ARTIYEMZ:

Security System using KINECT

ABSTRACT

ARTIYEMZ Security System using KINECT (ASSK) *provides a mean for providing security without regular monitoring and surveillance by humans. Normally security systems work using ordinary cameras which capture videos but a person should constantly monitor the system to detect unauthorized human intervention. Usually no security systems inform the users about the human intervention through SMS/MMS/Email which this project will do. Since KINECT is getting famous since the day of its release so we opted for a useful application using this device. ASSK tends to explore the area of face detection and it will be used to detect the face of the intruder.*

KINECT can be used for skeletal detection other than the conventional gaming applications and our project is aimed on designing a security system which will detect skeletal of a person via the depth camera and once the person is detected, he will be informed via SMS & his image will be captured using the standard RGB camera. This captured image will be sent through MMS/Email to the concerned person.

This project could be implemented using motion sensors and ordinary camera but the motion sensors are more expensive & processing of normal colored images is more difficult as compared with the RGB images by KINECT.

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CHAPTER 1

Introduction

The inspiration that emerged us to work on ***ASSK*** is KINECT'S market orientation. We wanted to pursue a project that would link us in some way with this technology.

1.1 Document purpose

The FYP Report will cover all the steps from requirement gathering to development of ***ARTIYEMZ: Security System using KINECT (ASSK)***. This report will provide a complete understanding of what is to be expected from the project being developed. The clear understanding of the ***ASSK*** and its' functionality will be provided here. It will provide the literature review for the project. From this report it can be understood, how the ***ASSK*** has been designed, constructed, and finally tested.

1.2 Problem Definition

Nowadays, it is easy to see security cameras everywhere. But, are there anyone watching behind them, are they recording, are they even working? These are the first questions that come to the mind. The main purpose of security cameras is to discourage the criminals. If a crime happens the security cameras can be used for an investigation. There is usually no person watching behind a security camera. Because employing a person for monitoring through a camera all the time is expensive for many businesses. Moreover, these systems are not really useful because of human factors. In many cases, after a security issue has occurred, the videos that have been recorded have to be watched for hours to find the exact time and event. Even it is not guaranteed that the criminal will be

found. Our team intends to solve this problem in every side. The security system with KINECT will be able to decrease the active monitoring time and increase the reliability of the camera system. It is going to decrease the spent time across the monitor by catching suspicious movements and instant reporting system. It will also Increase the reliability because our security system can work without the active help of a human.

1.3 Product Scope

This security system allows a complete Video-surveillance of any particular location (valuables) via the KINECT. As thieves are constant threats to households and lurking everywhere trying to break-in anytime. One might not like to give them an open space for pouncing in home and do an act of vandalism. ***ASSK*** is a full-featured video-surveillance system that only requires single peripheral with your system – a KINECT.

The KINECT is a great security camera. It has both an RGB video camera and a depth camera. The depth camera works in the dark and can very accurately detect motion, while making it easy to exclude things you don't want to detect, while the RGB camera is great for surveillance video.

The skeletal detection will start with the help of the depth map generated by the infrared camera of the KINECT. Once the skeletal is detected the intended person will be informed via SMS & then face detection module is triggered. The built-in standard visual-spectrum camera in KINECT allows capturing of cam shots. The system will make sure of selecting an appropriate image which clearly shows the face of the intruder from the captured live stream by the KINECT that will help in identifying the face of the intruder.

Once the image has been selected, this image will be sent to the subscriber via MMS/Email.

1.4 User and Literature Survey

In this project there are two sides of the literature survey. One side is what kind of applications is made by using KINECT. This side is critical for understanding abilities of KINECT and what could or could not do with KINECT. The other side is security systems and their limitations. By knowing security systems abilities we could know that how can we improve this systems.

When we look at the applications that are made by using KINECT, we saw that they are most games and entertainment purposed applications. However, when we examine these games uses skeletal information that KINECT provide, in run time. KINECT give us the ability of processing skeletal information simultaneously while getting this information. Literature survey shows us this is a new situation. Most of the research on processing skeletal information based on comparing information sets which previously recorded. In our project we will compare real time information that we obtain and previously recorded data. This ability make us could use KINECT based application as a security system. There are lots of camera based on security systems uses different technologies like surveillance, motion triggered and infra-red cameras. Some of them can inform peoples whether there are a movement or not .However none of these system could not identify what kind of a movement detected so this system cause a lots of an important warnings. For instance a mouse can cause a red alarm in a bank with motion triggered system. Our system solves this problem by identifying skeletal of human only. In addition

to this as a part of our application it can be defined usage specific movements, application will not use same data set for every place.

1.5 Modules of project

There will be following modules in the software:

- Image capturing
- Skeletal detection
- Face detection
- Image database
- Sending Alerts (MMS/SMS/Email)

Chapter 2

Introduction to KINECT

Kinect, originally known by the code name **Project Natal**, is described as a "controller-free gaming and entertainment experience" and is commonly sold bundled with the Xbox 360. KINECT is launched by Microsoft in November 2010, based around a webcam-style add-on peripheral, it enables users to control and interact without the need to touch a game controller, through a natural user interface using gestures and spoken commands. Microsoft has also released a non-commercial Kinect software development kit for Windows 7 which will allow .NET developers to write applications in C++/CLI, C#, or Visual Basic .NET.

Its capability to produce depth and RGB streams at a price much lower than traditional range sensors have made it a sensation in the field of Computer Vision.

2.1 The Hardware

KINECT is a box with some cameras that makes use of infra-red (IR) illumination to obtain depth data, color images and sound. The IR is used as a distance ranging device much in the same way a camera autofocus works. The system can measure distance with 1cm accuracy at 2m and has a resolution of 3mm at 2m. The depth image is also 640x480 i.e. standard VGA resolutions. The color image is 1600x1200.

A custom chip processes the data to provide a depth field that is correlated with the color image. That is the software can match each pixel with its approximate depth. The preprocessed data is fed to the machine via a USB interface in the form of a depth field map and a color image.

The Kinect sensor stands on a tilt motor, and one can change its elevation angle with a few lines of code.

Figure 2.1

2.2.1 Components of Kinect:

The components of Kinect for Windows are mainly the following:

- *Color VGA video camera:* This video camera aids in facial recognition and other detection features by detecting three color components: red, green and blue. Microsoft calls this an "RGB camera" referring to the color components it detects.

- *Depth sensor*: An infrared projector and a monochrome CMOS (complimentary metal-oxide semiconductor) sensor work together to "see" the room in 3-D regardless of the lighting conditions.

- *Multi-array microphone*: This is an array of four microphones that can isolate the voices of the players from the noise in the room. This allows the player to be a few feet away from the microphone and still use voice controls.

A further look at the technical specifications for Kinect reveal that both the video and depth sensor cameras have a 640 x 480-pixel resolution and run at 30 FPS (frames per second). The specifications also suggest that you should allow about 6 feet (1.8 meters) of play space between you and the Kinect sensor, though this could vary depending on where you put the sensor.

2.2 Kinect SDK

Kinect SDK version1.6 is a powerful kit designed for application developers and includes API, sample code & drivers. Kinect SDK enables the academic and enthusiast communities' easy access to the capabilities offered by the Microsoft Kinect device connected to computer running on Windows 7. Kinect SDK includes drivers, rich APIs for raw sensor streams and human motion tracking, installation documents, and resource materials. It provides Kinect capabilities to developers who build applications with C++, C#, or Visual Basic by using Microsoft Visual Studio 2010.

Here are some key features of KINECT SDK v1.6:

- *Microsoft Kinect drivers:* Windows 7 drivers for the Kinect sensor.
- *NUI API:* Core of the Kinect for the set of Windows API, supports fundamental image and device management features like access to the Kinect sensors that are connected to the computer, access to image and depth data streams from the Kinect image sensors and delivery of a processed version of image and depth data to support skeletal tracking.

- *Raw Sensor Stream:* Access to raw data streams from the depth sensor, color camera sensor, and four-element microphone array enables developers to build upon the low-level streams that are generated by the KINECT sensor.

- *Skeletal Tracking:* The capability to track the skeleton image of one or two people moving within the Kinect field of view make it easy to create gesture-driven applications.

- *Advance Audio capabilities:* Audio processing capabilities include sophisticated acoustic noise suppression and echo cancellation, beam formation to identify the current sound source, and integration with the Windows speech recognition API.

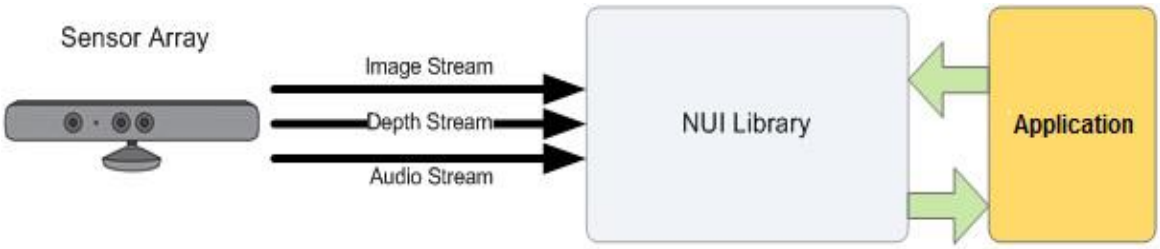


Figure 2.2

2.2.1 Requirements of Kinect SDK v1.6

- Kinect for Xbox 360 / Kinect for Windows sensor
- Computer with a dual-core, 2.66-GHz or faster processor
- Windows 7–compatible graphics card
- 2-GB RAM (4-GB RAM recommended)
- Visual Studio 2010
- Microsoft .NET Framework 4.0

2.3 Field of View

Kinect field of view of the users is determined by the settings of the IR camera, which are set with the Depth Range. In default range mode, Kinect can see people standing between 0.8 meters (2.6 feet) and 4.0 meters (13.1 feet) away; users will have to be able to use their arms at that distance, suggesting a practical range of 1.2 to 3.5 meters.

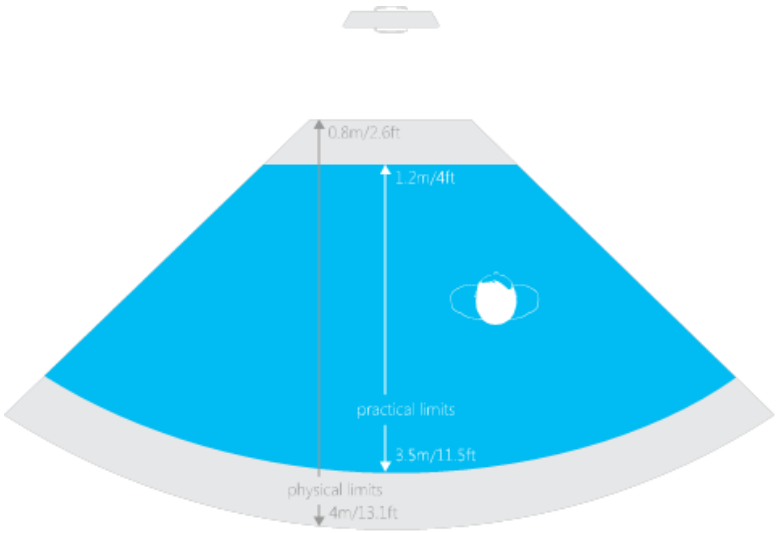


Figure 2.3 Kinect horizontal Field of View in default range

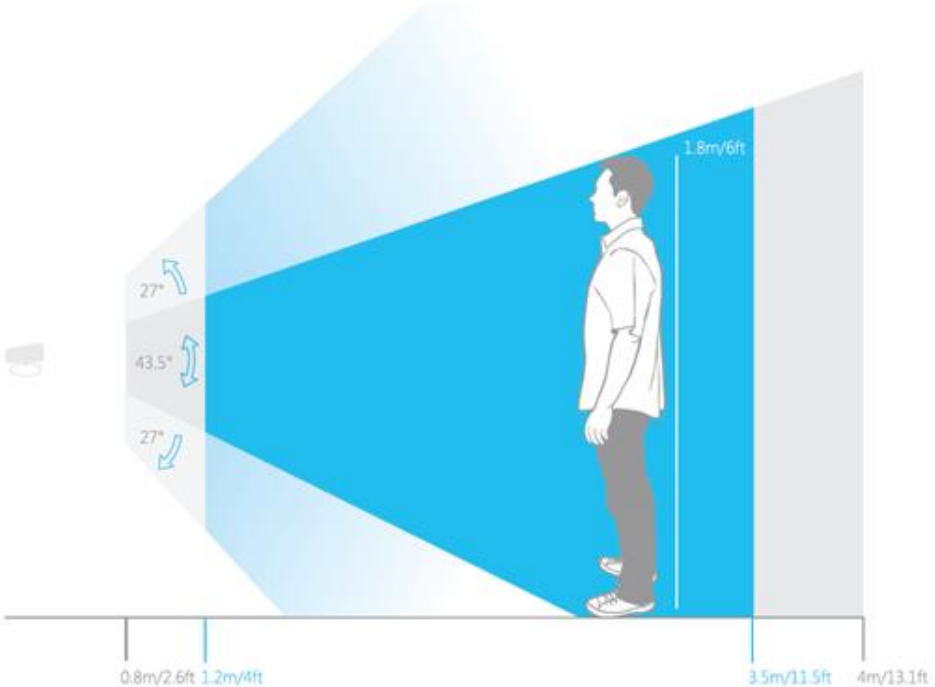


Figure 2.4 Kinect vertical Field of View in default range

Chapter 3

Introduction to ASSK

Our project is a **Kinect based security system** which detects any human intruder that enters the particular vicinity, in which the Kinect is set up. Once the skeleton is detected by the Kinect *depth camera*, it informs the user through SMS about unauthorized intervention. Now face detection comes in to play, the one image which clearly shows the face of the intruder is saved and is sent via MMS and email to the user. So this software implements techniques of *skeletal detection* and *face detection*. Normally security systems work using ordinary cameras which capture videos but a person should constantly monitor the system to detect unauthorized human intervention. Usually no security systems inform the users about the human intervention through MMS/SMS which our project does.

3.1 ASSK improves productivity

Before the ASSK system, it required a human to constantly monitor the videos for surveillance and it decreased the efficiency of such computer systems as it could not provide complete automation. Unfortunately such systems cannot work on their own selves and they are always prone to human errors.

But once an ASSK system is in place then it is a complete system that does not need any human to monitor the system, once the intruder gets detected, the authorized person will be given an instant alert via SMS/MMS and Email .So this is a very productive software in terms of the automation and real time control that it provides.

