
# Foundations of Human-Computer Interaction

**Syllabus**

What is HCI-design, Models, Evaluation, Need to understand people, Computers, and methods, Basic human abilities- vision, Hearing, Touch, Memory.

Computers : Speed, Interfaces, Widgets, and effects on interaction. Human : Memory, Attention span, Visual Perception, Psychology, Ergonomics, Understanding Users.

Methods for evaluation of interfaces with users : Goals of evaluation, Approaches, Ethics, Introspection, Extracting the conceptual model, Direct observation, Constructive interaction, Interviews and questionnaires, Continuous evaluation via user feedback and field studies, Choosing an evaluation method.

## 1.1 Introduction

This chapter emphasizes major objective and outcome along with important discussions presented as follows :

**Objective :** To design, implement, and evaluate effective and usable Human Computer Interfaces.

**Outcome :** To evaluate the basic of human and computational abilities and limitations.

**Important Discussions :**

- The keyboard and mouse are currently the main interfaces between man and computer.
- Humans communicate mainly by vision and sound, therefore, a man-machine interface would be more intuitive if it makes greater use of vision and audio recognition. The user not only can communicate from a distance but need have no physical contact with the computer. However, unlike audio commands, a visual system would be preferable in noisy environments or in situations where sound would cause a disturbance.
- The way humans interact with computers is constantly evolving, with the general purpose being to increase the efficiency and effectiveness by which interactive tasks are completed. Real-time, static hand gesture recognition affords users the ability to interact with computers in more natural and intuitive ways.

Real-time hand tracking and gesture recognition is an important problem in the field of Human Computer Interaction (HCI), since hand motion and gestures could potentially be used to interact with computers in more natural ways. Hand gesture has its specific meaning and is widely used for dumb and deaf people who understand Sign Language (SL) as alternative form of communication.

## 2 What is HCI ?

Human Computer Interaction (HCI) plays significant role in computer vision and pattern recognition along with object detection in real-time. HCI facilitates diversified and potential development of applications such as Hand Gesture Recognition System (HGRS), Character Recognition System, Emotion Recognition System, etc. It is science and technology that allows computers to behave like human being.

Human has its own capabilities and potential. Also, computer has its own capabilities and potential. But, human can think by his own and express emotions while computer may not thing by own and can't have emotions. So, it is almost tough development of mobile devices and sensors, hand gestures have become a popular way to interact with Tablet PC, phones, and personal computers.

HCI needs to include methodologies based on analytic and implementation.

In HCI applications, task analysis is performed at analysis phase, approximation is done at verification and validation phase, and calculation is done at pattern recognition phase.

HCI deals with input, processing on it using various image processing phases and produces output using classification, clustering, pattern recognition etc.

HCI is applicable in Hand Gesture Recognition System (HGRS), Character Recognition System (CRS), Emotion Recognition System (ERS) etc. These systems takes input from user and convert it into either text or speech.

In HGRS,Hand of the user acts as input that produces output as text using various processes such as image capturing, region extraction, feature extraction, feature matching, and pattern recognition along with text to speech conversion.

In CRS, character acts as input that produces output as alphabet / number / special character using sequential operations such as image segmentation, binarization, image preprocessing, image processing, and image post processing.

In ERS, Standard emotion of human is captured that allows to determine specific mind set of user.

With the widespread applications of HCI there exists scope of development of diversified applications related to biomedical, multiple sign language recognition, industrial engineering etc.



- HCI comprises two aspects such as human aspect and computer aspect.
  - (i) Human aspect of technical systems consists of emotions, memory, attention span, visual perception, psychology, ergonomics, Understanding, and mind set.
  - (ii) Computer aspects of technical system deals with speed, interfaces, widgets, effects on interaction, and computation ability.

### 1.2.1 HCI Design

- HCI mainly focuses on interaction design that includes design thinking about structuring of interactive and effective systems. In the past, real time applications have been considered as complicated task before the invention of HCI design. So interaction design using HCI design is used to think about designing interventions.
- The outcome of HCI designing is based on interactive design along with prototyping, task analysis along with evaluation. It deals with problem solving capability based on desired problem statement, case studies, decision support system along with. Also, it is related to various things that requires to fulfil requirements of final product such as Goals, Constraints, Trade-off.
- The major role in design is about choosing the correct idea, prediction analysis, various operations related to software architecture approach hand in hand with traditional software engineering approach.
- HCI design comprises following things :
  - (i) The Golden Rule of Design that includes understanding about problem and its solution related to design. Additionally, there exists heterogeneous raw data / material that is applicable for production of final product which the basis of golden rule of design. For HCI the materials used are the human and computer in which understanding computers and understanding people are crucial parts.
  - (ii) To err is human : The aforementioned material as human / people do the mistakes but this is not 'human error' however it is human nature. Many a times, design of contents by human may produce more failures as compared to computer. Therefore, computer system is applicable for designing to reduce those mistakes and to minimize the consequences when mistakes are done.
  - (iii) The central message : The user which is based on information related to human psychology techniques, technology, methodology, and systems. Success of HCI model is based on mind set of designer.

### 1.2.1.1 HCI Methodologies

**(a) Activity Theory**

Activity theory used in HCI is applicable for structuring and detailing of the framework. It is considered as tool for analysis and design phase required to work in problem domain and solution domain.

**(b) User-Centric Design**

User-Centric design emphasizes human as central element which make think, create, develop new ideas. As well as with the help of newer technologies and techniques human may design heterogeneous models. In addition to human capabilities are more superior than computer when the requirement is of real time problem solution and design thinking.

**(c) Principles of User Interface Design**

Principles of user interface design comprises creativity, visual perception, interpretation, decision support system, efforts, structuring, and consistency.

## 1.2.2 HCI Models

### 1.2.2.1 Seeheim Model for Structural Design

HCI model deals with basic level structuring of model that includes imagination, visual perception, human perspective. System is developed using multiple sub-systems, sub-systems comprises various components. Components are made from collaboration of various modules and modules made up of multiple programs.

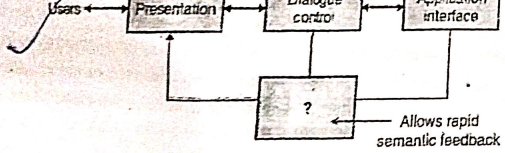


*Fig. 1.2.1 : Seeheim model*

Presentation layer is used to produce User Interface (UI) that is interacting with human / user. For example in hand gesture recognition system, user's hand act as input to web camera and it produces output as text which is displayed on screen. So, it is important human computer interface.





- Dialogue control act as mediator between presentation layer and application interface layer that bridges the communication gap between these tool. For example in hand gesture recognition system user interacts with computer via web camera only.
- Application interface is the notation to convey appropriate messages to the user. It may have some constraints or rules to display expected outcome based on processing applied on input. For Example in hand gesture recognition system display of text as a resultant of conversion of hand symbol into specific sign language which is applicable to hearing and speech impaired users.

### 1.2.2.2 Behavioural Model

Behavioural model focuses on analysis of raw data, information, knowledge used for further processing depending on multiple sequential operations and their outcomes.

**(a) Goals, Operators, Methods, and Selection (GOMS) Model**

A GOMS consists of four elements namely ; Goals, Operations, Methods, and Selection.

- **Goals :** The expected outcome of the system acts as goal of the system which is commonly achieved by the collaboration of various sub-systems, components, modules, software and hardware elements.
- **Operators :** The processing or operations applied on input elements produces expected outcome depending on various commands and techniques.
- **Methods :** In GOMS model, methodology plays important role in splitting goals into sub-goals. Diversified methods are applied on input to produce output in different ways to improve comparative performance of the system.
- **Selection :** In GOMS model, selection command is applicable for taking decisions of choosing the appropriate path by selecting correct data. Selection plays important role in fining best suitable solution by applying correct method on correct output and produces appropriate output.

**(b) Enhanced OAI Model**

- The basic level Object Action Interface (OAI) model is applicable for recognition of appropriate operations using interface object.
- **Interface object (O) :** Interface objects may contain various intrinsic controls such as command buttons, text, radio buttons, check boxes as a part of user interface. Also represents operations that are possible with command buttons along with multiple events generated by keyboard and mouse.

- **Interface action (A) :** Interface action is related to operations performed by buttons using multiple events related to keyboard and mouse such as mouse click and key press events.
- **Interface responded (R) :** Interface reflects outcome of the developed system using various controls, operations, methodologies and logics.

## Basic Human Ability

### Vision

Human vision is highly complex activity with a range of physical and perceptual limitations, yet it is primary source of information for the average person.

#### 1.1 The Human Eye

Vision begins with light. The eye is a mechanism for receiving light and transforming it into electrical energy. Light is reflected from objects in the world and their image is focussed upside down on the back of the eye. The receptors in the eye transform it into electrical signals, which are passed to the brain.

#### 1.2 Visual Perception

Visual perception deals with perspective of individual towards observing the things and analysing based on decision support system.

Visual perception correctly produces recognizing the appropriate patterns based on training received by human brain.

#### 1.3 Reading

The recognised pattern converted into text for reusability purpose and stored in textual format using writing and retrieved using reading process.

Reading allows to analyse, understand and gain the knowledge from the written materials.

### Hearing

Hearing is the ability used to exchange knowledge using input device as ears which are useful to recognise speech and helpful in speech processing using synthesis and analysis.

#### 2.1 Human Ear

Human ear acts as input device to receive speech and complete the communication among man. It is important to process the speech using human ear.





#### 1.3.2.2 Processing Sound

- As we have seen, sound is changes in vibrations in air pressure. It has a number of characteristics which we can differentiate.
- **Pitch** is the frequency of the sound a low frequency produces. A low pitch, a high frequency, a high pitch.
- **Loudness** is proportional to the type of the amplitude of the sound, the frequency remains constant.
- **Timbre** relates to the type of the sounds, sounds may have same pitch and loudness but be made by different instruments and so vary in timbre.
- The human ear can hear frequencies from about 20 Hz to 15 kHz. It can distinguish frequency changes of less than 1.5 Hz at low frequencies but it is less accurate at high frequencies.

