial morphology changes during aging and their connection with facial age estimation, International Conference on Information Technology Interfaces, pp. 481-486, 2011. [

[34] E. Gavopoulou, Investigation of correlation between dental and oral health and Alzheimer disease or other dementia forms, 32th Panhellenic Dental Congress, 2012.

[35] Z. Lin and L.S. Davis, Shape-Based Human Detection and Segmentation via Hierarchical PartTemplate Matching, IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 32, no. 4, pp. 604-618, 2010.

[36] The MOBISERV-AIIA Eating and Drinking multi-view database 273

[37] N. Tsapanos, A. Tefas and N. Nikolaidis and I. Pitas, Shape matching using a binary search tree structure of weak classifiers, Pattern Recognition, vol. 45, no.6, pp. 2363-2376, 2012.

[38] P. Viola and M. Jones, Rapid object detection using a boosted cascade of simple features, Computer Vision Pattern Recognition, pp. 511-518, 2012.

[39] N. Dalal and B. Triggs, Histograms of Oriented Gradients for Human Detection, Computer Vision Pattern Recognition, pp.886-893, 2005.

[40] I. Cherif, V. Solachidis and I. Pitas, A tracking framework for accurate face localization, Artificial Intelligence in Theory and Practice, vol. 1, pp. 385-393, 2006.

[41] S. Ali and M. Shah, Human Action Recognition in Videos Using Kinematic Features and Multiple Instance Learning, IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 32, no. 2, pp. 288-303, 2010.

[42] J. Hoey and J.J. Little, Representation and recognition of complex human motion, Computer Vision Pattern Recognition, pp.752-759, 2000.

[43] W. Yang and G. Mori, Hidden Part Models for Human Action Recognition: Probabilistic versus Max Margin, IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 33, no. 7, pp. 1310-1323, 2011.

[44] M.A. Giese and T. Poggio, Neural mechanisms for the recognition of biological movements, Nature Reviews Neuroscience, vol. 4, no. 3, pp. 179-192, 2003.

[45] A. Iosifidis, A. Tefas, N. Nikolaidis and I. Pitas, Multi-view human movement recognition based on fuzzy distances and Linear Discriminant Analysis, Computer Vision and Image Understanding, vol. 116, no. 3, pp. 347-360, 2012.

[46] A. Iosifidis, A. Tefas and I. Pitas, Multi-view action recognition based on action volumes, fuzzy distances and Cluster Discriminant Analysis, Signal Processing, vol. 93, no. 6, pp. 1445-1457, 2013.

[47] E. Marami, A. Tefas and I. Pitas, Nutrition Assistance based on Skin Color Segmentation and Support Vector Machines, Man-Machine Interactions, pp. 179-187, 2011.

[48] Grzejszczak T., Nalepa J., Kawulok M, Real-Time Wrist Localization in Hand Silhouettes, Proceedings of the 8th International Conference on Computer Recognition Systems CORES 2013 pp 439-449.

[49] H Chidananda, T Hanumantha Reddy. "Hand Activity Recognition and classification of hand involved in the hand activity." International Journal on Human Machine Interaction. (2015): 20-27. Print..

IOSR Journal of Computer Engineering (IOSR-JCE) is UGC approved Journal with Sl. No. 5019, Journal no. 49102.

H. Chidananda. "Human Eating/Drinking Activity Recognition Using Hand Movements to Monitor and Assist Elderly People." IOSR Journal of Computer Engineering (IOSR-JCE), vol. 19, no. 4, 2017, pp. 57–63.