# Wearable Computer Vision based Human Assistance System using Android 4.0.3 ICS Operating System

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## ABSTRACT
This paper describes a well defined and improved system for the human assistance, based on wearable computer vision using Android ICS operating system. The information is traditionally confined to paper or digitally to a screen; in contrast the proposed system introduces an Android tablet based wearable gestural interface to attempt for bringing information out into the tangible world. The system provides an extension to existing gesture interface system by integrating Android Operating system based wireless IP web camera. The system focuses on the Memory utilization, Computational time for various images from different sources. The system also elaborates peak CPU load with respect to the complexity of the connectivity and limited hardware. The proposed system well analyses the need of the technology for building the session between Android 4.0.3 ICS operating system and the traditional operating system at the user end. It also providing the structured analysis regarding the success rate, the resolution test and effect of different tools on the perspective of the Android 4.0.3 ICS based Operating system to improve the analytical parameters like processing time as well as response time.

## General Terms
Digital Image Processing

## Keywords
Android 4.0.3 ICS, Gestural Interface, Augmented Reality, Wearable Interface, Interaction styles

## 1. INTRODUCTION
Information is traditionally confined to paper or digitally to a screen. Here, a Wearable Gestural Interface (WGI), which attempts to bring information into the tangible world and take it back to digital world. It uses a tiny pocket projector or sound playback to generate outputs for users. Also a compact digital camera mounted on a hat or coupled in a pendant like wearable device can be used to grab inputs. Wearable Human assistance system sees what the user sees and accepts user's commands through gesture identification.

Most gestural and multi-touch based interactive systems are not mobile since small mobile devices fail to provide the intuitive experience of full-sized gestural system. But a recent development in hardware, like tremendous growth in ARM processor's abilities, opens up new opportunities for designer. Similarly integration of new software technologies, like Android 4.0.3 ICS- an open source and free operating system, will accelerate design process.

A computer-vision based wearable and gestural information interface that augments the physical world around us with digital information and proposes natural hand gestures as the mechanism to interact with that information. The aim of this work is to explore the hands-free gestural interaction.

## 2. PRESENT THEORIES AND PRACTICE USED
The software based designs like Visual basic, proposed in Pranav Mistry's "Wear Ur World - A Wearable Gestural Interface" is used as a bench mark for implementation of gesture recognition systems. This design focuses on good response time but it require a pocket projector to interact with user [1].

More advanced Augment reality (AR) related development presented in Yusuke Kurita [2] and Twinkle [7] focuses more on development of portable three-dimensional information projection system using spatial augmented reality technology. It requires special type of projector suitable for said Reality simulation. The technology proposed is copyrighted & patented.

Sixth Sense Technology proposed in WGI is a mini-projector coupled with a camera and a cell phone, which acts as the computer and connected to the Cloud, where all the information stored on the web. This system uses color markers to interact with cell phone using gesture [3][4]. These Wearable human assistance systems are designed with heavy and costly projectors. This projector needs to have bright and plane surface (like wall), which makes it unsuitable for outdoor use. In addition multiples need to be used for the comparative experiments since it is difficult to recognize the visual information accurately in the lighting condition for the portable projector [2].

Present theory concentrates more on providing image processing or gesture based solution for the user interface accessibility so it requires strong and powerful computing system enabled by processors like Pentium or core-i processor family. These requirements make it suitable for wearable applications and further easy to ensure uninterrupted power supply for longer amount of time.

In this paper, in order to realize the concept of human assistance, a prototype system which can provide lightweight, low cost and efficient gesture interface solution using Android 4.0.3 ICS operating system is developed.

## 3. SYSTEM DEVELOPMENT

Proposed system presents a solution for humans about how to interact with computers with gestures, where human need not do much than simple gestures. The work presented here aims to develop a wearable gestural interface for collaborative environment. The development of system includes design of two distinct parts: first part of system designed and realized for wearable image acquisition cum demonstrator and secondly a central computing system (CCS) with software application which consist of gesture recognition algorithms and tracking features. The block diagram shown in figure 1, consists of three main blocks

A. **Display device and Digital camera with data communication ability:** - Low cost VGA camera can satisfy the need. A mobile phone, PDA or a tablet PC can be used for display as well as image acquisition task[5].