3.2 Implementation of an ASSK

Implementing an ASSK is not an easy task to achieve; in fact it takes lots of searching & studying Kinect SDK. ASSK is extraordinary wide in scope and for many larger organizations can be extremely helpful as it needs less human resource and provides a complete automation. Implementing an ASSK will ultimately require a computer system continuously on, a Kinect device and a Nokia mobile phone connected to PC. While it may seem reasonable for an in house administrator that sets the system on properly and later will receive alerts in case if any intruder gets detected.

3.3 Description of modules in ASSK

The descriptions of modules present in ASSK are as follows:

- **Image capturing**

Kinect comes pre-loaded with an impressive array of aids like traditional RGB, infra-red depth and microphone sensors. There really is an impressively large amount that can be achieved with the basic RGB cameras, including the fact that you can use it to enhance the depth camera information on Kinect. The built-in standard visual-spectrum camera in Kinect allows capturing of cam shots. There are several different stages within the process which converts the light in a scene into a camera image. First, light passes through the lens and is converted to electrical charges. This signal is then amplified, sampled by an analogue-to-digital converter, and processed in the digital domain to apply white balance and gamma corrections. The sensor also needs to separate the red, green and blue color channels. In almost all modern consumer cameras this is done using something

called the Bayer Filter Mosaic. This module is responsible for the continuous capturing of videos and images from the Kinect RGB camera. It grabs the frames of the location which is visible by the camera and gives it a video view.

- **Skeletal Tracking**

Skeletal Tracking allows Kinect to recognize people and follow their actions. Using the infrared (IR) camera, Kinect can recognize up to six users in the field of view of the sensor. Of these, up to two users can be tracked in detail. An application can locate the joints of the tracked users in space and track their movements over time.

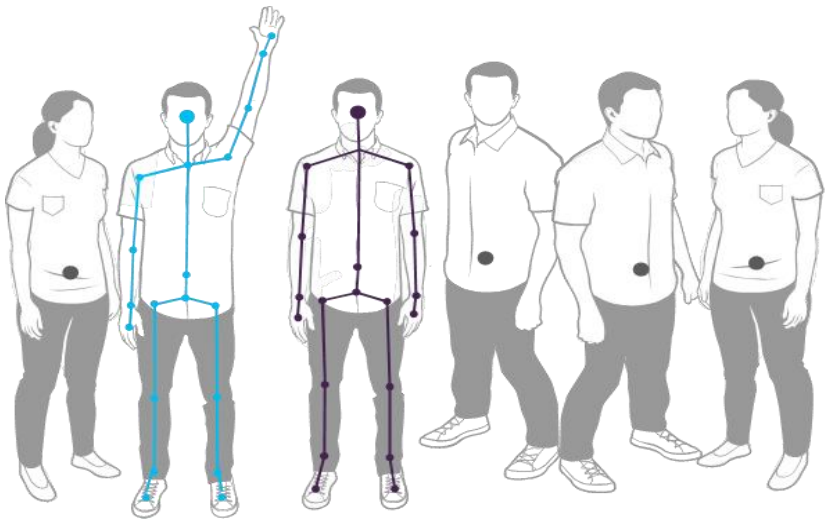


Figure 3.1 KINECT can recognize 6 people and track 2

Skeletal Tracking is optimized to recognize users standing or sitting, and facing the Kinect; sideways poses provide some challenges regarding the part of the user that is not visible to the sensor.

To be recognized, users simply need to be in front of the sensor, making sure the sensor can see their head and upper body; no specific pose or calibration action needs to be taken for a user to be tracked. In this way we are detecting an intruder.

- **Face Detection**

The SDK's face tracking engine analyzes input from a Kinect camera, deduces the head pose and facial expressions, and makes that information available to an application in real time. The face is detected using head joint.

The Face Tracking SDK uses the Kinect coordinate system to output its 3D tracking results. The origin is located at the camera's optical center (sensor), Z axis is pointing towards a user, Y axis is pointing up. The measurement units are meters for translation and degrees for rotation angles.

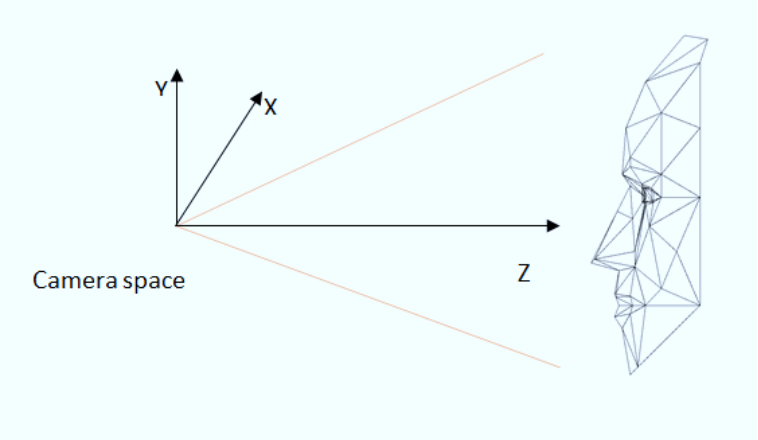


Figure 3.2

The Face Tracking SDK accepts Kinect color and depth images as input. The tracking quality may be affected by the image quality of these input frames (that is, darker or fuzzier frames track worse than brighter or sharp frames). Also, larger or closer faces are tracked better than smaller faces.

The Face Tracking SDK tracks the 87 2D points:

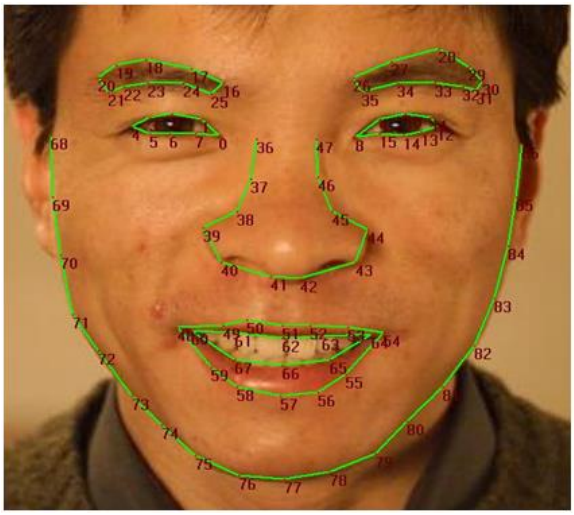


Figure 3.2

We are using this module for detecting the face of intruder from the color stream capturing from Kinect.

- **Image Database**

This module is saving the face detected image in the database so that the authorized user can see those images later through the ASSK application.

- **Sending Alerts**

The module automates alerting related processes. The offered functionality enhances the system's performance by eliminating paperwork and manual processes associated with informing the user. The sophisticated module helps to efficiently send intruder's data, improve the workforce management and minimize errors in sending alerts to user regarding the intruder.

- *Sending SMS*

  There are two ways to send SMS.

  - *Using GSM Modem* – Here we need to connect the Modem to PC then with the use of AT (Attention) commands we instruct the GSM Modem to send messages.

  - *Using Nokia Mobile phone* – Using a GSM Modem is costly than using a Nokia Mobile phone therefore we are using a Nokia cell phone with its OVI suite instead of GSM Modem for sending SMS.

- *Sending MMS*
  - The sending device encodes the multimedia content in a fashion similar to sending a MIME Email.
  - The message then forwarded to carrier's MMS store and forward server known as the MMSC.
  - The content is extracted and sent to a temporary storage server with an HTTP front-end an SMS "control message" containing the URL of the content is then sent to the recipient's handset.

- *Email*
  - Establishes SMTP connection
  - Using Gmail account sends image of the intruder to user.

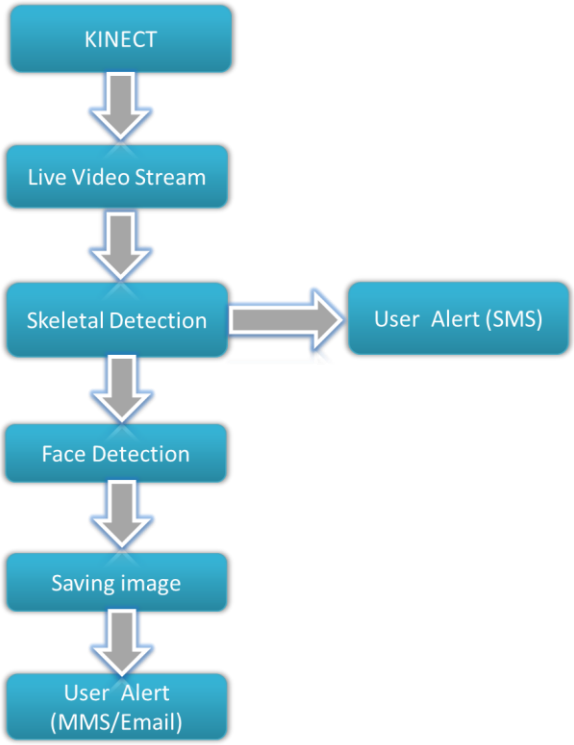


Figure 3.3

3.4 Measurable outputs

- ASSK has the support for detecting up to 20 joints.
- It can detect 6 people and can track 2 people at a time.
- Face Tracking detects and tracks the positions and orientations of faces in real-time and provides animated 3D meshes.
- Displays color video and skeletal positions in instantaneous 20 frames per second on the form.
- Obtain joints position from live streaming and converts into xyz coordinates.

3.5 Strengths:

- The security system with Kinect will be able to decrease the active monitoring time and increase the reliability of the camera system. It is going to decrease the time

spent in front of the monitor by catching suspicious movements and instant reporting system.

- Employing a person for monitoring through a camera all the time is expensive for many businesses; our project eliminates this cost, making it cheap.
- Currently the security systems, as we have come across, do not alert the subscribers with the pictures rather they just send a notification in the form of SMS.
- A record is maintained of the intruder images which help later in the investigation.

3.6 Limitations

- A Nokia cell phone, Kinect and PC should be available all the time.
- Videos are not being recorded.
- It can send MMS only to Ufone numbers since we don’t have GSM Modem.

CHAPTER 4

Software Requirements Specification

The following subsections of the Software Requirements Specifications (SRS) provide an overview of the entire SRS.

4.1 General Description

4.1.1 Product Perspective

The security system needs a Kinect device and a PC to be connected to.

- *Hardware Interfaces*
  - Kinect device
  - Computer with a dual core
  - Windows 7 compatible graphics card that supports Kinect
  - 2 GB RAM
  - Nokia cell phone (with connecting cable)
  - Smart phone (Having MMS configuration)
- *Software Interfaces*
  - Windows 7
  - Visual Studio 2010
  - SQL Server 2008
  - Kinect SDK
  - Nokia OVI Suit

Software for the security system will be written using C# which will detect the skeletal of any human intruder on the basis of the depth of the videos being captured by Kinect. SQL server will be used to maintain the database of images. Face detection will be done to detect a human face in the video and then it will send MMS or Email containing the picture of the intruder extracted from the live stream to inform the user of the system. Software will contain a necessary interface required to operate it.

4.1.2 **Product Function**

The major functions the security system are briefly described as follows:

- *Image Capturing:*
  - Images captured by KINECT and showing on the application, from that live stream of images we are saving only that image which clearly shows the face of the image (the first frame in which the face is detected).

- *Skeletal Detection:*
  - System will detect the skeletal in the video recorded by the Kinect with the help of this function.
  - Once detected, the system will send an alert in the form of SMS/MMS/Email to the subscriber of the system.

- *User Alerts:*
  - When any skeletal is detected by the system it will send a warning message to the user in the form of SMS/MMS/Email.
  - Email/MMS will contain the picture of the intruder.

4.1.3 **User characteristics**

- *Subscriber/user:*

He will use the system for security purposes at a place which he thinks of most importance.

4.1.4 **General constraints**

- ***Time constraints:*** we have to meet all the mentioned deadlines.
- ***Software constraints:*** visual studio 2010 &SQL server 2008
- ***Language constraint:*** visual c#.
- ***Case-tool constraints:*** MS office 2007, Rational Rose 2000.
- ***Communication constraints:*** internet connection and mms settings in cell phone.
- ***Security constraints:***
  - Kinect device should be hidden, in case the intruder may not be able to thieve it.
  - Unauthorized user should not login to the system.
- *The Kinect device should be handled with care.*

4.1.5 **Assumptions & dependencies**

- User knows how to connect Kinect through PC.
- User is an English literate.
- User has the internet connection.
- User has an Email account.
- User has subscribed for the MMS settings so that he may receive alerts by the system.

- User knows about sending and receiving MMS.
- User will be guided to use the system properly.
- System needs the PC and the Kinect device to be turned on throughout its operation.

4.2 Specific Requirements

This section contains all the software requirements at detailed level that are sufficient for designing & testing of the system that satisfies those requirements.

4.2.1 External interfaces

The system will use the standard input/output devices. This includes;

- Kinect device
- Computer with a dual core
- Windows 7 compatible graphics card that supports Kinect
- 2 GB RAM
- Cell phone

- *User Interfaces*

Whenever skeletal of intruder is detected by the system, it will capture the images from various angles and send a warning message to the user in the form of SMS/MMS/Email.

- *Communication Interfaces*

The system will be requiring Internet connection and MMS setting for sending and receiving the alert.

- *Software Interfaces*

The system shall interface with Visual Studio.Net (C#) and SQL server.

- *Hardware Interfaces*

This system runs on Microsoft Windows based system. Kinect sensors are connected to a single PC for image capturing purpose and skeletal detect.

The main features of Kinect are as follows:

- "Kinect" sensor

"Kinect" is the world's first system to combine an RGB camera, depth sensor, multi-array microphone and custom processor running proprietary software that brings "Project Natal" experiences to every Xbox 360 console. The "Kinect" sensor tracks full-body movement and individual voices, creating controller-free fun and social entertainment available only on Xbox 360.

- RGB camera

"Kinect" has a video camera that delivers the three basic color components. As part of the "Project Natal" sensor, the RGB camera helps enable facial detection and more.

- Depth sensor

An infrared projector combined with a monochrome CMOS sensor allows "Kinect" to see the room in 3-D (as opposed to inferring the room from a 2-D image) under any lighting condition.

4.2.2 Functional Requirements

Functional requirements define the fundamental actions that the system must perform. The functional requirements for the system are given below:

- *User Requirements:*

A. The user will turn on the Kinect device

B. The user will visit the home page

C. The user will visit login page

D. The user will visit the account settings page

E. The user will visit the recent captured photos page

F. The user will exit the system

- *System requirements:*

A.1 The user will supply power to the Kinect device.

A.2 The user will connect the device to pc via USB port.

A.3 The user will adjust the position of the device.

A.3.1 The user will move the direction of device to upward by clicking on move up button.

A.3.2 The user will move the direction of device to downward by clicking on move down button.

B.1 The user will execute the software.

B.1.1 It will show the home page of the software.

