TD 1

« Visualisation d'images sous X-Window »

Découvrir l'utilisation des programmes

1. *Léna en couleur sur Central Park*

En vous servant du programme « visual_true_color.c » (voir site Web http://www-igm.univ-mlv.fr/~riazano/ ou directement sur le disque dans le répertoire **`~riazano/cours/MASTER/ITI`**) et des images que vous trouverez sur le site Web ou sous le répertoire **`~riazano/cours/IMAGES`**, résoudre l'énigme en affichant à l'écran « ***Léna en couleur sur Central Park*** ». Léna est une image carrée et correspond à une femme dont la chair est de couleur rosée. L'image de New-York est-elle aussi carrée.

2. *Gare au mandrill*

Afficher l'image du mandrill. Ce singe est représenté en niveaux de gris dans une image « presque carrée ».

Examiner les fichiers image

3. *Couleur du pixel (0,0)*

Dans l'image « Léna », quelles sont les valeurs des trois composantes du pixel (0,0) qui est le premier pixel situé en haut à gauche.

R = ……. V = ……… B = ……..

Configuration du serveur X-Window

4. *Mapping des couleurs*

En utilisant la commande « xdpyinfo », déterminer la configuration du driver d'affichage utilisé par le serveur X :

- Quelles sont les dimensions de l'écran : …………. lignes x ……….. colonnes
- Quelle est le visual utilisé par défaut : ………………………. (classe …………………..)
- Quelle est la profondeur d'affichage : ………. bits
- Quels sont les masques d'affichage des composantes (écrire en hexadécimal et en binaire)

Rouge	0x………..	… … … … … … … …	… … … … … … … …	… … … … … … … …
Vert	0x………..	… … … … … … … …	… … … … … … … …	… … … … … … … …
Bleu	0x………..	… … … … … … … …	… … … … … … … …	… … … … … … … …

- Combien de bits sont utilisés et quel est le décalage gauche pour chacune des composantes dans le frame buffer ?

Rouge	….. bits	….. bits
Vert	….. bits	….. bits
Bleu	….. bits	….. bits

Modifier le programme visual_true_color.c

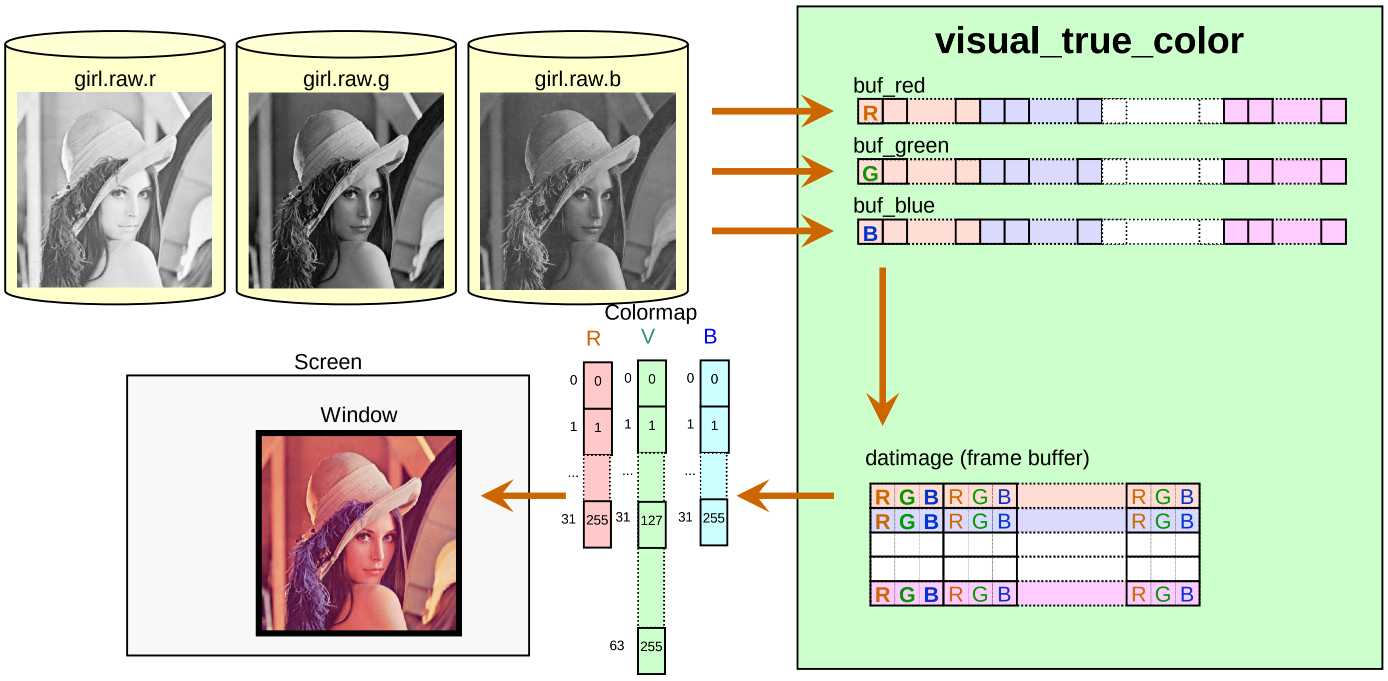
5. *Couleur et représentation interne du pixel (125,17)*