### 1.3.3 Touch

- Touch is the senses that we will consider. Touch is nothing but haptic perception.
- Touch provides us with vital information about our environment. It tells us when we touch something not or cold and can therefore act as a warning. It also provides us with feedback when we attempt to lift an object.
- The apparatus of touch differs from that of sight and hearing in that it is not localized. We receive stimuli through the skin. The skin contains three types of sensory receptor :
  - **(i) Thermoreceptors :** responds to heat and cold.
  - **(ii) Nociceptors :** responds to intense pressure, heat and pain.
  - **(iii) Mechanoreceptors :** Responds to pressure.

### 1.3.4 Human Memory

- Although computer has limited memory as compared to human memory but it has potential to remember the multiple things altogether. Based on capability of human memory cognition model is applied by practices to improve performance of human memory.

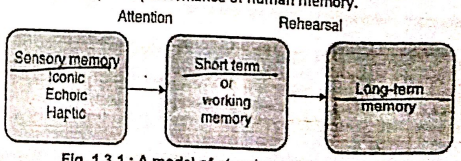


**Fig. 1.3.1 ; A model of structure of the memory**

### 1.3.4.1 Sensory Memory

This act as buffers for stimuli received through the senses. A sensory memory exists for each sensory channel

(i) Iconic memory for visual stimuli

(ii) Echoic memory for aural stimuli

(iii) Haptic memory for touch.

**Example**

**(i) Iconic memory**

Moving a finger in front of the eye. Can you see it in more than one place at once ? This indicates a persistence of the image after the stimulus has been removed.

**(ii) Echoic Memory**

- This is evidenced by our ability to ascertain the direction from which a sound originates.
- Have you ever had someone ask you a question when you are reading ? You ask them to repeat the question, only to realize that you know what was asked after all.

### 1.3.4.2 Short-term Memory

This act as a 'Scratch-Pad' for temporary recall of information. It is used to store information which is only required fleetingly.

**Example**

- Calculate the multiplication 35 x 6 in your head. The chances are that you will have done this calculation in stages, perhaps 5 x 6 and then 3 x 6 and added results or you may have used the fact that 6 = 2 x 3 and calculate 2 x 35 = 70 followed by 3 x 70 = 210. To perform calculations such as this we need to store the intermediate stages for use later.
- Short term memory also has a limited capacity. There are two basic methods for measuring capacity. The first involves determines the length of a sequence which can be remembered in order. The second allows items to be freely recalled in any order.



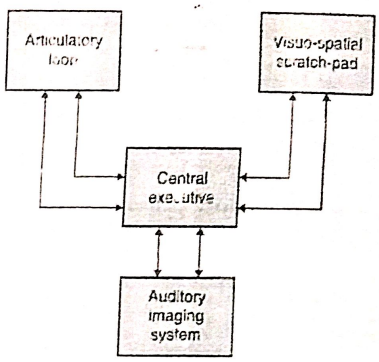


Fig. 1.3.2 : Model of short-term memory

### 1.3.4.3 Long-Term Memory

- Short-term memory is our working memory or 'Scratch-Pad', long term memory is our resource. Here we store factual information experiential knowledge, procedural rule behaviour-in fact, everything that we 'know'.
- Long term memory is intended for the long-term storage of information. Information is pla there from working memory through rehearsal.

There are two types

**(i) Episodic Memory**

This memory represents our memory of events and experiences in a serial form.

**(ii) Semantic memory**

This is a structured record of facts, concepts and skills that we have acquired.

## 1.4 Computers

In HCI, computer element deals with various aspect such as speed, interfaces, widgets, and effe on interaction that is discussed subsequently.

### 1.4.1 Speed

- Computers are expected to communicate through high speed local networks, rotationally ove WAN and probably via infrared, ultrasonic, cellular and other technology.

The speed of computer processing depends on the speed of CPU, the most relevant piece of speed in CPU is clock speed.

### 1.4.2 Interfaces

In computing, an interface is a shared boundary across which two or more separate components of a computer system exchange information.The exchange can be between software, computer hardware, peripheral devices, humans and combinations of these

### 1.4.3 Widgets

A widgets is an additional feature on extension to a software program operating system GUI or web page, which enables additional features.

A widget can add a wide variety of functionality, including Icon, Menus, buttons etc.

### 1.4.4 Effect on Interaction

The livelong experience of humans from interactions with other humans has led to expectations regarding the general rules of communication that are automatically applied to interactions with technical systems.

## 1.5 Human

### 1.5.1 Human Memory

Human memory deals with short term and long term memory. Computer memory is constructed on the basis of working of human memory.

### 1.5.2 Attention Span

Attention plays an essential role in task performance and interaction. It enables us to act, reason and communicate in physical or virtual environments that offer us stimuli exceeding, probably by several orders of magnitude, what we are actually capable of processing.

Long term attentional processes refer to processes that span over or length of time of minutes, long term memory and working memory.

### 1.5.3 Visual Perception

Visual perception is the first phase of computer vision applied for HCI applications that deals with correct perception gives correct outcome. Web camera acts as input device in computer while human we act as input device to have visual perception of various things.





### 1.5.4 Psychology

Psychology is totally depends on mind set, context, and circumstances happened in the life of human. It allows human to think differently in different situation.

### 1.5.5 Ergonomics

- It means designed for efficiency and comfort in the working environment.
- It studies of interfaces have focused almost exclusively on user's perceptual, cognitive and motor skills, rather than on affectively social or attitudinal factors, although work in the later fields.
- The challenge for interface designers is to design systems whose interaction with users will induce the latter to form mental models similar to the system's conceptual model.
  1. Learning
  2. Developing knowledge
  3. Unavoidable errors
  4. Needs analysis
  5. Prototyping

### 1.5.6 Understanding Users

**Why need to understand ?**

- Interacting with technology is cognitive.
- We need to provide knowledge about what users can and can't be expected to do.
- Identify and explain the nature and causes of problems users encounter.
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive product.

## 1.6 Methods for Evaluating of Interfaces with Users

### 1.6.1 Goals of Evaluation

- Assess extend of system functionality.
- Asses effect of interface of user.
- Identify specific problems.
- Check to ensure that the final interface is consistent.

- Investigate how technology affects working practices.
- Improve the usability of an existing product.

### 1.6.2 Approaches

- Evaluation test is the usability, functionality and acceptability of interactive system.
- Some approaches are based an expert evaluation.
  1. Analytic methods
  2. Review methods
  3. Model-based methods
- Some approaches involve users.
  1. Experimental methods
  2. Observational methods
  3. Query methods

### 1.6.3 Ethics

- You must not cause your subject distress.
  1. Invading privacy
  2. Physical abuse
  3. Unpleasant emotions
- Original material produced by subjects must be kept confidential.
- In reports, subjects should not be identifiable in any way.
- Participant consent form : Named and signed.

### 1.6.4 Introspection

- Designers tries the system or prototype out.
  i) Does the system "Feel right" ?
  ii) Most common evaluation method

**Benefits**

Can probably notice some major problems in early versions during every day use.

**Problems**

i) Not reliable as completely subjective.
ii) Not valid as introspector is non-typical user.





### 1.6.5 Extracting the Conceptual Model

- Show the user static images of :
  i) The paper prototype or
  ii) Screen snapshots or
  iii) Actual system screens during use.
- Have the user try to explain :
  i) What an element are
  ii What they would do to perform a particular task.
- Initial Vs formative conceptual models.
  i) **Initial -** How to person perceives a screen the very first time it is viewed.
  ii) **Formative -** The same, except after the system has been used for a while.
- Conceptual model extraction approach is excellent for extracting a novice's understanding of system. Requires active intervention by evaluator, which can get in the way.

### 1.6.6 Direct Observation

Observation involves watching and listening to the users. Observing users interacting with software, even casual observing, can tell you on enormous amount about what they do, the content in which they do it, how well technology supports them and what other support is needed.

### 1.6.7 Constructive Interaction

- It says test subjects to discuss and solve a problem.
- Constructive interaction by asking pairs of subjects to make collaborative decisions about how to proceed through hypertext
- The main advantage of this is that it yields a rich set of quantitative data that provide valuable insight into how the people perceive situations, how they go about solving problems.

### 1.6.8 Interviews and Questionnaires

**Interviews**

i) **Quantitative technique**
   - Gathering information about users by talking directly to them.
   - A method for discovering facts and opinions of the users.

**Format**

- It is usually done by one interviewer speaking to one user at a time.
- **Structured interview :** A pre-defined set of questions and users.
- **Open ended interview :** allows for as exploratory approach to uncover unexpected information.

**Problems**

The unstructured nature of the resulting data can be easily misinterpreted.

### estionnaires

**Qualitative technique**

Result can be quantified.

**Preparation**

- Keep questions simple, be clear and concise.
- Group questions appropriately and give explanation.

Pilot questionnaire before distributing it. It is still unreasonable to think that any one person can anticipate all the potential problems.

**Problems**

It is only as good as the questions it contains.

## 5.9 Continuous Evaluation via User Feedback and Field Studies

### ntinuous evaluation

Monitor systems in actual use

- Usually late stages of development
- Fix problem in next release

User feedback via gripe lines

- Users can provide feedback to designers while using the system.
  - i) Help desks
  - ii) Bulletin boards
  - iii) email
- Best combined with trouble shooting facility.
  - i) Users always get a response to their gripes.





**Case/field studies**

- Careful study of "System usage" at the site.
- Good for seeing "real life" use.
- External observer monitor behaviour.
- Site visits.