B.1.2 It will show the project name: “ARTIYEMZ: security system using Kinect”.

B.1.3 It will show 4 links.

B.1.3.1 Login

B.1.3.2 Account settings

B.1.3.3 Images

B.1.3.4 Exit

C.1 The user will click on the *login* button.

C.1.1 *Login* page will be visible to the user.

C.1.1.1 It will be compromised of 2 text boxes.

C.1.1.1.1 First will be for entering user name.

C.1.1.1.2 Second will be for entering password.

C.1.1.1.2.1 Characters in password text box will be appeared as '*' instead of actual characters.

C.1.1.2 User will enter the user name & password.

C.1.1.3 User will click the login button.

C.1.1.4 User name & password will be verified in the data base & only authentic user will be routed to KINECT window.

D.1 The user will click on the button of *account settings*.

D.1.1 The page of *account settings* will be visible.

D.1.1.1 It will be comprised of 4 text boxes.

F.1.1.1.1 First will be for first name.

F.1.1.1.2 Second will be for last name.

F.1.1.1.3 Third will be for email id.

F.1.1.1.4 Fourth will be for cell number.

E.1 The user will click on the button of *Images.*

E.1.1 The window of *recent captured photos* is visible which contains captured images of human intruder.

F.1 The user will click on the button of *logout*.

F.1.1 The current window will be closed and the user will route to the login window.

F.1.2 From the home window user can exit the system by clicking on the *exit* button.

4.2.3 Non-functional Requirements

Non-functional requirements define the needs in terms of performance, logical database requirements, design constraints, standards compliance, reliability, availability, security, maintainability, and portability.

4.2.3.1 Product Requirements

These requirements specify product behavior.

- *Performance requirements:*

Performance requirements define acceptable response times for system functionality.

- The alert (SMS/MMS/Email) sending time shall take no longer than 15 seconds.
- The system captures and save the image in database as long as motion is detected.

- *Reliability requirements:*

The system works reliably until & unless the Kinect works fine & PC is powered on.

- *Portability requirements:*

The system shall run in any Microsoft windows environment that contains MS visual studio & SQL server.

- *Usability requirements:*

The system should be user friendly that a person having little knowledge about programming & computer systems can easily interacts with the system.

4.2.3.2 Organizational requirements

- The software requires VS 2010, SQL server, Kinect SDK & Nokia Ovi Suite.
- The project should be completed before 26 Nov, 2011.

4.2.3.3 External requirements

- *Ethical requirements:*

- The human intruder should not be able to see the Kinect camera.
- The human intruder should not be able to login to the system.

- *Interoperability requirements:*

The software should interact effectively with the internet in order to successfully send the alert.

CHAPTER 5

Design (UML Diagrams)