Dans l'image « Léna », quelles sont les valeurs des images sur disque des trois composantes du pixel (125,17). Les coordonnées sont toujours exprimées en (ligne,colonne) et leurs valeurs commencent en 0.

R = ……. V = ……… B = ………

Quelle est la valeur dans le frame buffer du pixel (125,17) avant une éventuelle permutation LSB (little Endian) ? Ecrire en binaire puis en hexadécimal.

Pixel (125,17)	0x………..	… …



6. *Comparaison des programmes « visual_true_color » et « skelet »*

Le programme « skelet » est une amélioration du programme « visual_true_color ».

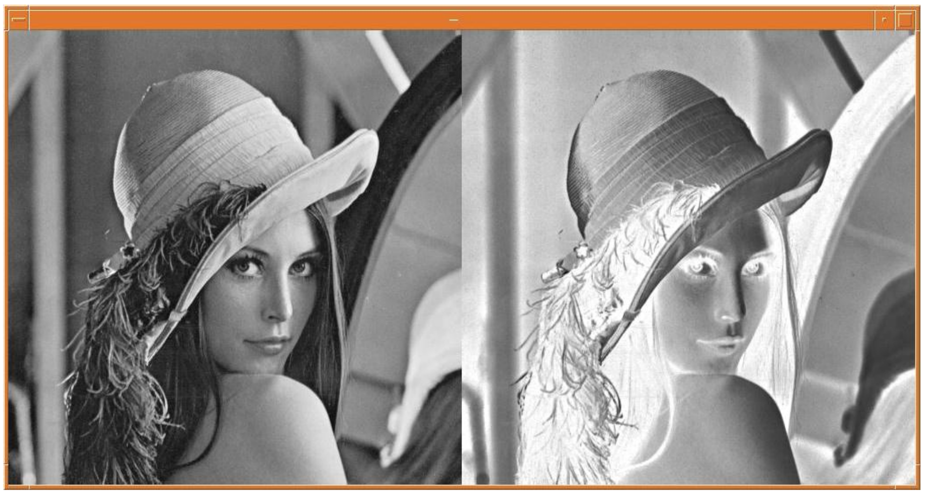
a. Quel est l'avantage de « skelet » dans la gestion des paramètres ? Illustrer ces avantages en montrant les appels possibles de « skelet » sur la ligne de commande.

b. Comment s'appellent les *frame buffers* dans « visual_true_color » et dans « skelet » ?

c. Pourquoi dans « skelet » les tâches d'initialisation de *frame buffer* ont-elles été reportées dans une fonction ?

d. Modifier le programme « skelet » pour que l'image traitée soit le négatif de l'image en entrée. On se servira de la constante MAX_COLOR.

L'image ci-contre illustre par exemple le négatif de Léna en niveaux de gris.