### 1.6.10 Choosing an Evaluation Method

| | | | |
|---|---|---|---|
| (i) | When in process | : | Design Vs implementation. |
| (ii) | Style of evaluation | : | Laboratory Vs field. |
| (iii) | How objective | : | Subjective Vs objective. |
| (iv) | Type of measures | : | Qualitative Vs quantitative. |
| (v) | Level of information | : | High level Vs low level. |
| (vi) | Level of interference | : | Obtrusive Vs unobtrusive. |
| (vii) | Resources available | : | Time, subjects, equipments, expertise. |

## Review Questions

Q. 1 What is HCI? What are the various phases involved in HCI ?

Q. 2 Explain comparison between Human and Computer.

Q. 3 Write down about entity Human based on following factors:

(a) Memory

(b) Attention

(c) Span

(d) Visual Perception

Q. 4 What is role of Psychology, Ergonomics, and Understanding in HCI ?

Q. 5 Write down about entity Computer based on following factors:

(a) Speed

(b) Interfaces

(c) Widgets

(d) Effect on Interaction

6 What is significant role of thinking in reasoning and problem solving abilities of Human?

7 List down real-time application of HCI.

8 Explain image capturing, image pre-processing, image post-processing, and pattern recognition phases involved in image processing.

9 What is role of HCI in smart phones ?

10 What is mean by Emotion? What is the role of Emotion in HCI?

11 Discuss all six standard emotion along with phases involved in Emotion Recognition.

12 How do we extract data and information by using Conceptual Model.

13 What is impact of direct observation and feedback based on it while constructing the HCI phases ?

14 Which are the factors applicable for choosing evaluation methods?

15 What is the significant role of Interaction, Interviews, and Questionnaires in HCI model?

□□□


# The Design Process

**Syllabus**

Interaction Design Basics, Interaction Styles. HCI in the Software Process. HCI design princ and rules: design principles, principles to support usability, golden rules and heuristics, patterns, design rules, HCI design standards. Direct Manipulation - Overview, Scope, Applicat Universal Design, User-centered design, task analysis/GOMS, Graphic Design

## 2.1 Introduction

This chapter emphasizes major objective and outcome along with important discuss presented as follows :

- **Objective :** To design, implement, and evaluate effective and usable Human Computer Interfac
- **Outcome :** To evaluate the basic of human and computational abilities and limitations.

**Important Discussions**

Design and detailed design phase plays significant role in HCI. Design changes as per perception and perspectives of individual. It is the ability of each and every person to solve problem. We may use creativity potential of human to design the problem in various ways. Firstly, discuss one innovative example to visualize the different designing styles and ways to design using same input for users or 40 users or many more. Input is one big square and 13 small squares with fix positions as shown in Fig. 2.1.1 below:

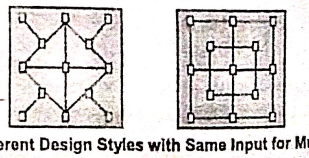



**Fig. 2.1.1 : Different Design Styles with Same Input for Multiple Users**

is observed from Fig. 2.1.1 that multiple users behave differently as per the perception and rspective of designing for the same inputs. Although, homogeneous input is given to human ain but then also multiple mindsets provides diversified or heterogeneous design styles.

condly, in this context if we provide heterogeneous inputs then also users may generate eterogeneous and complicated design structures. E.g. if 5 elements act as input namely; 2 circles, triangles, 1 square, 2 rectangle, 2 lines produces variety of complicated designs as presented in g. 2.1.2.

ere, if we the aforesaid heterogeneous elements provided as input to 2 users or 20 or many ore then also multiple designs are generated by different users. Therefore how to design and lve the given problem statement is totally dependent on perspective of user.

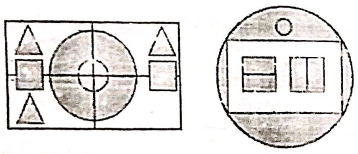

**Fig. 2.1.2 : Multiple Designing Structures using Heterogeneous Inputs**

milarly, if team of 4 programmers designs together for achieving common goal, then 4 mindsets nd 4 kinds of skill sets come to together and applies design thinking to solve the problem with ollaborative mindset and technical set. The collaborative approach results in interactive designing or the HCI system with same or different inputs and produces the effective output. E.g. Language ranslator System based on HCI may take any kind of language and produces best suitable anguage as resultant output.

equentially, designing may be standardized using common ways/methodology/algorithmic pproach of solving the given problem. Such kind of monomorphic design results if standard olution that may act as universal designing Various design structures deals with task analysis and nodel based solutions along with user centric approach. E.g. Architectural point of view while esigning the structure based on customers need.

asic design, interactive design, and universal designs play crucial role in the development of ystem Architecture of HCI System. E.g. System Architecture of Hand Gesture Recognition System HGRS) as depicted in Fig. 2.1.3 comprises six phases namely; Image Capturing, Image Pre-rocessing, Region Extraction, Feature Extraction, Feature Matching, and Pattern Recognition.





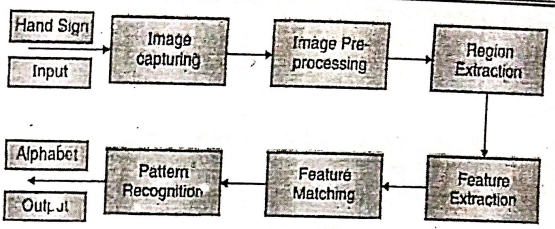


**Fig. 2.1.3 : System Architecture for Hand Gesture Recognition System (HGRS)**

## 2.2 Interaction Design Basics

### 2.2.1 Introduction

- Interactive design deals with interaction between multiple users mind sets and knowledge sets to achieve common goal. Heterogeneous mind set and technical skill sets come together to solve common problem based on HCI and produces standardized solution using HCI patterns.
- Outcome of interactive design may be solution to complicated problem in a easy way after detailed design phase.
- Interactive design mainly emphasizes module-wise, stage-wise, and phase-wise iterations of designing structures.
- Also, it focuses on interpretation and analysis of problem in a correct way because correct input only results in correct output.
- Technical, technological, analytical, and logical collaboration is required for the successful designing of HCI system.
- Design thinking act as base for interactive design.
- Software architecture is defined on the principle of interactive design that involves inter relation between sub systems, modules, components, hardware elements, software elements, stakeholders etc.

HCI system consists of interactive design as presented in Fig. 2.2.1.

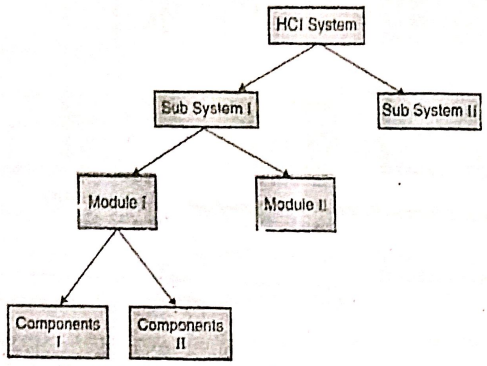


**Fig. 2.2.1 : HCI System based on Interactive Design**

## 2.2.2 Design

Design comprises tasks, process and solution in the form of goal. Human as user and Computer as machine are the two basic elements required to know about raw data. Design is concept of finding inter relationship between various components of HCI system along with limitations of designs. Design thinking is the pre requisite for basic design structure that includes input channel, Processing, and output channel. Design means "achieving the outcome within constraints".

Varieties of designs are generated by multiple users with their innovative ideas. Design comprises Goals, Constraints, and Trade-offs. Goals deal with expected outcome that appears after various HCI processes or operations such as pre-processing, processing, and post-processing operations. Constraints are based on basic level elements such as training dataset, input channel, methodologies, algorithmic approaches as per the requirements. Trade-offs suggest about bench mark and choice of standardized solution using Decision Support System (DSS).

## 2.2.3 The Process of Design

The design process includes various processes such as Correct Interpretation of problem statement, Analysis, Basic Design, Prototyping, Detailed Design, Iterative Design, and Standardized Design as depicted in Fig. 2.2.2 discussed as follows:





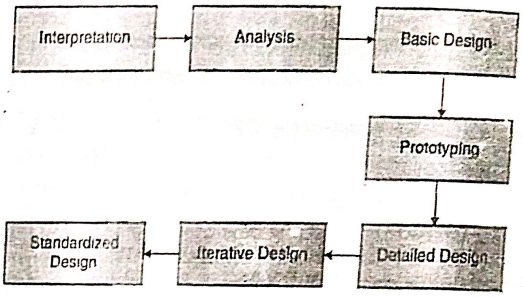


**Fig. 2.2.2 : Process of Design**

1. Correct interpretation of problem is the first step of understanding the problem correctly and thinking in brain about design thinking.
2. Analysis step deals with correct interpretation of actual structuring of problem on paper with collaborative thinking of team.
3. Basic design is related to software architectural point of view of user.
4. Prototypic comprises execution of basic design in the form of visualized model.
5. Detailed design consists of various design patterns and knowledge based study of each and every level of design.
6. Iterative design includes redesign and reconfigurations relevant to customers need.
7. Standardized design result into universal design model using standard input, best suitable technology after refinement of design based on interaction with stakeholders.

Interactive design empnasizes on mind set, knowledge set, and technical skill set of users and needs of solution and demand of solution in multiple scenarios. These scenarios may be pipelined approach of designing or simple representation of design for complex problems or deals with short term solutions or long term solutions. Moreover, interactive design can be designed using imagination. E.g. "Drawing of Nature" as presented in Fig. 2.2.3 is drawn by many users result in diversified representation of nature using common elements such as mountains, trees, birds, river, sky, clouds etc.