5.1 Use Case Diagram

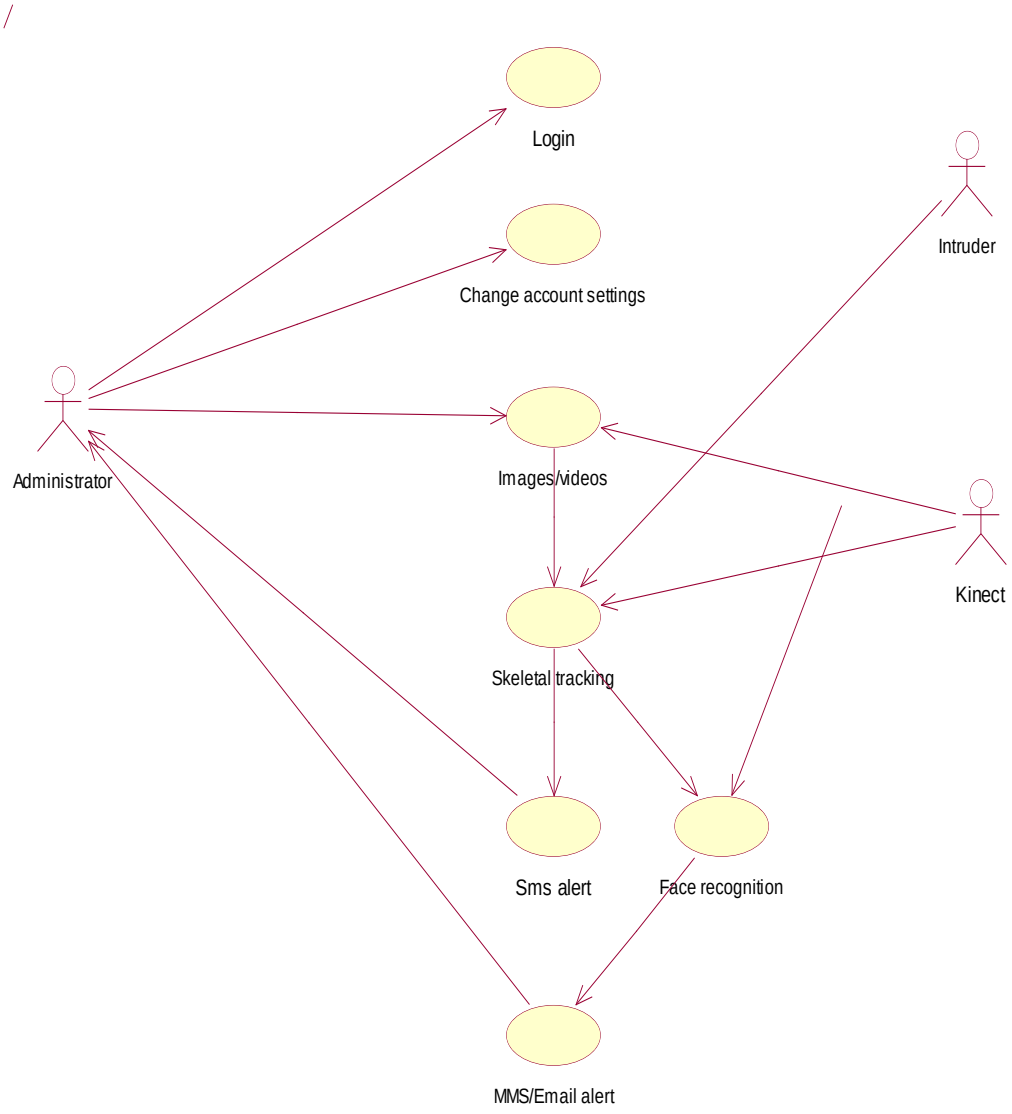


Figure 5.1

5.2 Sequence Diagrams

- *Login*

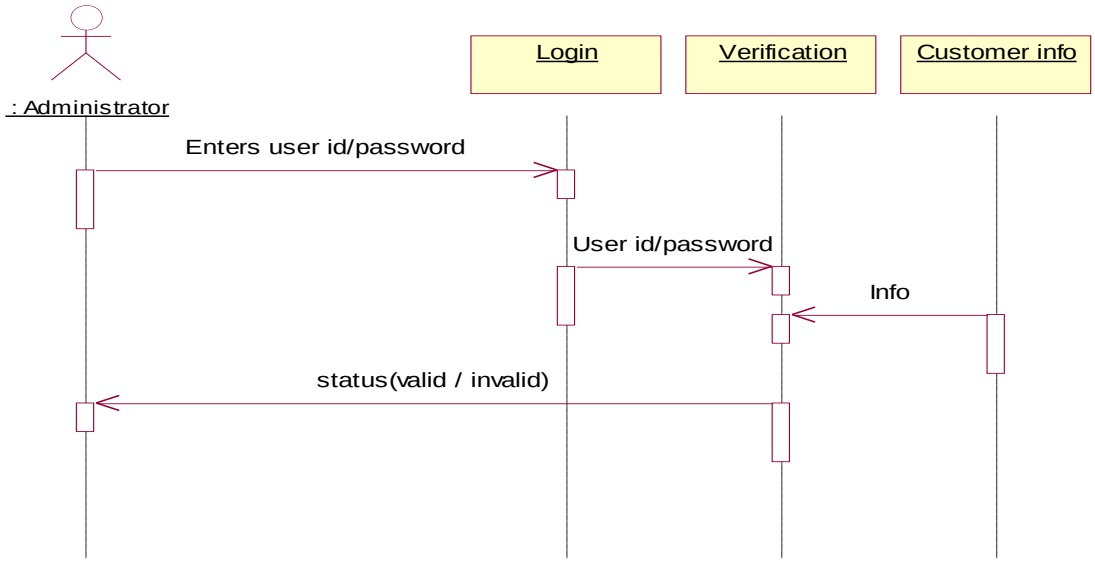


Figure 5.2

- *View Images*

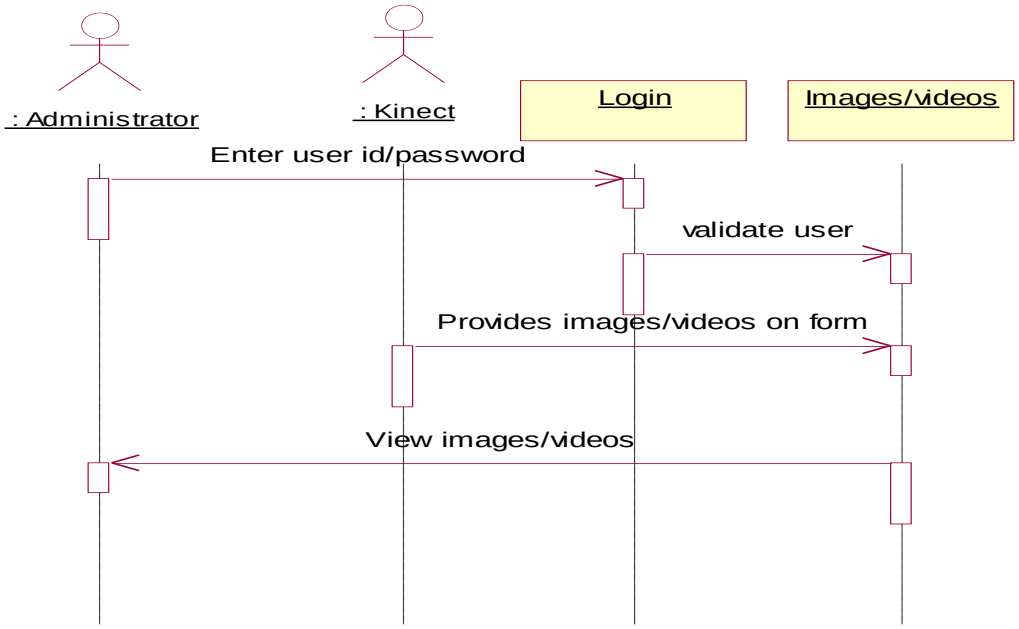


Figure 5.3

➢ *Change Account Settings*

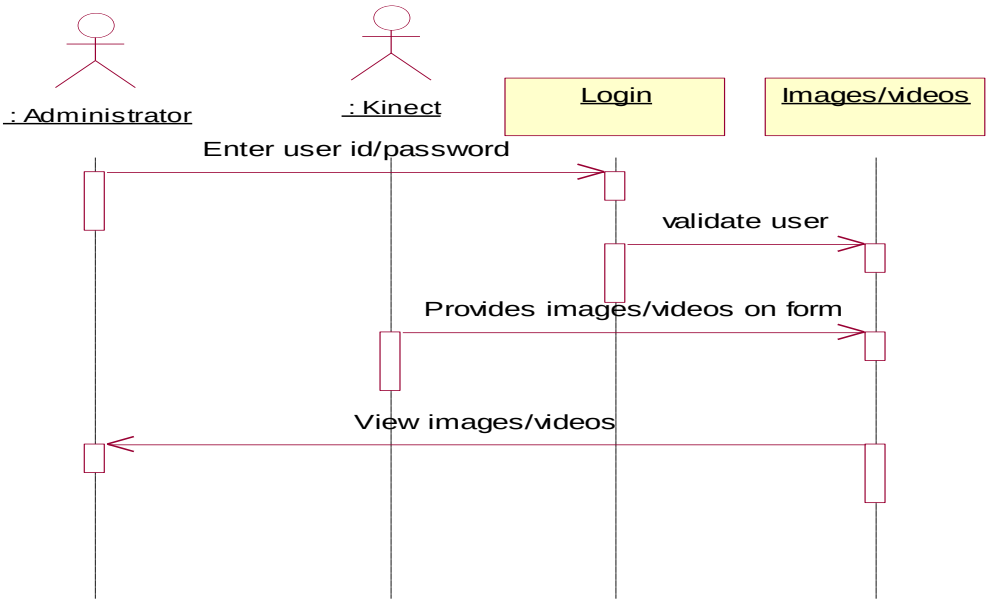


Figure 5.4

➢ *Face Detection*

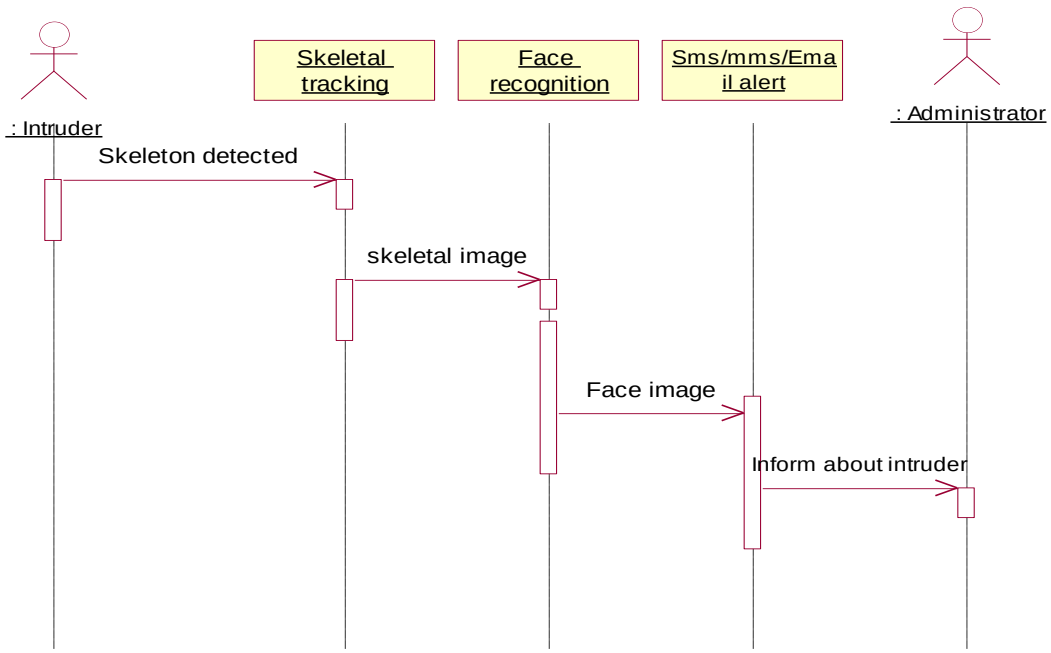


Figure 5.5

➢ *Skeletal Tracking*

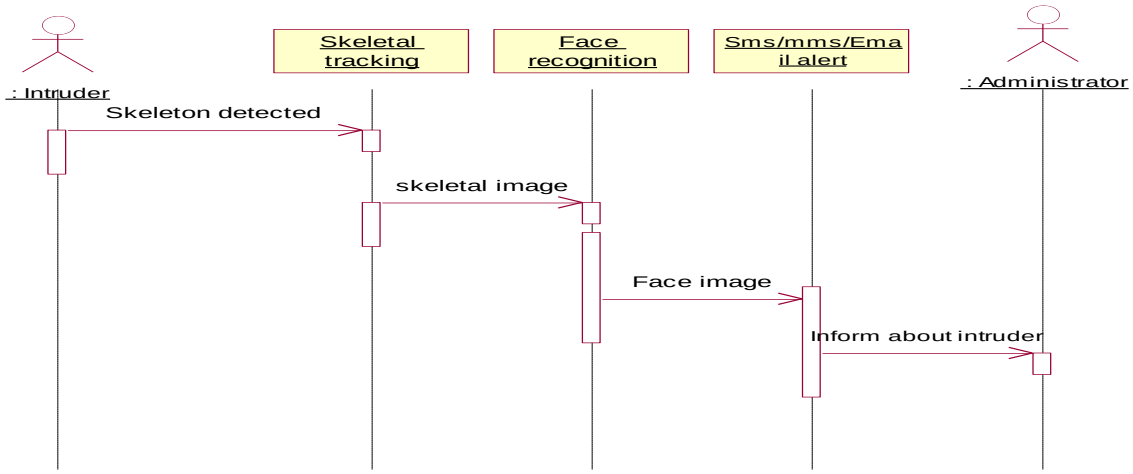


Figure 5.6

5.3 Collaboration Diagrams

➢ *Login*

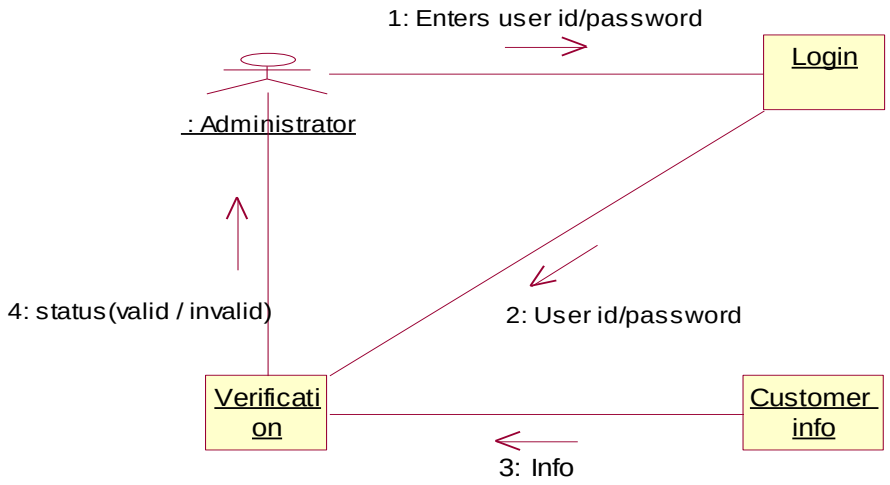


Figure 5.7

- *View Images*

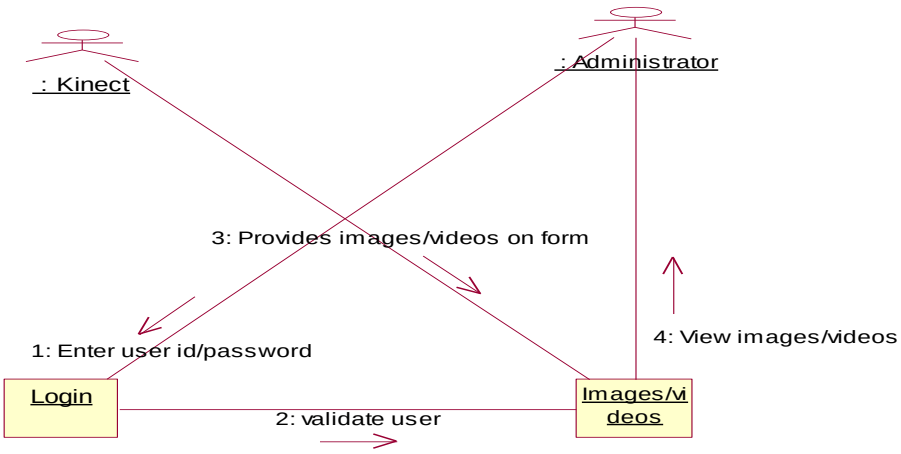


Figure 5.8

- *Change Account Settings*

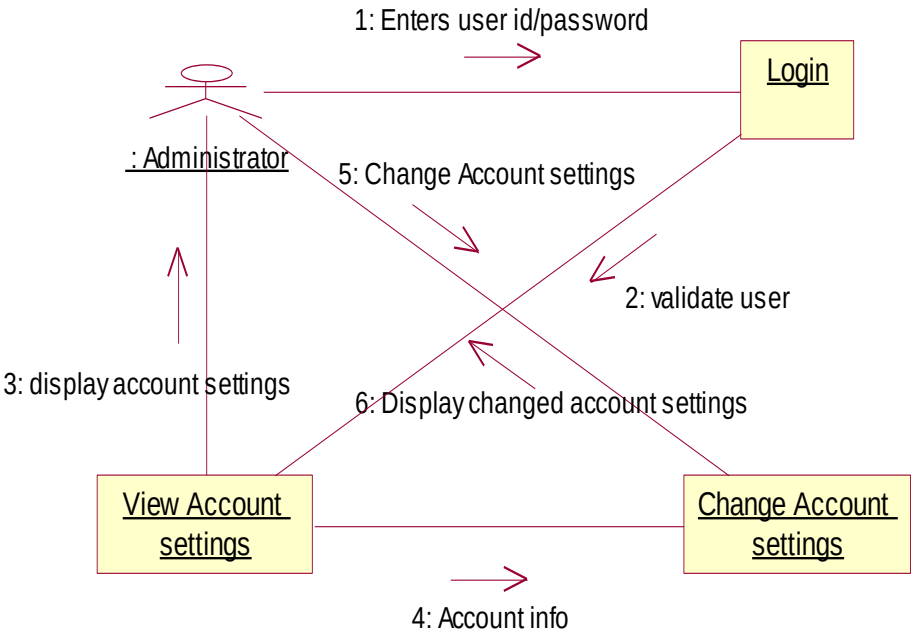


Figure 5.9

- *Face Detection*

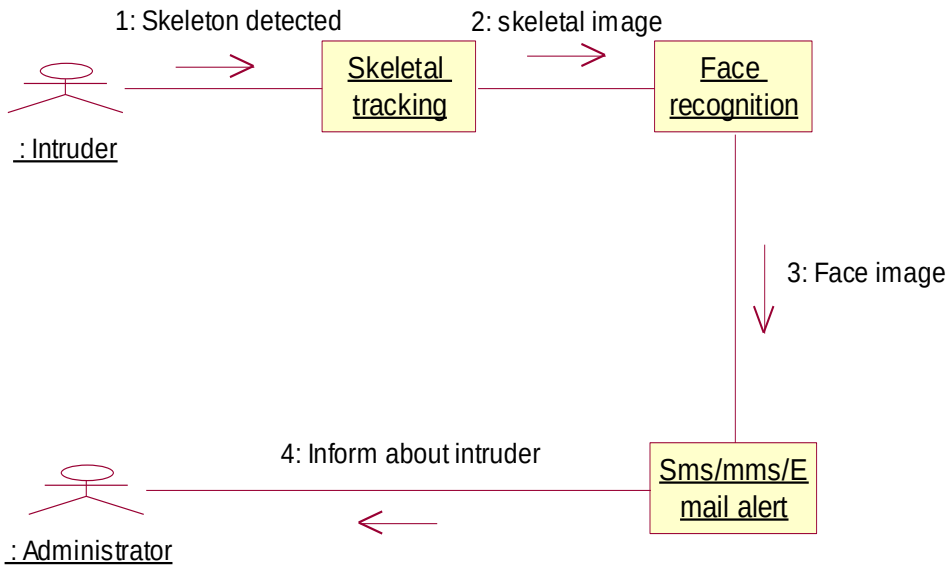


Figure 5.10

- *Skeletal Tracking*

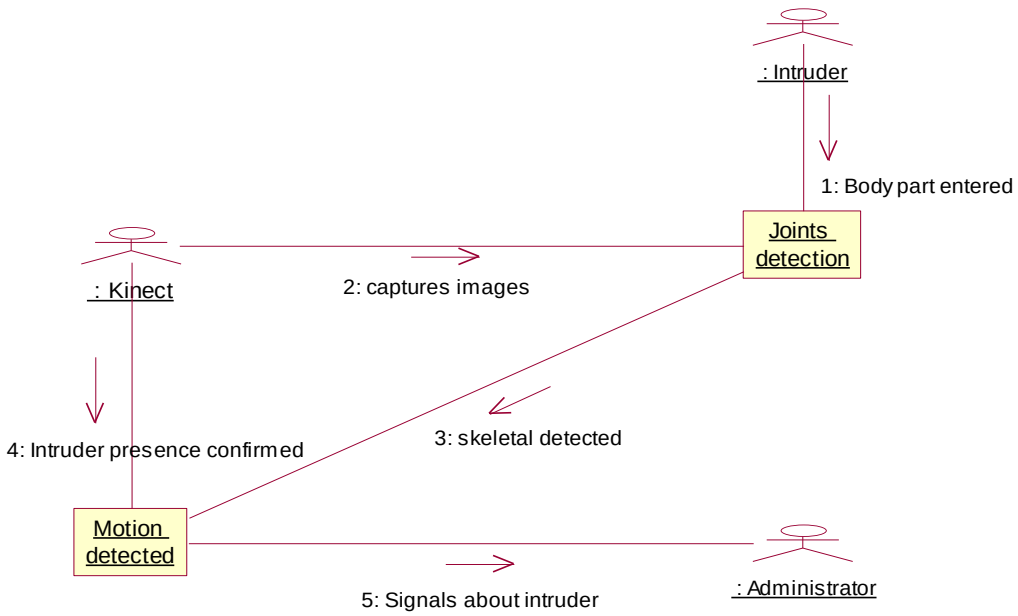


Figure 5.11

5.4 Functional Modeling

5.4.1 Dataflow Diagram Level 0

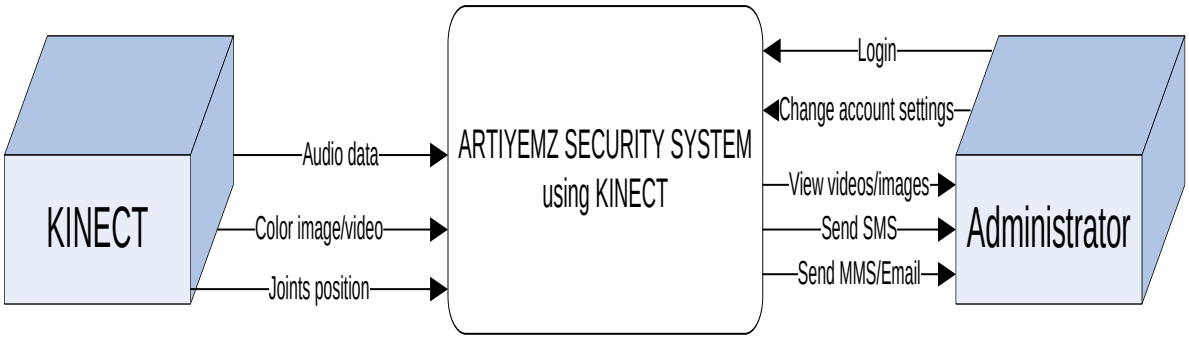


Figure 5.12

5.4.2 Dataflow Diagram Level 1

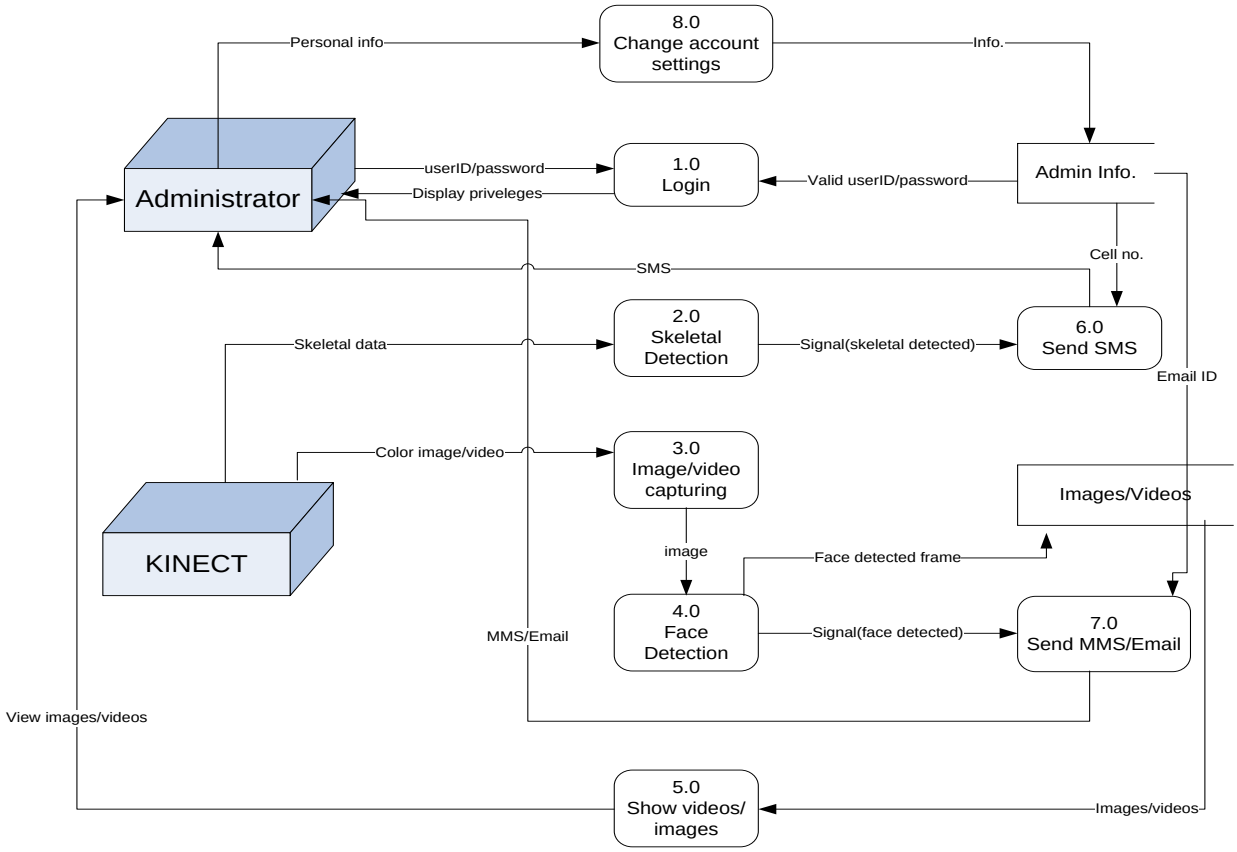


Figure 5.13

5.4.3 Dataflow Diagram Level 2

- *Login*

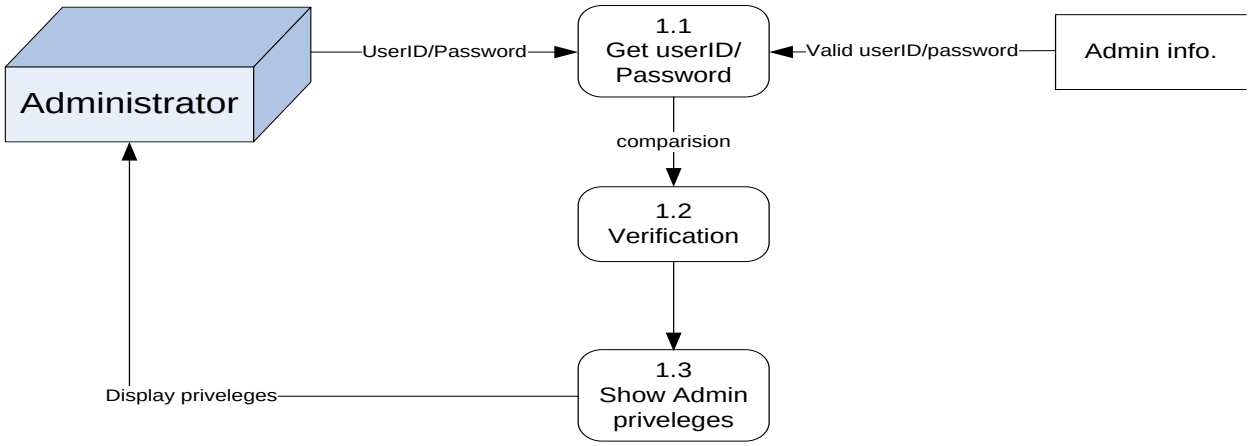


Figure 5.14

- *Skeletal Detection*

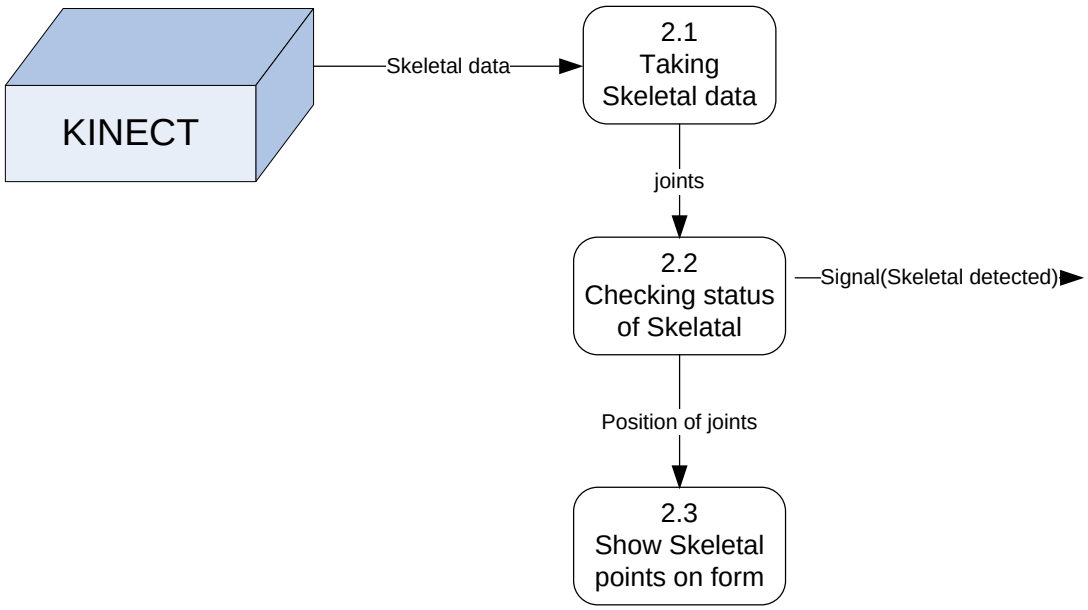


Figure 5.15

- *Image/Video Capturing*

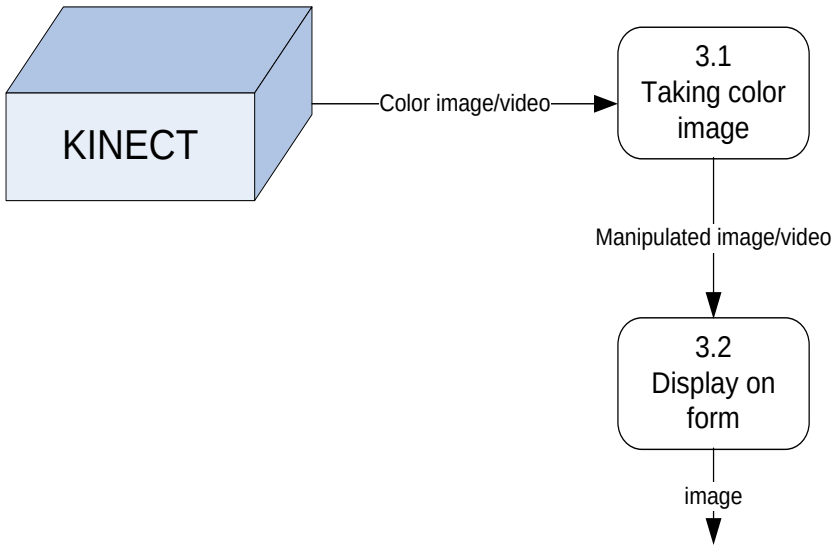


Figure 5.16

- *Face Detection*

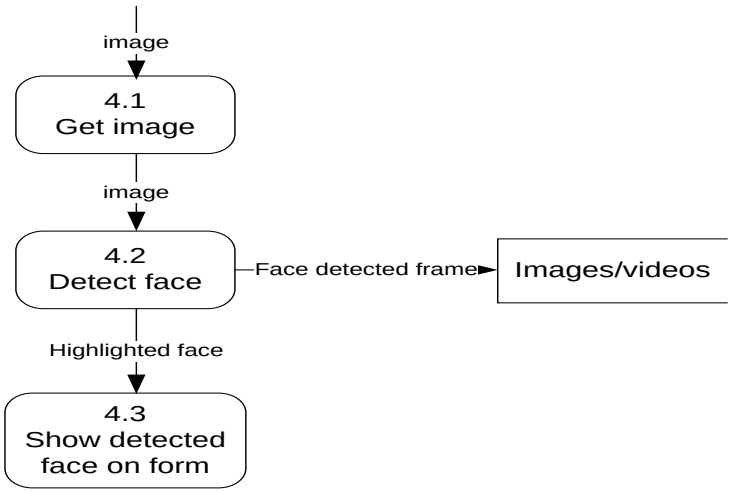


Figure 5.17

- *Show Videos*

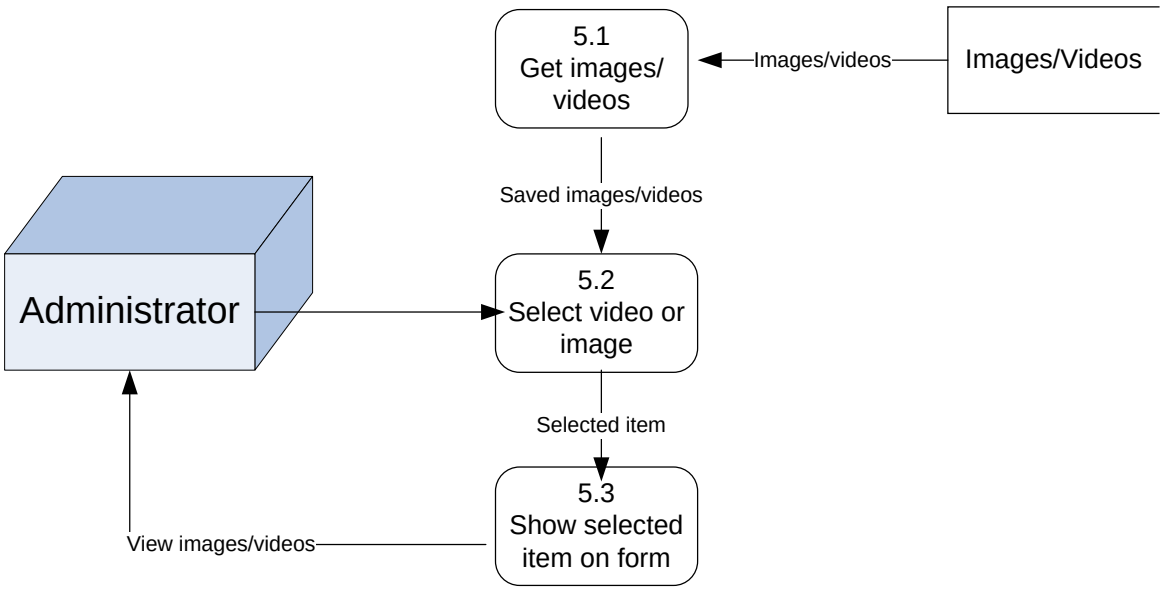


Figure 5.18

- *Send SMS*

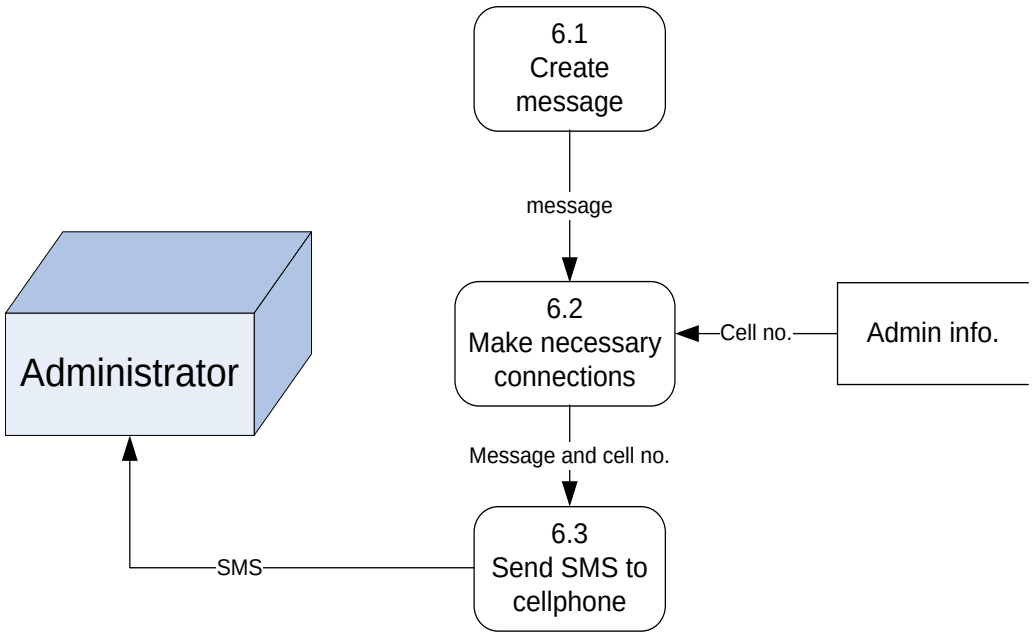