Le fichier « skelet.c » constituera dorénavant le canevas à partir duquel on réalisera dans chaque TD des essais d'algorithmes de traitement d'images dans la « PROCESSING SECTION ».

visual_true_color.c

```
/******************************************************************************/
/* NAME                                                                       */
/* visual_true_color is a basic process displaying one or three 8-bit image(s)*/
/* onto a TrueColor visual.                                                   */
/******************************************************************************/
/* SYNOPSIS                                                                   */
/* visual_true_color [ <image_red> <image_green> <image_blue> [ <line_number> */
/*                                                  [ <pixel_number> ] ] ]    */
/******************************************************************************/
/* DESCRIPTION                                                                */
/* This process connects to the X server and displays a RGB raster image.     */
/* Example: visual_true_color roissy.1 roissy.2 roissy.3 512 512              */
/*                                                                            */
/* To display a single image in gray scales, provide the same file name for   */
/* Red, Green and Blue components.                                            */
/* Example: visual_true_color girl girl girl 512 512                          */
/*                                                                            */
/* Images provided are supposed to have the same size (<line_number> and      */
/* <pixel_number>) given as last parameters.                                  */
/* These images in input must be in BSQ (Bit Sequential, also called DUMP)    */
/* format. In such organization, pixels are stored in the file as shown in the*/
/* figure.                                                                    */
/* Let (i,j) i=0,N-1 j=0,M-1 be the value of point in line i and pixel ,      */
/* data are stored in the file in the following order:                        */
/* (0,0) (0,1) ... (0,M-1) (1,0) (1,1) ... (1,M-1) ... (N-1,0) ... (N-1,M-1)  */
/*               0                       j        M-1                         */
/*             0 +-----------------------|---------+                          */
/*               |                       |         |                          */
/*               |                       |         |                          */
/*               |                       |         |                          */
/*               |                       |         |                          */
/*             i ------------------------*         |                          */
/*               |                                 |                          */
/*               |                                 |                          */
/*               |                                 |                          */
/*               |                                 |                          */
/*           N-1 +---------------------------------+                          */
/* Pixel representation expected in input is 8 bits per pixel.                */
/* As a consequence, size of input file must exactly match N x M bytes.       */
/******************************************************************************/
/* ADMINISTRATION                                                             */
/* Serge RIAZANOFF  | 28.01.00 | v00.01 | Creation of the SW component        */
/* Serge RIAZANOFF  | 14.02.00 | v00.02 | Adaptation on Sun Solaris 2.5       */
/* Serge RIAZANOFF  | 02.10.00 | v01.01 | Correction ROUGE/ROUGE/ROUGE        */
/******************************************************************************/

/******************************************************************************/
/* Standard inclusion files                                                   */
/******************************************************************************/
#include  <stdio.h>
#include  <stdlib.h>
#include  <string.h>
#include  <errno.h>
#include  <memory.h>

#include  <X11/X.h>
#include  <X11/Xlib.h>
#include  <X11/Intrinsic.h>

/******************************************************************************/
/* Constant definitions                                                       */
/******************************************************************************/
#define MAX_COLOR   255                 /* Greatest pixel value */

/******************************************************************************/
/* Macro definitions                                                          */
/******************************************************************************/
#define nint(float_value)  (((float_value)-(int)(float_value) > 0.5)?          \
                            (int)(float_value)+1 : (int)(float_value))


/******************************************************************************/
/* Application core                                                           */
/******************************************************************************/
int main (
   int              argc,               /* argument count */
   char             **argv)             /* argument list */
{
/******************************************************************************/
/* Local variables                                                            */
/******************************************************************************/
   Display          *display;           /* display returned from connection */
   int              screen;             /* default screen of connection */
   unsigned int     display_width;      /* screen width */
   unsigned int     display_height;     /* screen height */