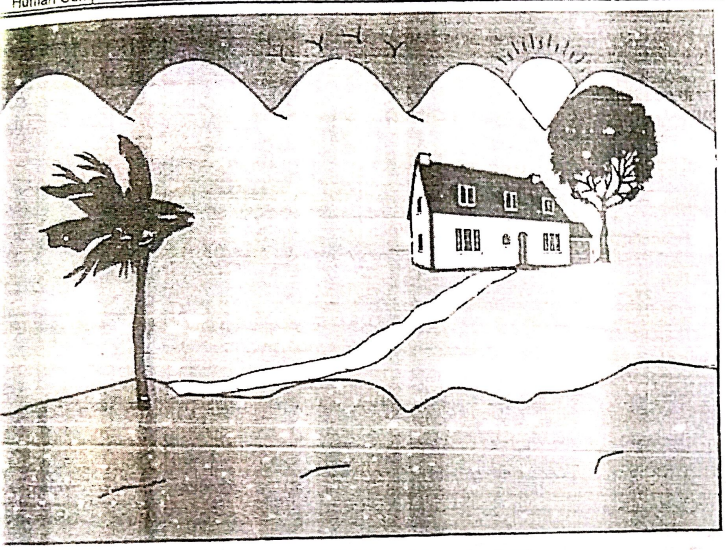

Fig. 2.2.3 : Drawing of Nature as Interactive Design

## 3 Interaction Styles

Interaction can be seen as a dialog between the computer and the user. The choice of interface yle can have a profound effect on the nature of this dialog. There are number of common interface yle includes,

### 3.1 Command Line Interface

This was the first interactive dialog style to be commonly used and in spite of the availability of menu driven interfaces, it is still widely used.

It provides a means of expressing instructions to the computer directly, using function keys, single characters, abbreviations or whole word commands.

### 3.2 Menus

In a menu - driven interface, the set of options available to the user is displayed on the screen and lected using the mouse or numeric or alphabetic keys. Since the options are visible they are less emanding of the user relying on recognition rather than recall.





### 2.3.3 Natural Language

- Perhaps the most attractive means of communicating with computers, at least at first glance is by natural language.
- Users, unable to remember a command or lost in a hierarchy of menus, may long for the computer that is able to understand instructions expressed in everyday words.
- Natural language understanding, both of speech and written i/p.

### 2.3.4 Question / Answer and Query Dialog

- Question and answer dialog is simple mechanism for providing i/p to an application in a specific domain. The user is asked a series of questions and so is led through the interaction step by step.

  **Example:** Web questionnaires

- Query language used to construct queries to retrieve information from a database. They use natural - language style phrases, but in fact require specific syntax, as well as knowledge of the database structure.

### 2.3.5 Form - Fills and Spreadsheets

- Form - filling interfaces are used primarily for data entry but can also be useful in data retrieval applications.
- The user is presented with display resembling a paper form, with slots to fill in.
- Spreadsheets are sophisticated variation of form filling. The spreadsheet comprises a grid of cells, each of which can contain a value or a formula. The formula can involve the values of other cells.

### 2.3.6 The WIMP Interface

- WIMP stands for windows, icons, menus and pointers. (Some times windows, icon, mice and pull down menus).
- This is the default interface style for the majority of interactive computer systems in use today, especially in the PC and desktop work station area.

**Example**

- Microsoft Windows for IBM PC
- Mac OS
- X windows for UNIX.

### 2.3.7 Point and Click Interface

- You may point at a word in some text and when you click you see a definition of the word.
- This interface style is obviously closely related to the WIMP style. It clearly overlaps in the use of buttons, but may also include other WIMP elements.

### 2.3.8 Three - dimensional Interface

- There is increasing use of 3D effects in user interfaces. The most obvious example is virtual reality, but VR is only part of a range of 3D techniques available to the interface designer.
- The simplest technique is where ordinary WIMP elements, buttons, scroll bars etc. are given 3D appearance using shading, giving the appearance being sculpted out of stone.

## 2.4 HCI in the Software Process

### 2.4.1 Introduction

Within computer science there is already a large sub-discipline that addresses the management and technical issues the development of software system called software engineering.

### 2.4.2 Software Life Cycle

- One of the claims for software development is that it should be considered as an engineering discipline, in a way similar to how electrical engineering is considered for hardware development.
- Software Life Cycle with sequential phases is depicted in Fig. 2.4.1.

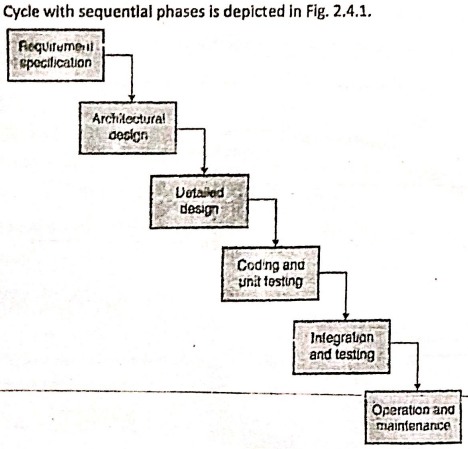


**Fig. 2.4.1 : The activities in the waterfall model of the software life cycle**





**Requirements Specification**

- In this phase, the designer and customer try to capture a description of what the eventual system will be expected to provide.
- This is in contrast to determine how the system will provide the expected services.

**Architectural Design**

This provides a decomposition of the system description that allows for isolated development of separate components which will later be integrated.

**Detailed Design**

- This is refinement of the component description provided by the architectural design.
- The behaviour implied by the higher-level description must be preserved in the more detailed description.

**Coding and Unit Testing**

- The detailed design for a component of the system should be in such a form that it is possible to implement it in some executable programming language.
- After coding the component can be tested to verify that it performs correctly, according to some test criteria that were determined in earlier activities.

**Integration and Testing**

- Once enough components have been implemented and individually tested, they must be integrated. Further testing is done to ensure correct behaviour and acceptable use of shared resources.
- It is also possible that the system meets their requirements. It is only after acceptance of the integrated system that the product is finally released to the customer.

**Maintenance**

After product release, all work on the system is considered under the category of maintenance until such time as a new version of the product demands a total redesign or the product is phased out entirely.

### 2.4.3 Usability Engineering

- Usability is based on measurement of users experience with it. Therefore, since a users direct experience with an interactive system is at the physical interface, focus on the actual user interface is understandable.

ability objective

Suitability for the task

Appropriate for trained users

Learn ability

Error tolerance

e problem with usability is that they rely on measurements of very specific user actions in very ecific situations.

## Interactive Design and Proto typing

ne design can be modified to correct any false assumptions that were revealed in the testing. his is the essence of interactive design, a purposeful design process which tries to overcome the herent problems of incomplete requirements specifications.

On the technical side, iterative design is described by the use of prototypes, artifacts that simulate r animate some but not all features of the intended system. There are three main approaches of rototyping namely; Throw-away, Incremental, and Evolutionary that are discussed subsequently.

### Throw - away

The prototype is built and tested and is depicted in Fig. 2.4.2.

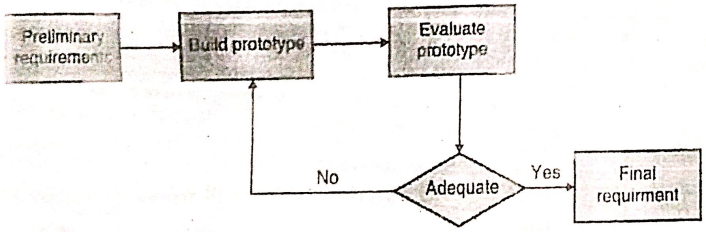


**Fig . 2.4.2 : Throw - away Prototyping**

### Incremental

The final product is built as separate components, one at a time and is presented in Fig. 2.4.3.

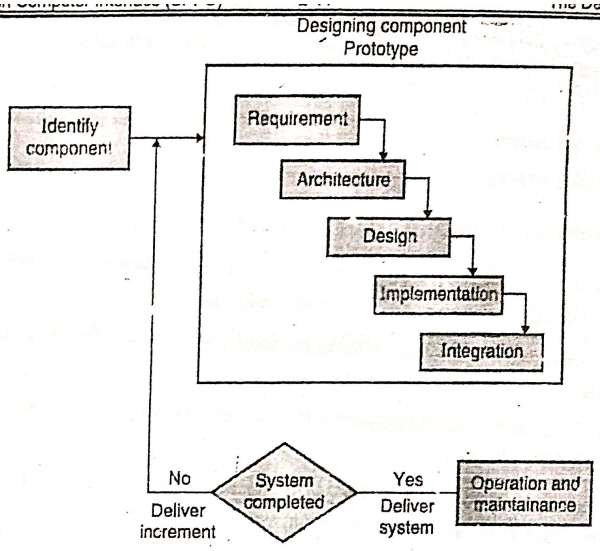


**Fig. 2.4.3 : Incremental Prototyping**

### 3. Evolutionary

Here, the prototype is not discarded and serves as the basis for the next iteration of design shown in Fig. 2.4.4.

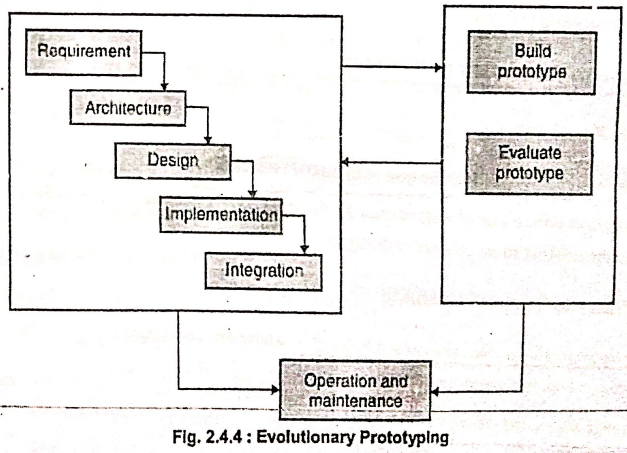


**Fig. 2.4.4 : Evolutionary Prototyping**

**Techniques or Prototyping**

(1) Story board
(2) Limited functionality simulations
(3) High level programming support

### 2.4.5 Design Rationale

- Design rationale i. the information that explains why a computer system is the way it is, including its structural or architectural description and its functional or behavioural description.
- Design rational relates to an activity of both reflection and documentation that occurs throughout the entire life cycle.
- The effort required to produce a design rationale forces the designer to deliberate more carefully about design decisions.
- The design rationale provides a common mechanism among the members of a design team, so that during later stages of design for maintenance it is possible to understand what critical decisions were made.
- Type of Design Rationale
  (1) Process oriented design rationale
  (2) Design space analysis
  (3) Psychological design rationale

## 2.5 HCI Design Principles and Rules

### 2.5.1 Design Principles

- Designing for maximum usability is the goal of interactive system design.
- Abstract principles offer a way of understanding usability in a more general sense, especially if we can express them within some coherent catalogue.