Figure 5.19

- *Send MMS/Email*

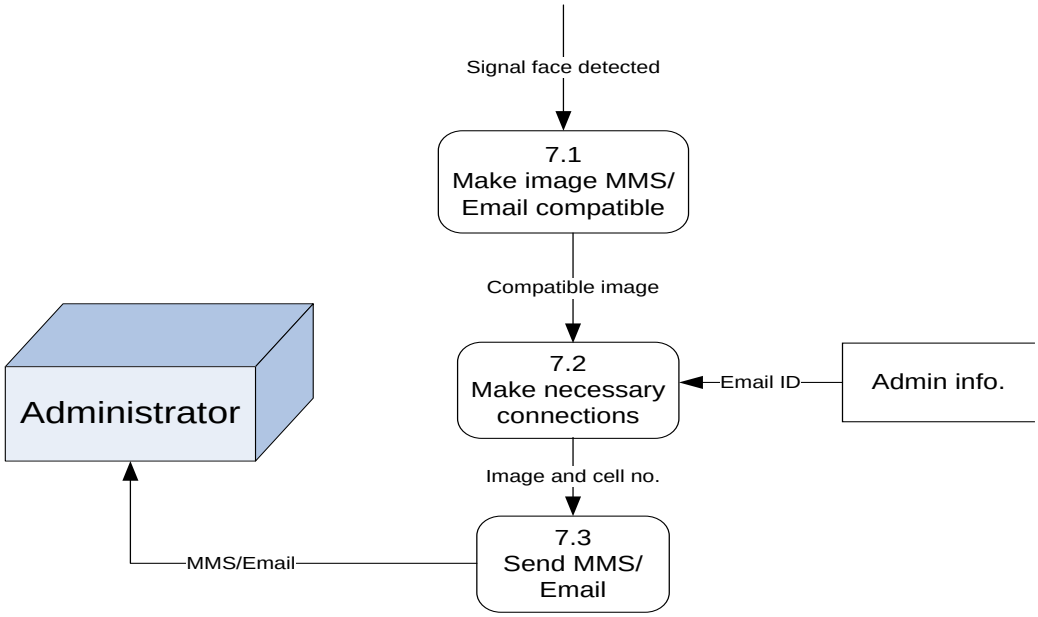


Figure 5.20

- *Change Account Settings*

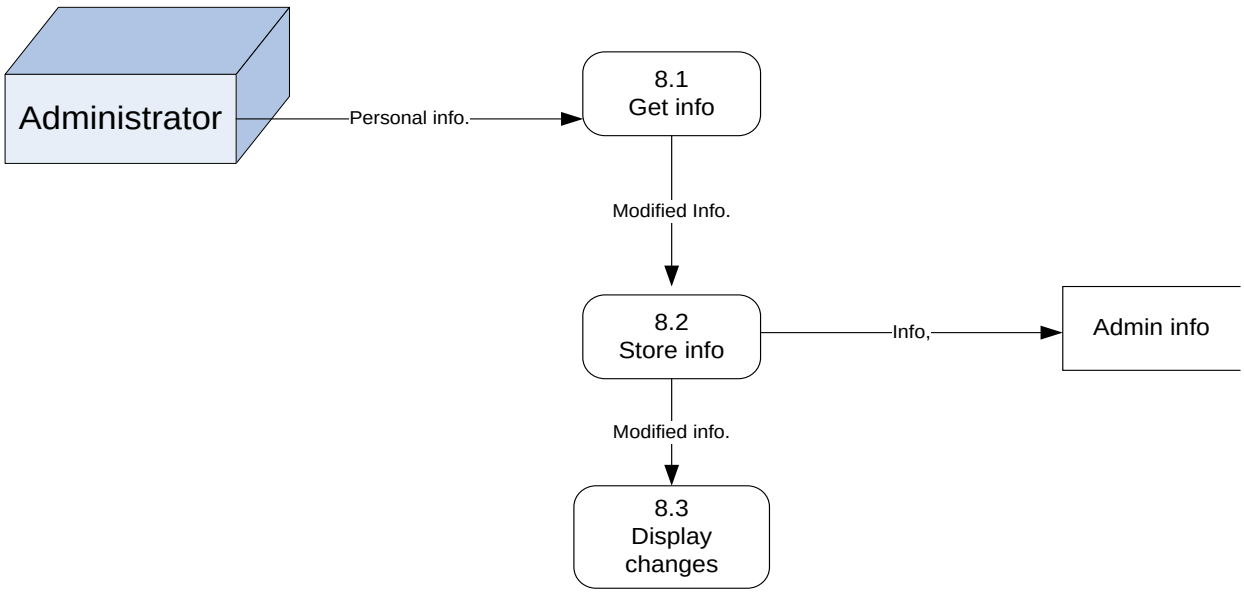


Figure 5.21

5.5 Behavioral Modeling

5.5.1 State Transition Diagram

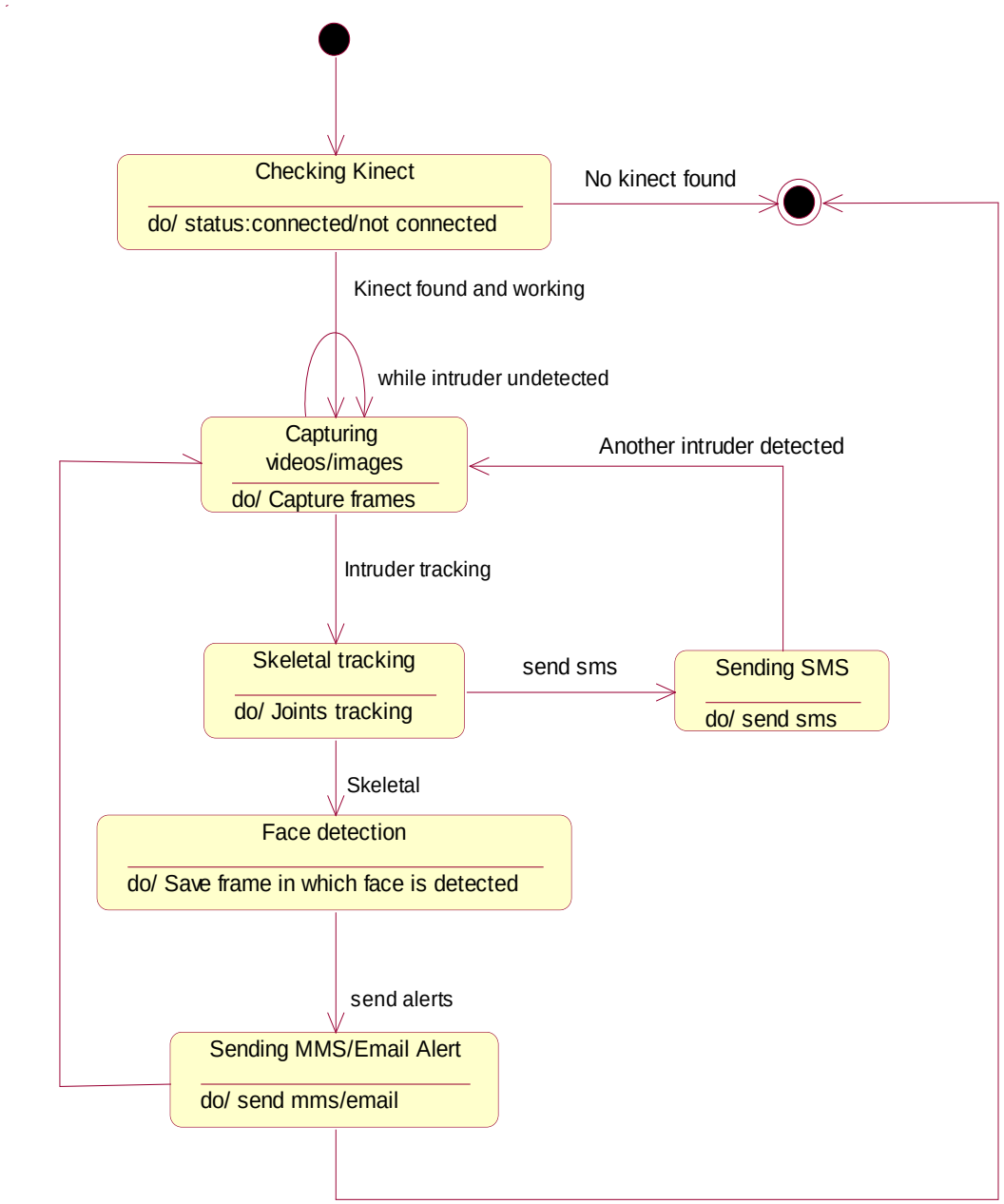


Figure 5.22

CHAPTER 6

Entity Relationship Diagram

6.1 ER Diagram

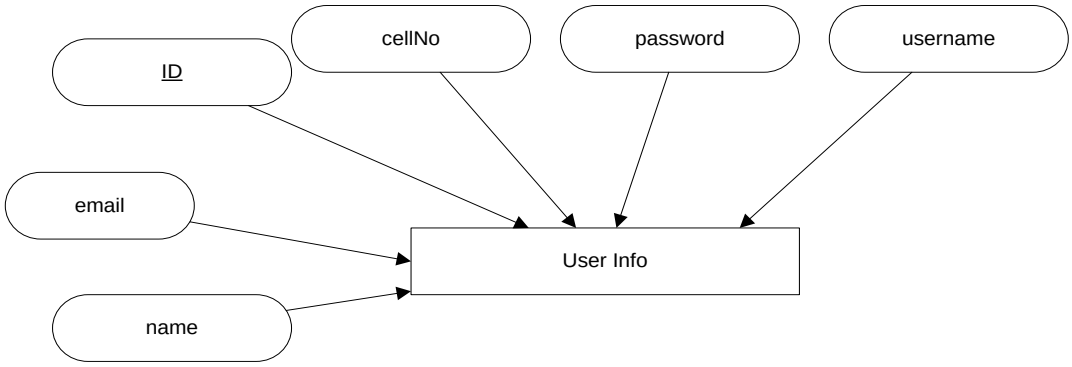


Figure 5.23

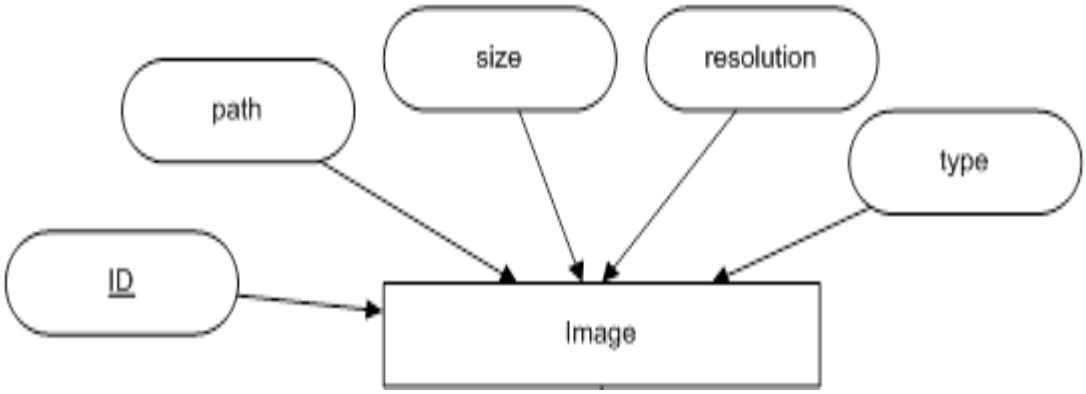


Figure 5.24

6.2 Mapping ER Diagram to Tables

1. **User Info** (ID, name, email, cellNo, password, username)
2. **Image** (ID, path, size, resolution, type)

CHAPTER 7

Object Oriented Design

7.1 Class Diagram

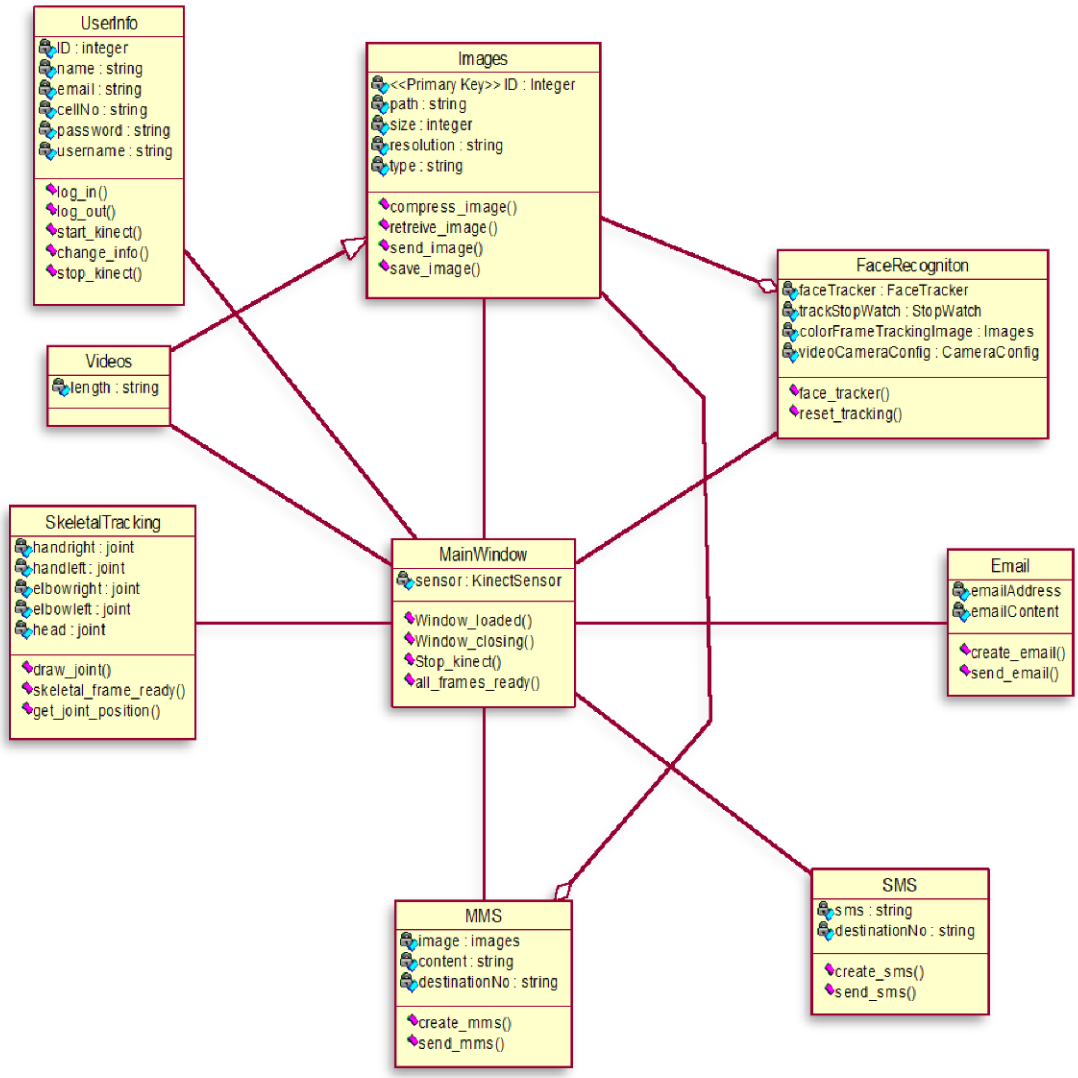


Figure 5.25

7.2 Data Dictionary

- *User info:*

Field Name	Field Data type	Constraint	Range	Byte	Example
ID	Integer	Primary Key	---	---	53
Name	String	Not Null	---	30	Adeel
Email	String	Not Null	---	---	someone@something.com
Cell No.	String	Not Null	---	---	+923311234567
Password	String	Not Null	---	---	********
Username	String	Not Null	---	20	example

- *Images:*

Field Name	Field Data type	Constraint	Range	Byte	Example
Path	String	Not Null	---	30	C:\Documents and Settings\Images\
Size	Integer	Not Null, in KBs	---	---	24
Resolution	String	---	Normally used resolutions	---	400x1200 pixels
Type	String	Not Null	.jpg, .png etc	---	.jpg

CHAPTER 8

Implementation

8.1 Overview

Implementing an ASSK is not an easy task to achieve; in fact it takes lots of searching & studying Kinect SDK. ASSK is extraordinary wide in scope and for many larger organizations can be extremely helpful as it needs less human resource and provides a complete automation. Implementing an ASSK will ultimately require a computer system continuously on, a Kinect device and a Nokia mobile phone connected to PC. While it may seem reasonable for an in house administrator that sets the system on properly and later will receive alerts in case if any intruder gets detected.

By comparing different software development kits for Kinect released on internet, the team had decided to opt for the official Kinect SDK v1- The Kinect for Windows SDK Beta v1.6 and for a WPF project, XAML is main component for creating user interfaces with code-behind in, for example using C#, xaml.cs.

8.2 Project's implementation

8.2.1 Division of the project implementation

Project implementation is divided into following three main phases:

- Analysis & Design
- Implementation & Integration
- Post-Implementation monitoring & considerations

8.2.1.1 Analysis and Design

The basic and most important phase for developing a module or partition of any software is the *analysis phase*. In this phase, all the modules of the software are analyzed i.e. analyzing the structure of software, working of modules on individual basis, their interaction with each other, using different attributes and values among different modules etc. The deliverable of the analysis phase is SRS that includes description of existing modules along with the requirements for the software being engineered.