B. **Central computing system (CCS):-** PC or a laptop with good processing ability and fast networking interface.

C. **High speed communication link:** - High speed IP connectivity, like WiFi, to inter connects CCS and Display device. Link should have capacity to carry video signal.

In association with the recent growth in mobile platform great user interface to system for image acquisition and demonstration could be used effectively. However inabilities of mobile platforms, to processing huge amount of data like number of images per second, can be overcome by outsourcing job of processing to a Central Computing Server (CCS)[5].

The CCS system only needs to have good processing ability and fast networking interface. The processing ability includes ability to receive video frames over the network, perform image transformation functions and send a result back for display all in real time. Whereas networking interface should have a speed of 2Mbps in both the directions so that it can carry video signals in real time, in order to satisfy above requirements, simple desktop PC or Laptop with Wi-Fi connectivity can be used for implementation of CCS. Mobile platform like Android power tablet PC can be chosen for capturing image or video as well as displaying output. Simplicity, Flexibility, re-programmability, inbuilt networking support and robustness make Android a best choice for proposed design.

## 4. IMPLEMENTATION

The implementation of system takes place in two steps. Firstly implementation of an algorithm on CCS for Optical Character Recognition (OCR) which extracts English characters, and by means of these sentences, from image captured with text is well extracted. Similarly implementation of a gesture recognition algorithm on CCS for different type of hand gestures, to pop up different windows applications. Secondly an apps for an Android tablet PC to capture an image and display the processed image results. So preferred a Toshiba satellite series laptop with basic configuration for CCS implementation. At the same time by using BSNL Penta IS701C for implementation of image acquisition and presentation device.

The CCS accepts a color image as input to algorithm. This image may be either grasped from inbuilt VGA camera of laptop or from inbuilt camera of Android tablet. Further the image is converted to gray level for simplicity of processing and then thresholding done to highlight the characters or hand gestures. The threshold value is chosen very carefully based on color to be extracted like skin color in gesture interface application. This image is then forwarded for region crop to remove unwanted pixel areas and chose area of interest like a character. At the later on stage this image part is compared with standard database images using following function of correlation [9].

The correlation coefficient between image a and b, where a and b are matrices or vectors of the same size. Then 2-D correlation coefficient computes using

$$r = \frac{\sum_m a \sum_n (a_{mn} - \bar{a})(b_{mn} - \bar{b})}{\sqrt{\left(\sum_m \sum_n (a_{mn} - \bar{a})^2\right)\left(\sum_m \sum_n (b_{mn} - \bar{b})^2\right)}}$$

Where, a = mean2 (a), and $\bar{b}$= mean2 (b)
mean2 () is average or mean of matrix.

The database entry showing maximum correlation is nothing but actual character to be recognized or gesture to be identified. The gesture identified then triggers a windows application.

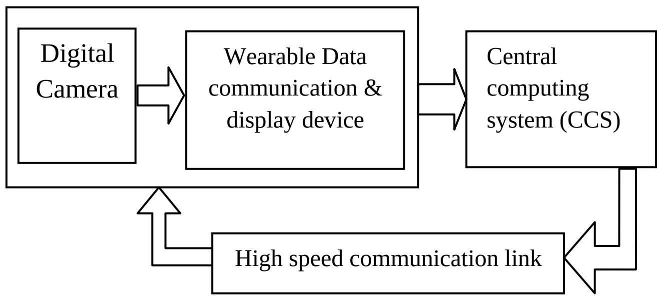


**Fig 1: Proposed System block diagram**

## 5. EXPERIMENTAL RESULT

The experiments performed for the captured images and saved images on Hard Disk (HDD) locally, images using VGA camera of laptop and images acquired using an Android tablets webcam with different resolution.

The proposed system is tested with a variety of images run 10 times on the same inputs and an average computation time as well as success rate is calculated [8].

The processing times measured in the application occur within the individual functions listed under the various activities. The process tick counts measured by the built in functions in MATLAB as well as Java packages in MATLAB to get the system time. With the grab of a time stamp at the beginning of processing and then a time stamp at the end of processing obtained the total processing time. It would also be useful work to determine the time to acquire and display an image in the preview [8]. The detailed analysis of the processing time for said application is summarized in table 1 and same is plotted in the fig 2.