### 2.5.2 Principles to Support Usability

- The most abstract design rules are general principles, which can be applied to the design of an interactive system in order to promote its usability.
- The principles are divided into three parts.





#### 2.5.2.1 Learnability

- The ease with which new users can begin effective interaction and achieve maximal performan
- Following table shows the specific principles which support to learnability.

| Sr. No. | Principle | Definition | Related Principles |
|---|---|---|---|
| 1. | Predictability | Support for the user to determine the effect of future action based on post interaction history. | Operation Visibility |
| 2. | Synthesizability | Support for the user to assess the effect of post operations on the current state. | Immediate Honesty |
| 3. | Familiarity | The extend to which a user's knowledge and experience in real world or computer based domain. | Guessability affordance. |
| 4. | Generalizability | Support for the user to extend knowledge of specific interaction within and across applications to other similar situations. | - |
| 5. | Consistency | Likeness in input-output behavior arising from similar situations or similar task objectives | - |

#### 2.5.2.2 Flexibility

- Flexibility refers to the multiplicity of ways in which the end user of the system exchange information.
- Following table shows principles of flexibility.

| Sr. No. | Principle | Definition | Related Principles |
|---|---|---|---|
| 1. | Dialog Initiative | Allowing the user freedom from artificial constraints on the i/p dialog imposed by the system. | System / user pre-emptiveness |
| 2. | Multi threading | Ability of the system to support user interaction pertaining to more than one task at a time. | Concurrent us interleaving multi-modality. |
| 3. | Task Migrability | The ability to pass control for the execution of a given task so that it becomes either internalized by the user or the system. | - |
| 4. | Substitutivity | Allowing equivalent values of I/O to be arbitrarily substituted for each other. | Represents multiplicity equal opportunity. |
| 5. | Customizability | Modifiability of the user interface by the user on system. | Adaptivity, adaptability |

## 2.3 Robustness

In the work or task domain, a user is engaged with a computer in order to achieve some set of goals. The robustness of that interaction covers features that support the successful achievement and assessment of goals.

Following table shows principles of Robustness.

| No. | Principles | Definition | Related Principles |
|---|---|---|---|
| 1. | Observability | Ability of the user to evaluate the internal state of the system from its perceivable representation. | static/dynamic defaults. |
| 2. | Recoverability | Ability of the user to take corrective action once an error has been recognized. | Reachability |
| 3. | Responsiveness | How the user perceives the rate of communication with the system. | Stability |
| 4. | Task conformance | The degree to which the system services support all of the tasks. | Completeness |

## 3 Golden Rules and Heuristics

### 3.1 Shneiderman's Eight Golden Rules of interface design

Strive for consistency in action sequences, layout, terminology, command use and so on.

Enable frequent users to use shortcuts, such as abbreviations, special key sequences of macros to perform regular actions.

Offer informative feedback for every user action.

Design dialogs to yield closure so that user knows when they have completed a task.

Offer error prevention and simple handling

Permit easy reversal of actions.

Support internal locus of control.

Reduce short term memory load.

### 3.2 Norman's Seven Principles for Transforming Difficult tasks into Simple ones

Use both knowledge in the world and knowledge in the head.

Simplify the structure of tasks.

Make things visible.

Get the mapping right.





(5) Exploit the power of constraints.

(6) Design for error.

(7) When all else fails, standardize.

### 2.5.4 HCI Patterns

- Patterns are an approach to capturing and reusing the knowledge of abstracting the essential details of successful design so that these can be applied again and again in new situations.
- Patterns originated in architecture, where they have been used successfully and they are also used widely in software development to capture solutions to common programming problems.
- A pattern is an invariant solution to a recurrent problem within a specific context. Pattern address the problems that designers face by providing a 'Solution Statement'.
- The pattern also has references to other patterns, indicating both the context in which it can be applied and the patterns that may be needed to complete it. This connects the patterns together into a language.
- Patterns distinguishes from other design rules as,
  - (1) They captures design practice and embody knowledge about successful solutions.
  - (2) They captures the essential common properties of good design.
  - (3) They represent design knowledge.
  - (4) They are not neutral but embody values within their rationale.
  - (5) The concept of pattern language is generative.
  - (6) They are generally intuitive and readable.

### 2.5.5 Design Rules

The design rules consist of following factors:

1. Designing for maximum usability
2. Principle of usability
3. Standard and guidelines
4. Design Patterns

**Types of Design Rules**

1. **Principles**
   - Abstract design rules
   - Low authority
   - High generality
2. **Standard**
   - Specific design rule
   - High authority
   - Limited application
3. **Guidelines**
   - lower authority
   - more general applications

### 2.5.6 HCI Design Standards

- Standards for interactive system design are usually set by national or international bodies to ensure compliance with a set of design rules by a large community.

Standards can apply specifically to either the hardware or the software used to build the interactive system.

**Design Standards**

(1) Underlying theory

(2) Change

**(1) Underlying Theory**

Standards for hardware are based on an understanding of physiology or economics/human factors, the results of which are relatively well known, fixed and readily adaptable to design of the hardware.

**(2) Change**

Hardware is more difficult and expensive to change than software, which is usually designed to be very flexible, consequently, requirements changes for hardware do not occur as frequently as for software.





**Standard Institutions**

(1) British Standards Institution (BSI) or

(2) ISO

(3) National Military Agency

## 2.6 Direct Manipulation

### 2.6.1 Overview

- In the early 1980's as the price of fast and high-quality graphics hardware was steadily decreasing, designers were beginning to see that their products were gaining popularity as their visual content increased.
- As long as the user system dialog remained largely unidirectional from user command to system command line prompt - computing was going to stay within the minority population of the hackers who revelled in the challenge of complexity.
- In a standard command line interface, the only way to get any feedback on the results of previous interaction is to know that you have to ask for it and to know how to ask for it.

### 2.6.2 Scope

- Rapid visual and audio feedback on a high resolution display screen or through a high-quality sound system makes it possible to provide evaluative information for every executed user action.
- Rapid feedback is just one feature of the interaction technique known as direct manipulation.
- Direct manipulation is the WYS / WYG.
- Paradigm i.e. "Which you see is What you get."

### 2.6.3 Applications

- Visibility of the objects of interest.
- Incremental action at the interface with rapid feedback on all actions.
- Reversibility of all actions, so that users are encouraged to explore without severe penalties.
- Syntactic correctness of all actions, so that every user action is a legal operation.
- Replacement of complex command languages with actions to manipulate directly the visible objects.

## 2.7 Universal Design

### 2.7.1 Introduction

Universal design is the process of designing products so that they can be used by as many people as possible in as many situations as possible.

### 2.7.2 Universal Design Principles

In the late 1990's a group at North Carolina state university in the USA proposed seven general principles of universal design. These were intended to cover all areas of design and are equally applicable to the design of interactive systems.

Principles are as follows,

1) **Equitable use**

The design is useful to people with a range of abilities and appealing to all.

2) **Flexibility in use**

The design allows for a range of ability and preference.

3) **The system be simple and intuitive to use**

4) **Perceptible information**

The design should provide effective communication of information regard less of environmental conditions.

5) **Tolerance for error**

Minimizing the impact and damage caused by mistakes or unintended behavior.

6) **Low physical effort**

System should be designed to be comfortable to use, minimizing physical effort and fatigue.

7) **Requires size and space for approach and use.**

### 2.7.3 Multi - Model Interaction

There are five senses - sight, sound, touch, taste and smell.

**Sight** is the predominant, sense for majority of people of most interactive systems consequently use the visual channel as their primary means of presentations, through graphics, text, video and animation.



- **Sound** is also an important channel, keeping us aware of our surroundings, monitoring people and events around us, reacting to sudden noises, providing clues and cues that switch our attention from one thing to another.
- **Touch**, too, provides important information tactile feedback forms an intrinsic part of the operations of many common tools - cars, musical instruments, pens anything that requires holding or moving.
- **Taste and Smell** are often less appreciated ' ut they also provide useful information in daily life. Checking if food is bad or good, detecting early signs of fire.

#### 2.7.3.1 Sound in the interface

Speech in the interface

- Structure of speech
- Speech recognition
- Speech synthesis
- Uninterrupted speech
- Non - speech sound

#### 2.7.3.2 Handwriting Recognition

Handwriting recognition system consists of handwritten words by various users as input channel and output as best suitable pattern in the form of recognized text or speech. Handwriting Recognition System is presented in Fig. 2.7.1.

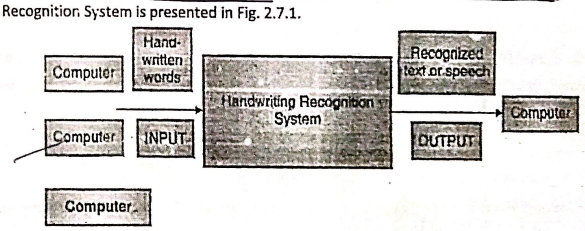


**Fig. 2.7.1 : Handwriting Recognition System**

#### 2.7.3.3 Gesture Recognition

- Hand gestures are powerful means of communication among humans and sign language is the most natural and expressive way of communication for dump and deaf people. In this work, real-time hand gesture system is proposed. Experimental setup of the system uses fixed position

low-cost web camera with 10 mega pixel resolution mounted on the top of monitor of computer which captures snapshot using Red Green Blue (RGB) color space from fixed distance. This work is divided into four stages such as image preprocessing, region extraction, feature extraction, feature matching.