Design phase involves representing the functionality and flow of data of existing modules with the help of flowcharts, use case diagrams, sequence diagrams, functional modeling using data flow diagrams. The deliverable of this phase is the design document. Software tools used in the design document preparation are:

- Rational Rose
- Visio
- MS Word 2010

8.2.1.2 Implementation and Integration

Implementation of a project becomes easy if SRS and Design Documents are developed with proper care as rest of phases i.e. implementation and modifications are based on them. Following tools are used for implementation:

- **Visual Studio 2010:** Windows Presentation Foundation i.e. WPF is used as the programming platform with C# as the programming language.
- **Kinect SDK v1.6:** For being able to use the basic functionality provided by the device.
- **SQL Server 2008:** For creating database containing user information as well as the images of the intruder being stored by ASSK.

- **Nokia Ovi suite:** For connecting the Nokia cell phone to the PC and using it as an SMS sending device.

8.2.2 Modules of project

There are following modules in the software:

- Image capturing
- Skeletal detection
- Face detection
- Image database
- Sending Alerts (MMS/SMS/Email)

➢ **Image Capturing**

Kinect is being used as a camera to capture a live video stream & then show on the WPF window and all the rest operations like skeletal & face detection are performed on this live stream.

➢ **Skeletal Detection**

The detection of an intruder depends mainly on the detection of his/her skeleton, so, human skeletal tracking was the first task. Focusing on detecting user motion by means of the motion in skeleton, the essential part of Kinect to be utilized is Skeletal tracking, i.e. to track the skeleton image of user moving within the Kinect field of view. It allows us to create gesture-driven applications too. As soon as the skeleton has been tracked, it is drawn out for testing purpose. It includes two parts: bones and joints. By coloring with *Brush* using a set of colors for different parts of skeleton (i.e. body segment), they are drawn and added to the *Skeleton*. Parts like left arm, right arm, left leg, right leg and (head

to hip) are individually drawn using *Polyline*. For each part of *Skeleton*, joints are drawn by *points*, which are pre-defined with different colors in order to identify the joints. The skeleton is drawn on another image control to separate it from the live video stream.

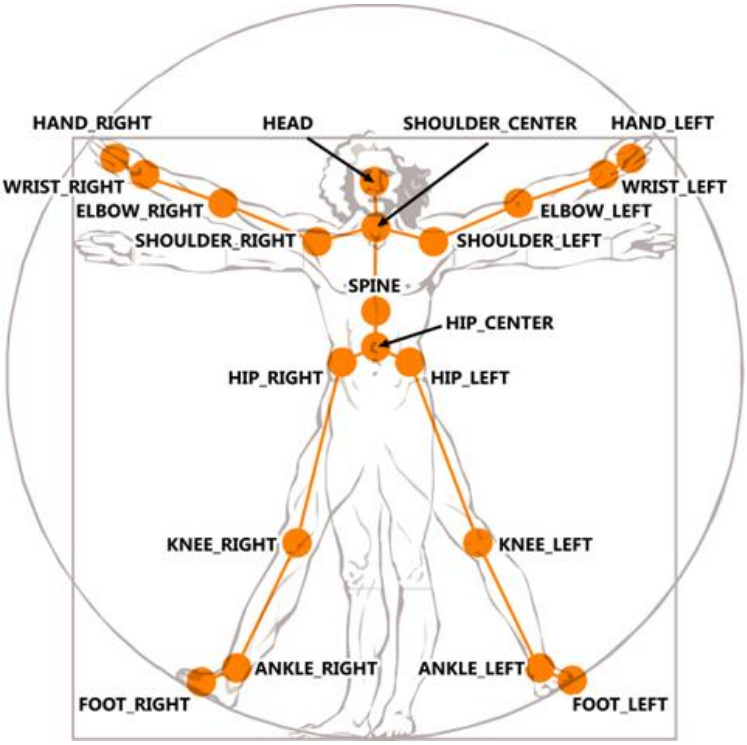


Figure 8.1 Indicating the joints that can be detect by KINECT

- **Face Detection**

After the skeleton has been detected and well-drawn, on the window, ASSK starts its search for a face in the live video stream being continuously captured by the Kinect device using face detection algorithms in the code and when it succeeds in finding a face, it indicates it by drawing a 3D mesh on the face in the live stream. This 3D mesh is flexible enough to change its position as the face position changes and can also animate eye brow positions, and mouth shape in real time.

Figure 8.2 Indicating the face has been detected by drawing 3D meshes on the face

- **Image Database**

For sending the intruder's images to the subscriber, ASSK needs to capture still images from the live video stream which clearly show the face (i.e. after the face detection) of the intruder. ASSK captures the whole frame and stores it as an image in the image database. When it needs to send to the user it first retrieves the image from the database and attaches it in an email/MMS and sends to the subscriber.

```
public void saveImage()
{
    BitmapSource image = (BitmapSource)ColorImage.Source;

    image.Save("E:\\KinectSnaps\\" + DateTime.Now.ToString("ddMMyyyy HHmmss") + ".jpg", ImageFormat.Jpeg);

    |
}
```

Figure 8.3 Function that save the required frame in a particular folder with the system date and time in the Jpeg format

➢ **Sending Alerts**

It contains three types of alerts:

- **SMS**

  As soon as a skeleton is detected, an SMS is sent to the subscriber's number, taken from the database of the user information. It alerts the subscriber about the intruder. The SMS sending module needs Nokia Ovi suite for functioning with the code and a Nokia cell phone must be attached to the PC via cable continuously. The SMS contains only text.

- **Email**

  After SMS alert, next step is to send the subscriber, the image of the intruder if found. Image is sent in two ways using Email and MMS. An Email is sent to the subscriber's Email address which contains the image as attachment, using the SMTP server (Gmail account). This module requires internet connection.

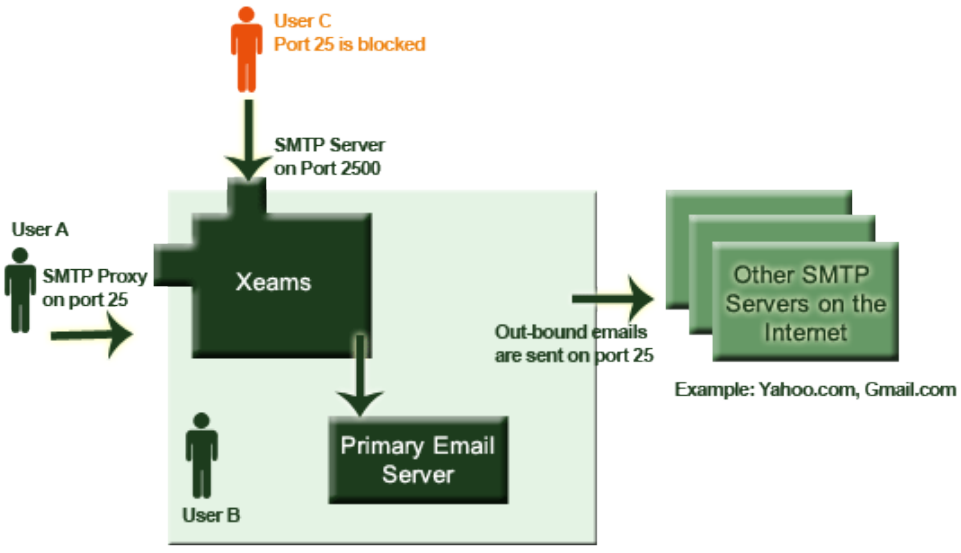


Figure 8.3 Indicating the procedure of sending Email using SMTP

- **MMS**

An MMS is also sent in parallel with the Email to the subscriber's number containing the image of the intruder. This module also requires the internet connection. And the subscriber must have an MMS compatible cell phone. For the MMS to be sent the user information database must contain the carrier for the subscriber's service provider.

We are sending MMS in the Email format. Since we don't have GSM Modem so we opt for its alternative i.e. *Email to Phone* procedure. In this procedure we have to write the number in the Email address format. Ufone network provide the feature of *Email to phone* so for a user having Ufone number we are sending MMS to his number through *"number@ufonemms.com"*

CHAPTER 9

Test Plan

Software testing is a realistic analysis steered to deliver users with information about the quality of the product or service under test, with respect to the environment in which it is envisioned to maneuver. Our primary purpose for testing was to:

- Meet the requirements that guided its design and development,
- Work as expected,
- Implement with the same characteristics as proposed,
- Design tests that systematically uncover different classes of errors with minimum time and effort.
- And, satisfy the needs of users.

Our test plan is dynamic. We have applied Black-Box testing, Unit testing, Integration testing, Recovery testing, Specification-based testing and Non-functional software testing. Few snaps were taken during testing, that are presented as follows:

- **Black Box Testing**

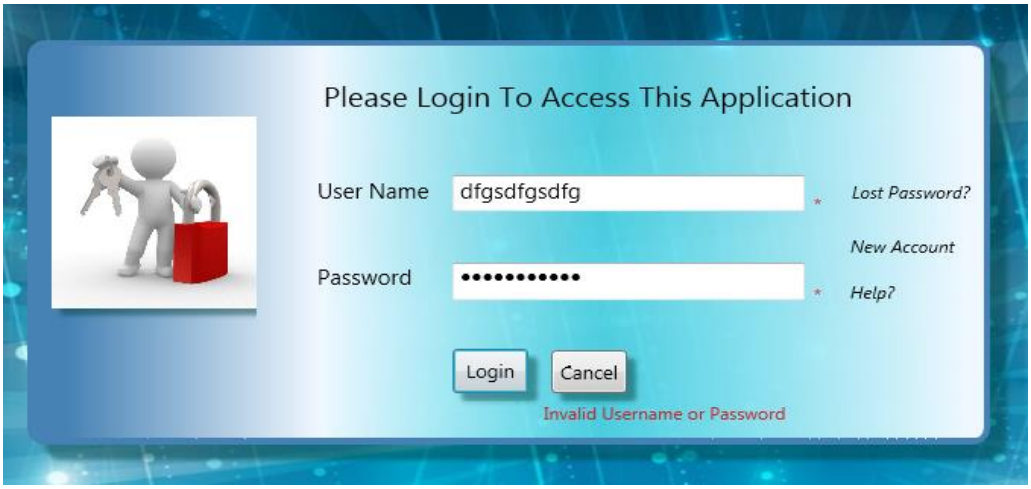


Figure 9.1 Indicating that Invalid username or password has entered

- **Unit Testing**

Unit testing tests the minimal software component, or module. Each unit (basic component) of the software is tested to verify that the detail design for the unit has been correctly implemented. The primary goal of unit testing is to take the smallest piece of testable software in the application, isolate it from the remainder of the code, whether it behaves exactly as you expect. It is done to show whether a unit (the smallest piece of software that can be independently compiled or assembled, loaded and tested) satisfies its functional specification or its implemented structures matches and intended design structure.

In our project we have implemented unit testing on almost all the forms by using the various "required fields validator" to handle various error conditions like incorrect data entry, entering text in integer data fields, handling code repetition etc. The "compare validator" has been use in various forms like sign-in to compare password written by the user. The main purpose of required field validator is to bind the user to enter correct data in the mandatory data fields. To prevent the user from entering wrong data some error or warning messages are used to guide the user for data entry.

Figure 9.2 Indicating that on writing the error free information your account will be created

- **Integration Testing:**

Finding the error (or errors) in the integrated module is much more complicated than first isolating the units, testing each, then integrating them and testing as a whole. Integration testing is the logical testing of unit testing. In its simplest form, multiple units that have already been tested are combined into a component and the interface between them is tested. A component, in the sense, refers to an integrated aggregate of more than one unit. The idea is to test combinations of pieces and eventually expend the process to test your modules to those of other groups. Eventually all the modules making up a process are tested together. Beyond that, if the program is more than one process, they should be tested in the pairs rather than all at once.

Integration testing identifies problems that occur when modules or subsystems are combined. Integration testing in a variety of ways but the following common strategies used is top-down and bottom-up.

- **Recovery testing**

In this test all the basic functions of the system were tested. The analysis are made that whether the system was competent to recover from unknown and unidentified situations and perform in an efficient manner. This test makes sure that it does not loose any data during the updating of the database.

- **Specification-based testing:**

Specification-based testing aims to test the functionality according to the requirements. Thus, the tester inputs data and only sees the output from the test object. This level of testing usually requires through test cases to be provided to the tester who then can simply verify that for a given input, the output value (or behavior), is the same as

the expected value specified in the test case. Specification-based testing is necessary but insufficient to guard against certain risks. In our software we have performed testing according to the gathered specification and used our understanding of the data semantics to test the system.

System testing is performed to see whether the system produces the expected results under the given conditions. The purpose of testing is to validate an application's accuracy and completeness in performing the functions as designed. System testing stimulates real life scenarios that occur in a "simulated real life" test environment and test all functions of the system that are required. System testing us deemed complete when actual results and expected results are either in lines or differences are explainable or acceptable, based on client input.

- **Non Functional Software Testing**

Special methods exist to test non-functional expects of software.

- Performance testing checks to see if the software can handle large quantities of data. This is generally referred as software scalability.
- Usability testing is needed to check if the user interface is easy to use and understand.
- Security testing is essential for software which processes confidential data.
- Internationalization and localization is needed to test these aspects of software, for which a pseudo localization method can be used.

In contrast to functional testing, which establishes the correct operation of the software (correct in that it matches the expected behavior defined in the design requirements), non-functional testing verifies that the software functions properly even when it receives invalid or unexpected inputs.

Figure 9.3 Indicating that user has crossed the limit of username or password

CHAPTER 10

Future Enhancements & Recommendations

We firmly believe that the below mentioned enhancements and initiatives will contribute to development of our project in an improved way giving high throughput and reliability to the users:

- Optimize for detecting more than two people.
- Accurately determine the difference between an intruder, authorized person, object and an animal.
- Accurately determine the intruder in a bunch of people.
- Accurately determine intruder actions and normal actions.
- Inclusion of video recording and sending relevant video to users.
- Inclusion of the time stamps.
- Control of lag timing in between recording or taking snaps.
- Device and platform independent as to be used on I-pads, smartphones and android phones.
- Introduce the concepts of clouds for efficient information gathering, data processing and data retrieval.
- Send information to users using Wireless or Bluetooth.
- Deploy a sensor network which can buzz the alarm or trigger the information to the base station on all events.
- Concepts can be used to mark attendance during lectures or on work environments.
- Concepts can be used in banks security systems, highly secured labs or DMZ environments to prevent intruder coming to restricted areas.

- If GMS Modem is available we can send MMS to any network.