**Table 1. Processing time delay**

| Source Image→ | Delay (Sec) | | |
|---|---|---|---|
| | **Image1** | **Image2** | **Image3** |
| **Images saved on HDD** | 7.02 | 3.66 | 1.41 |
| **Image captured through inbuilt PC camera** | 7.77 | 6.21 | 5.21 |
| **Image captured via Android tablet** | 8.10 | 6.86 | 5.47 |

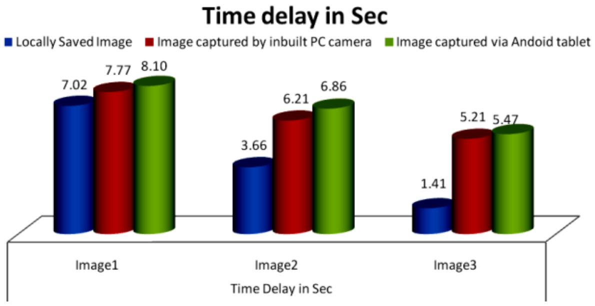


**Fig 2: Processing time delay**

The proposed system is also tested for success rate or recognition rate. Normalized ratio of number of characters successfully identified in an image captured to number of characters present in an image is used for said rate in the application of OCR. Table 2 contains success rate observations for three images. Graphical representation of success rate is shown in the Fig 3.

**Table 2. Success rate**

| Source Image | Success rate (%) | | |
|---|---|---|---|
| | **Image1** | **Image2** | **Image3** |
| **Images saved on HDD** | 100 | 100 | 100 |
| **Image captured through inbuilt PC camera** | 73.4 | 98.4 | 83.9 |
| **Image captured via Android tablet** | 83.4 | 97.6 | 95.2 |

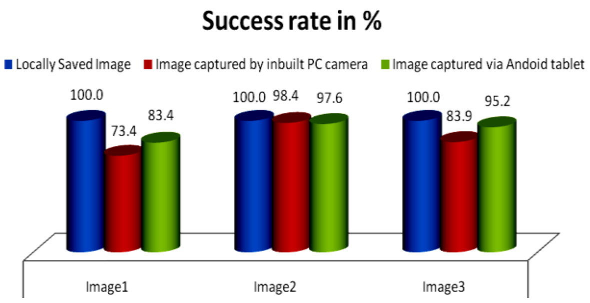


**Fig 3: Success rate**

The performance analysis of proposed system with respects to processing time and success rate concludes that if an image processing application withstand with an additional average delay of 416ms proposed system could be good solution for it.

In the part of implementation and execution, Android tablet goes all the way through five distinct steps. CPU utilization and memory consumption of the tablet for these five steps are shown in the fig 4 and fig 5 respectively.

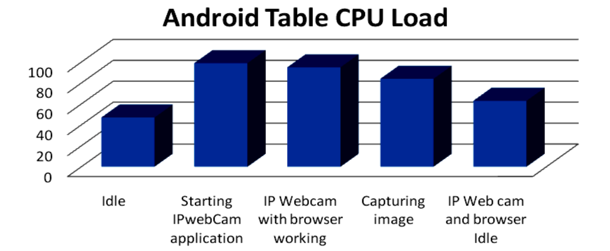


**Fig 4: Android tablet CPU utilization**

The Android Operating System supports the running of simultaneous applications and depending on the priority of the application processing times may be impacted. For instance, if an incoming phone call occurs while an image is being processed the call takes precedence over other applications.

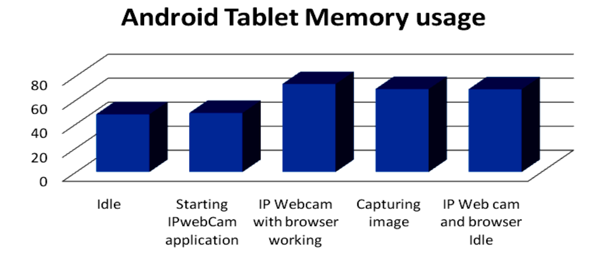


**Fig 5: Android tablet memory usage**

Study of CPU and memory utilization of Android proves that systems resource consumption for client end is moderate and hence tolerable one.

Proposed application uses image of standard resolution 320x240. Same application is tested for 640x480 resolution too. Observations are plotted in fig 6.