- First stage converts captured RGB image into binary image using gray threshold method with noise removed using median filter (medfilt2) and Guassian filter, followed by morphological operations. Second stage extracts hand region using blob and crop is applied for getting region of interest and then "Sobel" edge detection is applied on extracted region. Third stage produces feature vector as centroid and area of edge, which will be compared with feature vectors of training dataset of gestures using Euclidian distance in the fourth stage.
- Least Euclidian distance gives recognition of perfect matching gesture for display of ASL alphabet, meaningful words using file handling. This paper includes experiments for 26 static hand gestures related to A-Z alphabets. Training dataset consists of 100 samples of each ASL symbol in different lightning conditions, different sizes and shapes of hand. This gesture recognition system can reliably recognize single-hand gestures in real time and can achieve a 90.19% recognition rate in complex background with a "minimum-possible constraints" approach. The Hand Gesture Recognition System (HGRS) for ASL Recognition is depicted in Fig. 2.7.2.

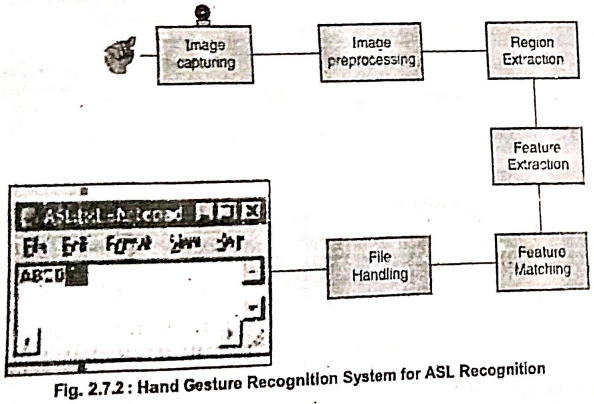


**Fig. 2.7.2 : Hand Gesture Recognition System for ASL Recognition**

## 2.7.4 User Centred Design (UCD)

- UCD is an iterative design process in which designers focus on the users and their needs in each phase of the design process.





- UCD calls for involving users throughout the design process via a variety of research and design techniques so as to create highly usable and accessible product for them.
- UCD demands that designers employ a mixture of investigative (e.g. surveys and interview) and generative methods and tools to develop an understanding of user needs.
- Generally, each iteration of the UCD approach involves phases as depicted in Fig. 2.7.3 and listed as follows:
  - Content
  - Requirements
  - Design
  - Evaluation

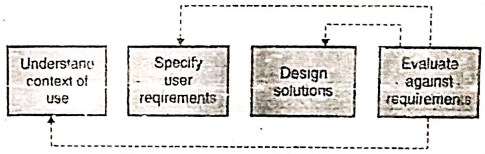


**Fig. 2.7.3 : User Centered Design**

- UCD is an iterative process that focuses on an understanding of the uses and their content in all stages of design and development.
- In UCD, designers base their projects upon an explicit, understanding of the users, task and environments.
- The process aims to capture and address the whole user experience.

## 2.8 Task Analysis / GOMS

Task analysis is the process of analysis the way people perform their jobs, the things they do, the things they act on the things they need to know.

**Example**

- If we were considering the job of house keeping, we would want to say things like,
- In order to clean the house
  (1) Get the vacuum cleaner out.
  (2) Fix the appropriate attachment.
  (3) Clean the rooms.

(4) When the dust bag gets full, empty it.

(5) Put the vacuum cleaner and tools away.

To perform such a task, we need to know about vacuum cleaners, their attachments, dust bags, cup boards, rooms and so on.

Three different approaches to task analysis.

### 2.8.1 Task Decomposition

Task Decomposition as presented in Fig. 2.8.1 requires splitting or dividing a task into sub tasks and the order in which these are performed.

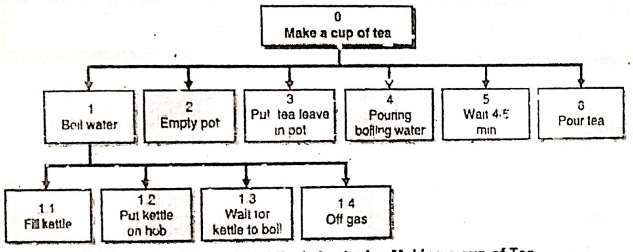


**Fig. 2.8.1 : Hierarchical Task Analysis : Making a cup of Tea**

- Time sharing
- Discretionary
- Mixtures

### 2.8.2 Knowledge based Analysis

Which look at what users need to know about the objects and actions involved in task and how knowledge is organized.

**Example**

Kitchen Job

'____ Preparation
beating, Mixing

'____ Cooking
frying, boiling, baking

'____ Dining
pouring, eating, drinking





### 2.8.3 Entity - Relation based Analysis

Which is an object based approach where the emphasis an identifying the actors and objects, the relationships between and actions they performed.

**Example**

Object Pump Simple - irrigation pump attributes

Status : on / off / faulty

Capacity : 100 liters / minute

- Sources of information in task analysis :
  - Documentation
  - Observation
  - Interviews
  - Initial analysis
  - Sorting and classification

## 2.9 Graphic Design

- It is a craft of creating visual content to communicate messages. Applying visual hierarchy and page layout techniques, graphic designers use typography and pictures to meet users specific needs and focus on the logic of displaying elements in interactive designs to optimize the user experience.
- Graphic design is an ancient craft, dating back past Egyptian hieroglyphs to 17,000 year old cave paintings. As a term originating in the 1920's print industry and covering a range of activities including 1090 creation, it concerns aesthetic appeal and marketing - attracting viewers using images, colour and typography.
- However, graphic designers working in user experience (UX) design must justify stylistic choices regarding, say, image locations of front with human - centred approach, focusing on - seeking maximum empathy with users while creating good - looking designs that maximize usability.
- In UX design we don't create art of art's sake. So, when doing graphic design for UX, you should consider the information architecture of your interactive designs, to ensure accessibility for users and leverage graphic design skills in creating output that considers the entire user experience, including users visual processing abilities.

**Example**

- Typography plays a crucial role in graphic design as shown in Fig. 2.9.1.

- The same font can convey very different meaning.

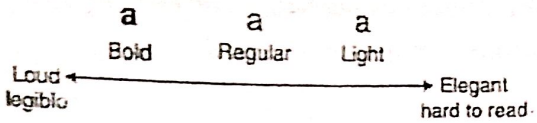


Fig. 2.9.1 : Graphic Design

## Review Questions

Q.1 Explain Interaction Design Basics and Various Interaction Styles for Human and Computer.

Q.2 Elaborate Software Processes applied in HCI for Construction, Structuring, and Development of Software in HCI.

Q.3 Explain HCI Design Principle and Rules in detail.

(a) Principles to Support Usability

(b) Golden Rules Heuristics

(c) HCI Patterns

(d) Design Rules

(e) HCI Design Standards

Q.4 Which are the Design Principles used to support Usability in HCI?

Q. 5 List down golden rules used in Heuristics.

Q. 6 What is role of Software Architecture and Design Patters in designing HCI Patterns.

Q. 7 Explain all the phases required for Pattern Recognition (Consider Character Recognition).

Q. 8 What are the HCI Design Rules and HCI Design Standards ? Consider Emotion Recognition.

Q. 9 Explain Hand Gesture Recognition System using HCI Patters.

Q. 10 What is use of Universal Design Model is the development of HCI System.

Q.11 What is GOMS model? Explain step-wise and stage-wise use of GOMS is HCI Patterns.

Q. 12 Discuss about User-Centered Design by considering real-time Problems and Solutions.


# Implementation

**Syllabus**

Implementation Tools, Technology and change designing for the Web, Designing for portable devices, Handling errors and Designing Help, Prototyping and UI Software.

## 3.1 Introduction

This chapter emphasizes major objective and outcome along with important discussion presented as follows:

- **Objective :** To design, implement, and evaluate effective and usable Human Computer Interfaces.
- **Outcome :** To evaluate the basic of human and computational abilities and limitations and to inculcate basic theory, tools and techniques in HCI.

### Important Discussions

- Implementation plays important role in HCI processes. Design and detailed design phase acts as input for implementation phase. Implementation may change as per the perception, perspectives, technical, and technological knowledge of programmer. It provides solution in the form of methodological and algorithmic approach.
- The methodologies and algorithms are transformed and conveyed in the form of prototype and user interface for end users accessibility and learnability purpose. HCI uses enhance techniques for pattern recognition, clustering, and classification. Additionally, HCI require various software and tools such as MATLAB, OpenCV, Java Android, etc.
- We may use technical potential of programmer for design, development, and implantation of HCI systems to construct user interface. In this context, we discuss about Real-time Hand Gesture Recognition System (HGRS) implementation from technical and methodological point of view subsequently.

Real-time static Hand Gesture Recognition Systems (HGRS) have been developed for the recognition of different sign languages as American Sign Language (ASL), Chinese Sign Language (CSL), Arabic Sign Language (ArSL) etc. Gesture deals with the movement of the body part/ s which involves information or feelings whereas gesture detection is concerned with the mechanism used to understand the meaning of corresponding gesture.

Hand gesture recognition is an extremely challenging area of research due to the richness in diversities, complexity and limitation of computerized perception of hand. There exist two main approaches in the hand gesture analysis namely; vision-based and device-based approach. Vision-based approach is the most natural way of constructing Human Computer Interface (HCI) as it includes environment and surrounding information.

Moreover, In vision-based approach the user does not require to wear anything. Instead the system requires only camera(s), which are used to capture the images of hands for interaction between human and computers. However, conventional device-based approach for HGRS has been designed with external devices such as data gloves, markers, sensory gloves, colored gloves etc.

There exist two categories of hand gestures namely; static hand gestures and dynamic hand gestures. In static gestures, the hand remains in a fixed position and usually snapshot of a certain gesture is performed.

On the other hand, dynamic gestures considers factors such as the direction in which the hand is progressing, velocity, orientation etc. which makes the task of recognizing the gesture even more challenging. Hand motion and gestures potentially are used to interact with computers in more natural ways. There exist applications of HGRS such as Sign Language (SL) recognition, Human-Robot Interaction (HRI), controller less video gaming, smart TV etc. Hand gesture has its precise meaning and is widely worn for dump and hearing-impaired people who understand SL as alternative way of communication. DSL script is used mainly in Marathi speaking community. It consists of a typical character set with 13 vowels, 33 consonants, and numerals set (0-9).