Moreover, it should be noted that the mentioned initiatives were not covered because they require few quality years to come up with an optimal algorithm, software and hardware with a large research team and funding. And also, because few concepts are beyond the undergrad level to be accomplished.

CHAPTER 11

Conclusion

The FYP report will cover all the steps from requirement gathering to development of ***ARTIYEMZ Security System using Kinect (ASSK)***. This report will provide a complete understanding of what is to be expected from the project being developed. The clear understanding of the ***ASSK*** and its' functionality will be provided here. It will provide the literature review for the project. From this report it can be understood, how the ***ASSK*** has been designed, constructed, and finally tested.

This document gives information about the ARTIYEMZ Security System using Kinect. It starts with a definition of the real world problem and explains the solution that the project proposes. This explanation includes basic functionality of the system, interface requirements of the system, performance, attributes, and design constraints imposed on the implementation. In the implementation part, all of the functions that this system will perform are explained one by one. Data objects that are used in the system are modeled and behavioral models are presented. Consequently, this document is prepared to conduct better design approaches to Security System with Microsoft Kinect project at implementation. It also explains the various modules that we have implemented and how we have carried out the work for them.

Appendix A: Implementation Design (Conceptual Schema)

Table 1: User Information

```
CREATE TABLE USER_INFO (
ID NUMBER (5) PRIMARY KEY,
first_name VARCHAR (15) NOT NULL,
last_name VARCHAR (15) NOT NULL,
password VARCHAR (15) NOT NULL,
email VARCHAR2 (15) NOT NULL,
cellNoVARCHAR2(15) NOT NULL,
username VARCHAR2 (15) NOT NULL UNIQUE,
);
```

Table 2: Image

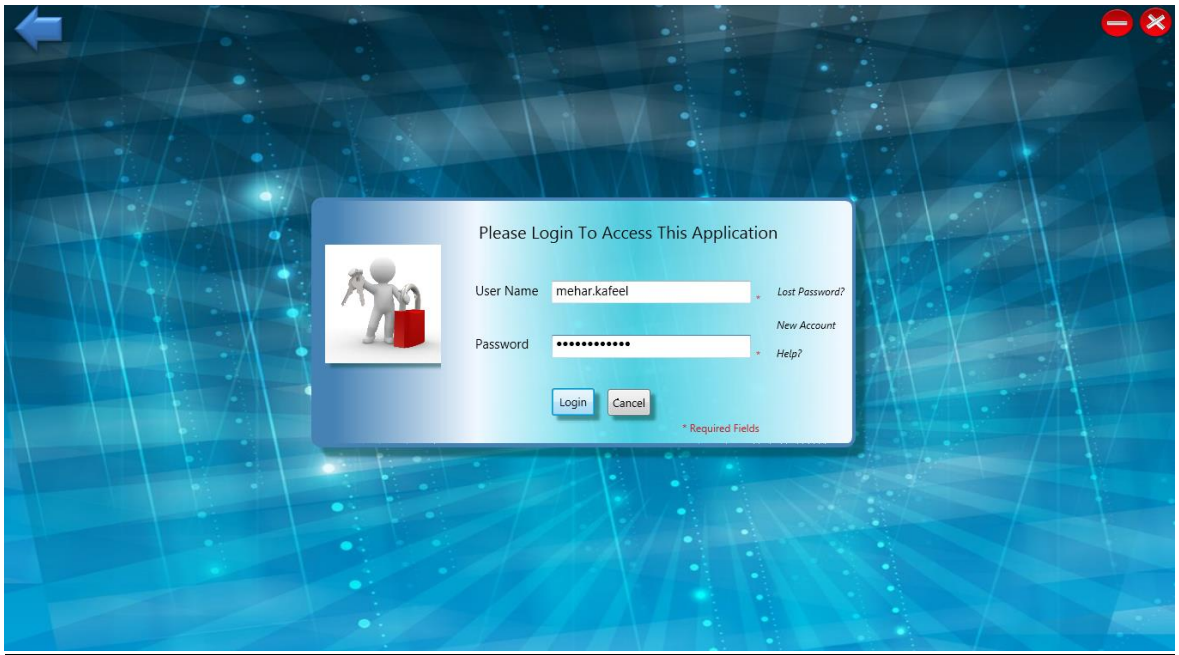
```
CREATE TABLE IMAGE (
ID NUMBER(5) PRIMARY KEY,
path VARCHAR (100) NOT NULL,
sizeNUMBER (4) NOT NULL,
resolution VARCHAR (15) NOT NULL,
type VARCHAR2 (15) NOT NULL,
);
```

Appendix B: Working Sessions/Snapshots of ASSK

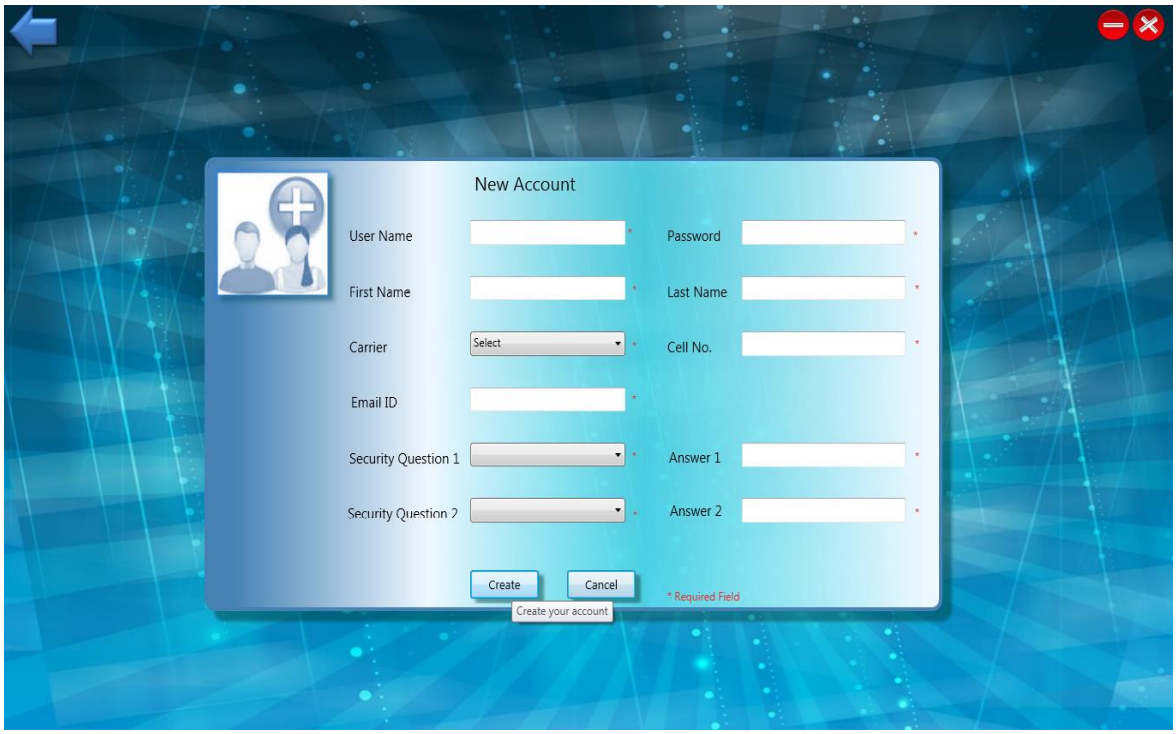
Following are the snap shots of various windows:

- *Home Window*

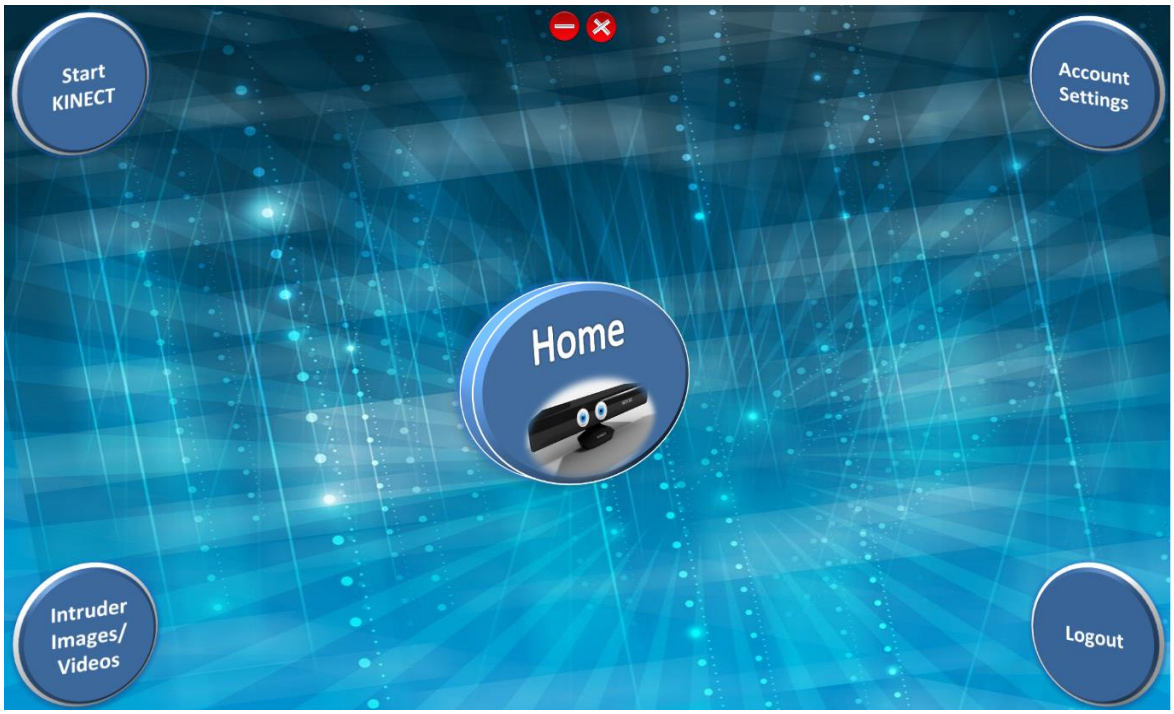
- *Login Window*



- *New Account Window*

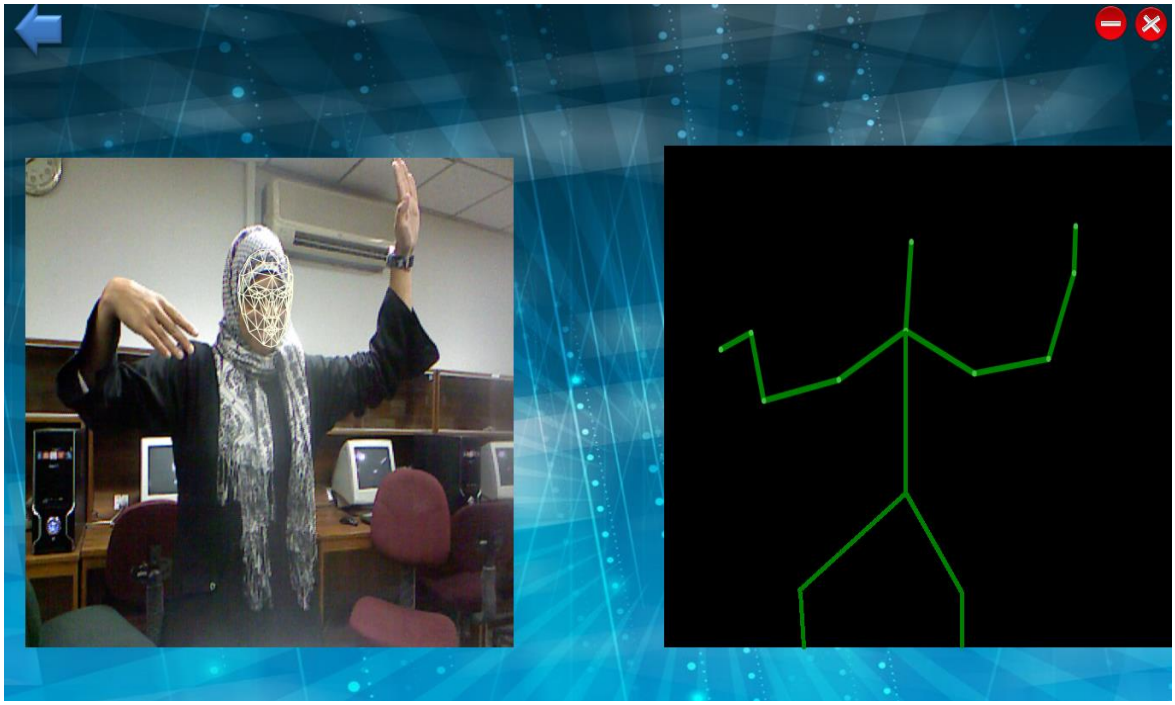


- *Main Window*



- *Intruder Images Window*

- *Skeletal Tracking & Face Detection Window*



References

Website:

- http://www.roborealm.com/help/Microsoft_Kinect.php
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Books:

- ***Software Engineering*** *by Roger S. Pressman.*
- ***Beginning Kinect Programming with the Microsoft Kinect SDK*** *by Jarrett Webb and James*
- ***Meet the Kinect: An Introduction to Programming Natural User Interfaces (Technology in Action)*** *by Sean Kean, Jonathan Hall and Phoenix Perry*
- ***Start Here! Learn the Kinect API*** *by Rob S. Miles*

Glossary

- **ASSK** – Artiyemz Security System using Kinect.
- **Intruder –**Unwanted person.
- **API –**Application Programming Interface.
- **ER Diagram –**Entity Relationship Diagram.
- **Nokia OVI Suite –**Software for synchronizing cell phone on PC.
- **SRS** – Software Requirements Specification.
- **Requirements** – *Singular documented need of what a particular product or service should be or perform.*
- **Kinect –** A motion sensing input device by Microsoft.
- **SDK –**Software Development Toolkit.
- **Skeletal Detection –**Detecting human joints.
- **Face Detection –**Detect face in human body using head joint.
- **Database –** The records of every customer are saved here.
- **Interoperability –** It isthe ability to exchange and use information.
- **Usability –** It is how much your software is user friendly.
- **SMS –** Is a text messaging service component of phone, web, or mobile communication systems, using standardized communications protocols that allow the exchange of short text messages between fixed line or mobile phone devices.
- **MMS –** Multimedia Messaging Service is a standard way to send messages that include multimedia content.
- **Motion detection–**Motion detection is a process of confirming a change in position of an object relative to its surroundings or the change in the surroundings relative to an object.

- **RGB–** RGB camera delivers the three basic color components (red, green, and blue) on three different wires. This type of camera often uses three independent CCD sensors to acquire the three color signals.
- **UML–**Unified Modeling Language. UML is a standard notation and modeling technique for analyzing real world objects, developing systems, designing software modules in object-oriented approach.