Resolution test clearly indicates that if resolution increased it adversely impacts on average processing delay. By increasing resolution to 640x480 from 320x240 overall delays increased 7.65 times.

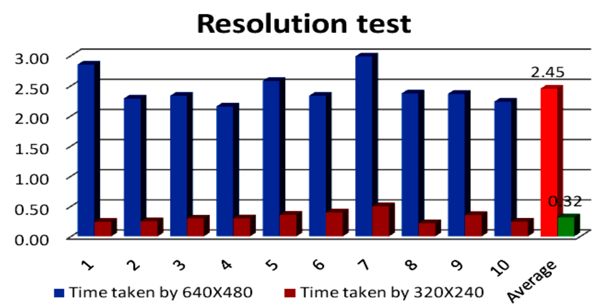


**Fig 6: Resolution test**

Image processing and hosting application is one of the well-liked areas in Android app development. Two popular app are IP web cam and Epoc cam. Performance glance is done in fig 7 for standard resolution of 320x240.

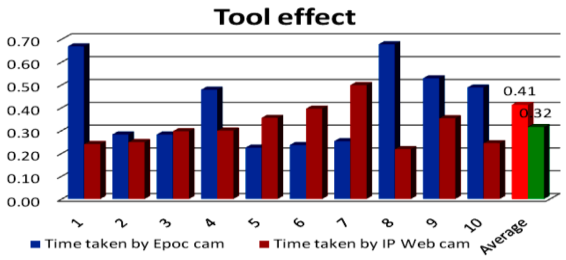


**Fig 7: Effect of different tools**

Figure 7 shows that IP webcam tool is greatly efficient as compared to Epoc cam. Hence for the implementation of proposed system IP Webcam is used.

Actual processing of an image is performed on CCS. It adds additional overhead of CPU and memory consumption. Detailed CPU and memory utilization of MATLAB process for 10 iterations are illustrated in fig 8 and fig 9.

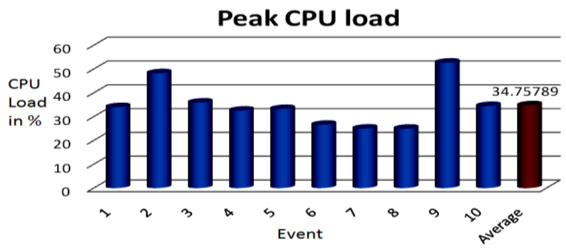


**Fig 8: Peak CPU load of CCS**

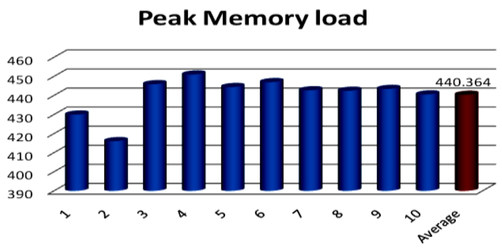


**Fig 9: Peak memory utilization of CCS**

## 6. DISCUSSION

Laptops and smart phones are indispensable now a day. These gadgets are not only used for work in the office but also to get information on the way and to interact with augmented reality. The basic drawback of limited resource availability can be overcome by outsourcing job of computation to CCS.

Analysis of processing time delay conveying that this additional delay of 416ms is very much acceptable for majority of image processing application like number plate recognition, sign board recognition and translation, which involve human assistance. Proposed system provides the minimum value of delay for standard resolution of 320x240 Pixels as compared to 640x480. Analysis of the different Android apps, like IPweb cam and epoc cam, for Android 4.0.3 ICS platform shows result with great evolution with respect o processing time or delay. The proposed system shows moderate result for CPU and memory consumption for CCS as well as Android tablet.

## 7. FUTURE SCOPE

The next step of for this development is to implement and test it for more complex image processing applications that contain aggregates of the benchmarked image processing routines like the Hough Transform or the SURF algorithm [1][2]. A similar runtime analysis to what was performed here in this paper would be performed on these applications

The offline and online peak CPU utilization and peak memory utilization can be improved by significant changes at the shared connectivity i.e. Wi-Fi. Overall system performance could be improved with innovative and dedicated apps at the Android 4.0.3 transceiver end.

MATLAB processing time can be significantly reduced by decreasing resolution of image being compared with standard database of characters.

## 8. ACKNOWLEDGMENTS

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