**thodology**

Since DHGRS is fragmented in to six consequent stages namely; Image capturing, Image pre-processing, Region extraction, Feature extraction, Feature matching, and Pattern recognition, it is possible to explore recognition of DSL script/ DSL symbol set in complex background using this generalized approach.

A model may be designed for DSL script recognition by applying the best suitable feature matching and pattern recognition technique thereby improving the accuracy of DHGRS. Similarly, accuracy of DHGRS may be improved by applying hybrid approaches.





- It will be essential to develop training dataset by collecting samples in different backgrounds, various lightning conditions, variety of hand shapes, multiple resolutions of web camera etc.

**Expected Outcome**

Using the proposed techniques, our DHGRS will be able recognize the DSL script (with 46 DSL alphabets and 10 DSL numbers) in complex background with possibly the highest recognition rate.

(6) Any 2 in detail.

## 3.2 Implementation Tools, Technology and Change Designing for the Web, Designing for the Portable Devices

### 3.2.1 Implementation Tools

#### 3.2.1.1 Screen Mock-up and Prototyping Tools

- Paper and pencil
- Word Processor
- Slide presentation software for presenting contents as shown in Fig. 3.2.1.
- Specialized prototyping tools (Authology, courseware, hypercard)

also called interac
Techniques, gadget
widgets. These obj
have predefined
behaviour

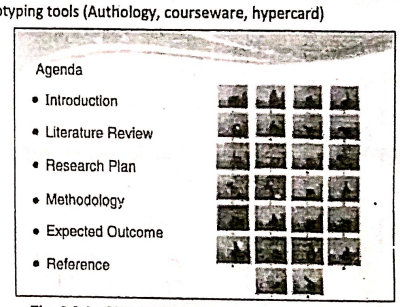


**Fig. 3.2.1 : Slide Presentation as Prototyping Tool**

#### 3.2.1.2 Programming Toolkits

- Handle standard widgets: MS Window developer's toolkit, Apple MacApp, Unix Xtk. In Fig. 3.2.2, App using programming toolkit of Java and Android handles encoding and decoding of image on mobile.

To help programmer in fixing i/p & o/p behaviour another level of abstraction of windowing system is toolkit. It provides the Prograamm. with set of ready made interaction objects

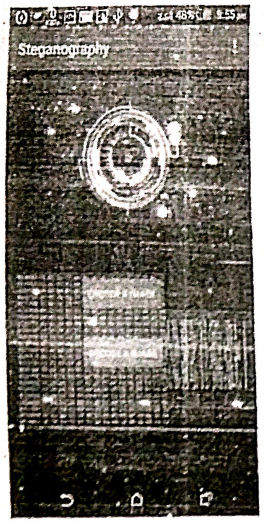


Fig. 3.2.2 : App using Java and Android

### 2.1.3 User Interface Management System (UIMS)

User Interface Generator.

High Level Specification i.e. source code of UI.

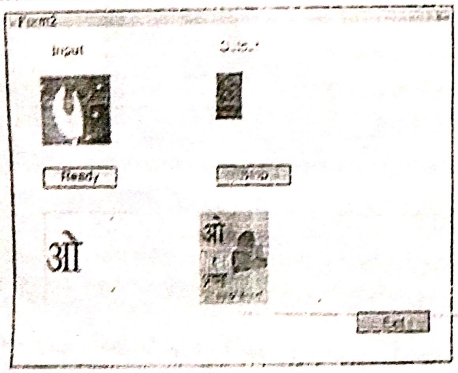


Fig. 3.2.3 : User Interface Management System (UIMS)





### 3.2.2 Implementation Technology and Change Designing for the Web

**HCI – Present and Future Trends**

- It is multidisciplinary research area focused on interaction modalities between human and computers, sometime, the more general term Human Machine Interface (HMI) is used to refer to the user interface in a manufacturing.
- The HCI investigate and tackles all issues related to the design and implementation of the interface between humans and computers.
- Due to its nature and goals, it involves multiple computer science related disciplines (image processing, computer vision, programming language and so on) and disciplines related to human sciences.
- An intuitive nature, efficient, robust and customizable interface can greatly reduce the gap between a human's mental model and the way a computer, machine or robot can accomplish a given task.

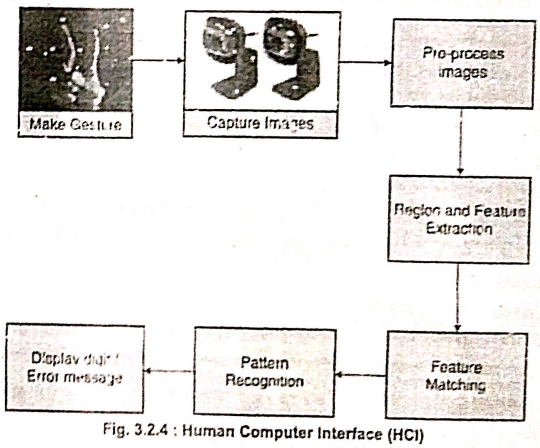


Fig. 3.2.4 : Human Computer Interface (HCI)

**Designing Goals**

- Reduce visual work
- Reduce intellectual work
- Reduce memory work
- Reduce mentor work

Eliminate instructions

Change designing for the web

Implementation Support

Programming tools for interactive system provide a means of effectively translating abstract design and usability principles into an executable form. These tools provides different levels of services for the programmer as in Fig. 3.2.5.

| | | | |
|---|---|---|---|
| Application | Desktop Interaction | Games | Sign Language |
| API | AFORGE.NET AND EMGU CV | | |
| Image Processing | Gesture Pecognation | Template Matching | Pattern Recognition |
| | Blob Extraction | Filled Edge | Region and Feature Extraction |
| | Noise Removal / Skin Detection | Normalisation | Pre-Processing |
| | Image Capturing | | |

**Fig. 3.2.5 : Implementation Support**

### Architecture of Windowing system

There exists three possible options in windowing system as depicted in Fig. 3.2.6 for implementations as :

(1) First option is to implement the management of the multiple process within each of the separate application. It is not the satisfactory application because it focuses on each application to consider the difficult problems of resolves synchronization conflict with the shared hardware devices.

(2) Second option, is to implement the management role within the kernel of the operating system, it centralizing the management role by freeing it from the individual application.

(3) Third option provides the most probability, as the management function is written as a separate application in it's own right.





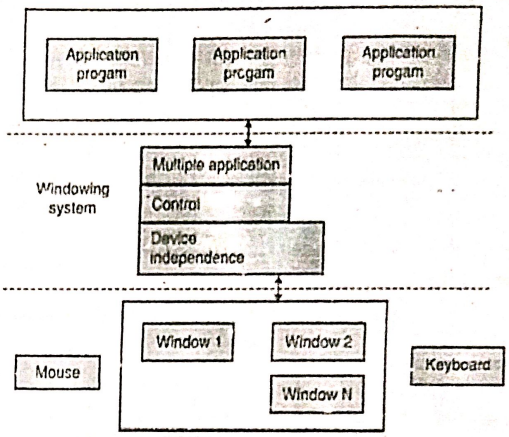


**Fig. 3.2.6 : Role of Windowing System**

### (b) Client-server architecture

- Client-Server architecture represented in Fig. 3.2.7 is used to support resources.
- So applications built for windows system which is nationally based on the client-server model may not be as portable as one would think.
- The example of windowing system based on the client-server architecture.
- In client-server architecture server is used to provide services to single client or multiple clients.
- Single machine may also act as server as well as client using tightly coupled architecture.
- Moreover, client and server may be present on different machines with loosely coupled architecture.
- Client server architecture is also used in distributed computing for remotely placed server and client/ clients for solving common problem using shared interfaces e.g. Remote Method Invocation (RMI) or CORBA.

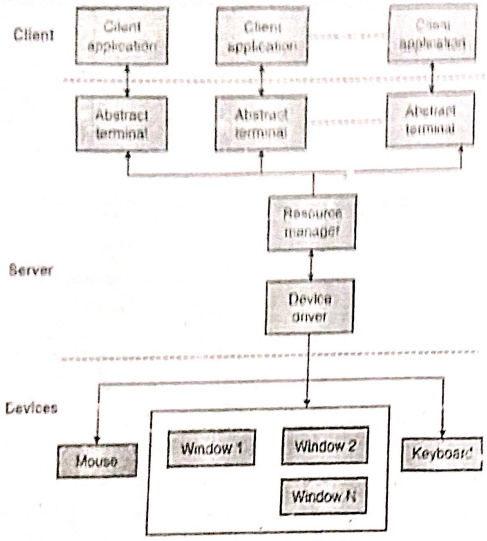


Fig 3.2.7 : Client-server Architecture

### (c) The X Windows System (Release-II) Architecture

- It is based on fixed based imaging model and assumes that there is some pointing mechanism, the X differ from windows system is that it added as a standard, that X is based on network protocol which clearly defines the client-server communication as shown in Fig. 3.2.8.
- The X protocol can be implemented on different computers and operating system, making X device independent. It also means that client server need not even be on the system in order to communicate to the server, each client as the X II server is associated to an abstract terminal or main window. The X server performs, the following tasks :

(i) Allows access to the display from multiple client applications.

(ii) Interprets requests from clients to perform screen operation or provide other information.

(iii) Demultiplexes the system of physical input events from the user and passes them to the appropriate client.





(iv) It is used to minimize the traffic along the network by relieving the clients from having to keep track of certain display information.

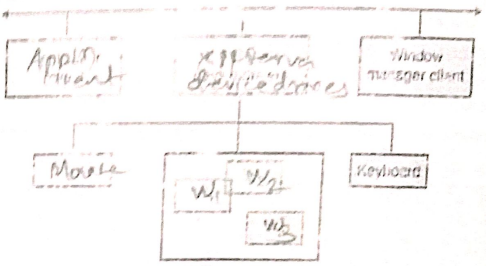


Fig. 3.2.8 : X Windows System (Release II) Architecture

## 3.2.3 Designing for the Portable Devices

- Portable devices are those intended to be moved regularly, but not necessarily for handheld use. Portable device design has requirements of rugged packaging, being relatively compact and lightweight and sometimes required battery operation. E.g. Music player operations are handled by using hand gesture as shown in Fig. 3.2.9.

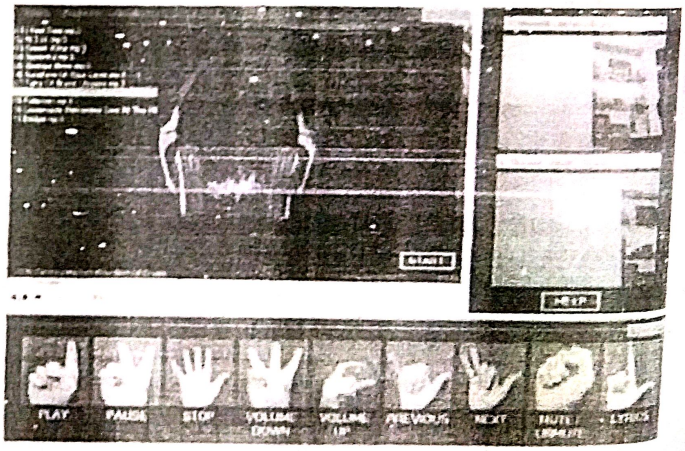


Fig. 3.2.9 : Music Player Operations Handled using Hand Gestures

Handheld device design must ensure that the device can be comfortably held by a person and has a number of added constrains :

(i) Very lightweight

(ii) Intuitive to use

(iii) Easily read display

(iv) Button press

(v) Touch screen use must not be fatigue.

(vi) Usually battery operated

(vii) Can't get too warm to hold

Since the year 2000, in hand has developed expertise in the technologies and processes required for successful portable electronic design and handheld electronic design. This includes :

(i) The selection of low power

(ii) High performance

(iii) Long availability embedded processors.

(iv) The ability to customize circuit design for low power and small spaces.

(v) Tweaking operating systems to accommodate these customizations.

Portable devices design and handheld device design incorporates associated electronic designs into packaged products. Enclosures for these devices must be lightweight and often water-tight sealed, but they should also be able to withstand physical abuse while being ergonomic and easy to use.

The combination of these factors makes the design of portable and handheld devices a niche area of expertise. To maximize success with minimal cost, short schedules and low risks, a system engineering approaches analyzes use cases and applications specifications within a proven design processes.

Portable Design Technology Expertise :

→ Low power design

→ Small footprint design

→ Displays/ touchscreens

→ Rugged design

→ Operating system

→ Security



→ Remote device management

- Applications / Use
  - → Military / defence
  - → Medical
  - → Industrial
  - → Test and measurement
  - → Aviation
  - → Utilities
  - → Transportations

## 3.3 Handling Errors and Designing Help

### Handling Errors

When we focus on operator errors and errors caused by a HCI, in some system the main goal when as the user interface is to prevent the operator from making a mistake and causing a hazard. Hand Gesture Recognition System (HGRS) using HCI produces error message for incorrect pattern as shown in Fig. 3.3.1.

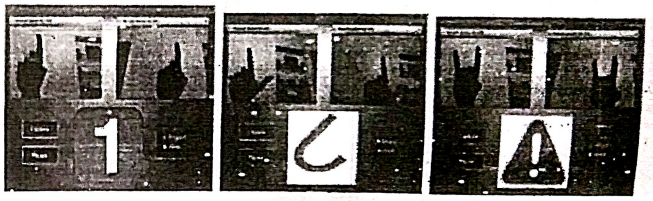

**Fig. 3.3.1 : Error Handling using HCI**

### Objective of errors

(i) Identification variety of errors people make and their possible causes.

(ii) Discuss guideline to prevent the errors from happening by reducing the causes.

(iii) Discuss ways to recover from errors when they do happen.

### Errors are

**(a) Error identification**

When error can occur during perceptual errors, cognitive error. How errors can occur during mistakes, failures etc.

(1) Perceptual errors due to misleading perceptual sensory overload such as battery indications, different buttons, underlined sentence in a line.

(2) Cognitive errors occur during complex decision process and high load on memory.

(3) Failures we know that what to do but difficult to do it successfully, such as holding a thread in the eye as a niddle etc.

(4) Mistakes happen when we do the wrong thing for the good, applying role in a wrong situation, make a bad decision etc.

(5) Slips and lapses

Slips i.e. failure of execution

Lapses i.e. failure of memory

**Types of errors**

(i) Capture errors

(ii) Description errors

(iii) Data Driven errors

(iv) Associate activation

(v) Loss of activation

(vi) Mode errors

**(b) Preventing errors**

Avoid the causes such as,

(i) Perceptual – Avoid misleading visual cues

(ii) Cognitive – Avoid memory load

(iii) Motor – Avoid unnatural motor movement

**(c) Error recovery**

- Provide undo
- Provide cancel
- For form input errors, help users locate the fields that need to be fixed.
- Provide context sensitive help.
- Comfort the users.





## 3.4 Prototyping and UI Software

### 3.4.1 Prototyping

- Prototyping means the visualization of imagination and thought process of user. Prototype conveys complete information about actual model development. The inputs, outputs and operations of HCI system are designed and developed using prototyping. Prototype may be in the form system architecture of HCI system.
- System architecture deals with sequential phases along with input and output. Prototype (System Architecture) for Hand Gesture Recognition System (HGRS) is as depicted in Fig. 3.4.1 is fragmented in six consequent stages.

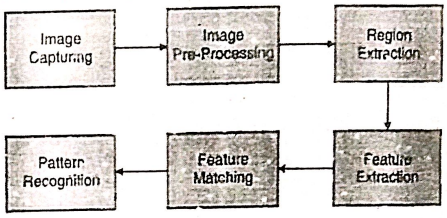


Fig. 3.4.1 : **Prototype of HGRS using HCI**

### 3.4.2 UI Software

- User Interface (UI) is the front-end application view to which user interacts in order to use the software. User can manipulate and control the software and hardware by means of UI. Today UI is found at almost every place where digital technology exists, right from computers, mobile phones, cars, music players, ships, airplanes etc.
- UI is a part of software and is designed such a way that it is executed to provide the user insight of the software. UI provides fundamental platform for HCI as shown in Fig. 3.4.2.

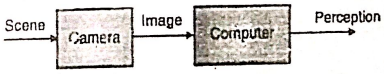


**Fig. 3.4.2 : Computer Vision for Human Computer Interaction**

- UI is a part of software and is designed such a way that it is executed to provide the user insight of the software. UI provides fundamental platform for HCI as represented in Fig. 3.4.3.

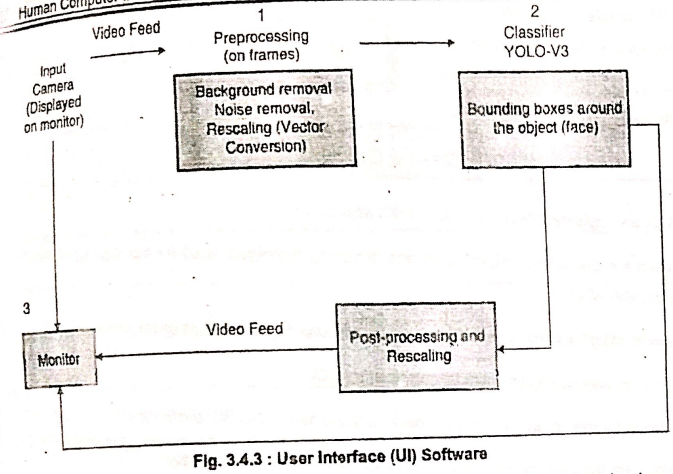


**Fig. 3.4.3 : User Interface (UI) Software**

UI can be graphical, text based, audio-video based, depending upon the underlying hardware and software combination. Software can becomes more popular if its UI is :

1. Attractive
2. Simple to use
3. Responsive in short time
4. Clear to understand
5. Consistent on all interfacing screens

UI is broadly divided into two categories :

(i) Command line arguments (CLI)

(ii) Graphical user interface (GUI)

i) **CLI Elements**

1. Command prompt
2. Cursor
3. Command

ii) **GUI Elements**

1. Window
2. Tabs
3. Menu
4. Icon
5. Cursor



**User Interface Design Activities**

- The process of GUI design and implementation is a like SDLC. Any model can be used for GUI implementation among waterfall, iterative or spiral model as shown in Fig. 3.4.4.
- A model used for GUI design and development should fulfil these following GUI specific steps.

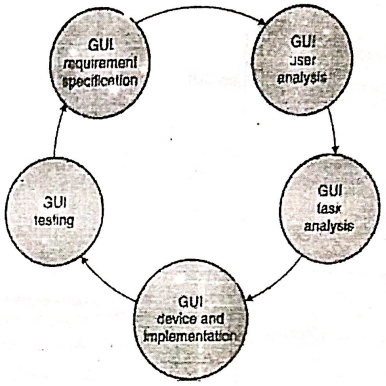


**Fig. 3.4.4 : User Interface Design Activities**

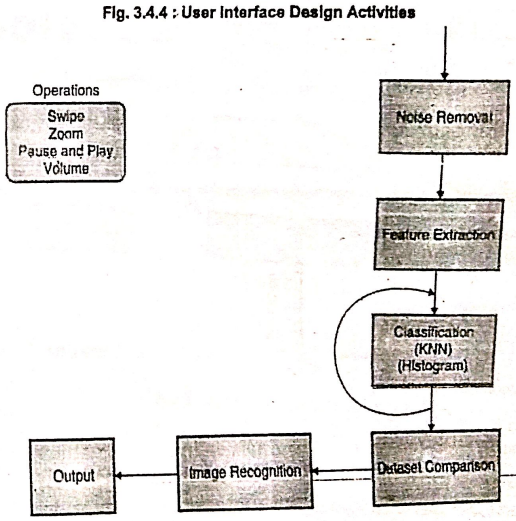


**Fig. 3.4.5 : User Interface Design Activities for Handling Operations using Hand Gesture**