   unsigned int     display_planes;     /* screen color planes */
   XImage           *ximage;            /* XImage structure for frame buffer */
   Visual           *visual;            /* true-color visual */
   XVisualInfo      visual_info;        /* structure used to get visual info */
   int              format;             /* format in XImage */
   int              offset;             /* data offset in XImage */
   unsigned char    *datimage;          /* RGB frame buffer */
   int              bitmap_pad;         /* data padding in XImage */
   int              bytes_per_line;     /* Bytes per line in XImage */
   Window           win;                /* window XID */
   int              x = 0;              /* horizontal location of window UL */
   int              y = 0;              /* vertical location of window UL */
   GC               gc;                 /* default graphic context */
   int              src_x;              /* X-coord in XImage for display */
   int              src_y;              /* Y-coord in XImage for display */
   int              dst_x;              /* X-coord in window for display */
   int              dst_y;              /* Y-coord in window for display */
   int              icolor_red;         /* color value for component red */
   int              icolor_green;       /* color value for component green */
   int              icolor_blue;        /* color value for component blue */
   int              icolor_rgb;         /* color value for compound RGB values*/
   XEvent           event;              /* standard event structure */
   char             file_name_red[80];  /* name of red image file */
   char             file_name_green[80];/* name of green image file */
   char             file_name_blue[80]; /* name of blue image file */
   char             window_title[3*80]; /* title reported in window bar */
   FILE             *fp_red;            /* red image file pointer */
   FILE             *fp_green;          /* green image file pointer */
   FILE             *fp_blue;           /* blue image file pointer */
   unsigned char    *buf_red;           /* buffer used to get one image line */
   unsigned char    *buf_green;         /* buffer used to get one image line */
   unsigned char    *buf_blue;          /* buffer used to get one image line */
   int              nliin;              /* input line number */
   int              npxin;              /* input pixel number */
   int              ili;                /* index among lines */
   int              ipx;                /* index among pixels */
   int              nread;              /* number of bytes actually read */

   int              required_depth;     /* expected depth when getting visual */
   int              status;             /* status returned by X function call */

   int              red_colormap_entries; /* nb.of possible values for Red */
   int              red_offset;         /* left offset to match the Red mask*/
   int              green_colormap_entries; /* nb.of possible values for Green*/
   int              green_offset;       /* left offset to match the Green mask*/
   int              blue_colormap_entries; /* nb.of possible values for Blue */
   int              blue_offset;         /* left offset to match the Blue mask*/
   int              bits_per_rgb;        /* bits nb.per RGB pixel in frame buf*/
   int              bytes_per_rgb;       /* bytes nb.per RGB pixel in frame bu*/
   XSetWindowAttributes window_attributes; /* used to set window attributes */
   unsigned char    byte_order[4];       /* used to check byte order in int */
   int              int_MSB_first;       /* "Most Significant Byte first in
                                            integer representation" flag */

/*****************************************************************************/
/* Connect to X server                                                       */
/*****************************************************************************/
   if ((display=XOpenDisplay(NULL)) == NULL)
   {
      fprintf (stderr,"visual_true_color : Cannot connect to X server.\n");
      exit (1);
   }
   screen = DefaultScreen (display);
   display_height = DisplayHeight (display,screen);
   display_width  = DisplayWidth  (display,screen);
   display_planes = DisplayPlanes (display,screen);
/*****************************************************************************/
/* Get the TrueColor visual                                                  */
/*****************************************************************************/
   required_depth = 24;
   do
   {
      if ((status=XMatchVisualInfo(display,screen,required_depth,TrueColor,
           &visual_info)) == 0)
      {
         required_depth = required_depth - 1;
      }
   } while ((status == 0) && (required_depth >= 8));
   if (required_depth < 8)
   {
      fprintf (stderr,
     "visual_true_color : Cannot get a TrueColor visual for whatever depth.\n");
      exit (1);
   }
/*=========================================================================*/
/* Check that the number of bits per pixels in frame buffer is multiple of 8  */
/*=========================================================================*/
   bits_per_rgb = BitmapUnit(display);
   if (required_depth == 16)
      bits_per_rgb = 16;
   if (bits_per_rgb % 8 != 0)
   {
      fprintf (stderr,"visual_true_color : Only number of bits per pixels in ");
      fprintf (stderr,"frame buffer multiple of 8 are supported.\n");
      exit (1);
   }
   bytes_per_rgb = bits_per_rgb / 8;
/*****************************************************************************/
/* Analyze the way Red, Green and Blue component are mapped in frame buffer   */
/*****************************************************************************/
/* Red component                                                             */
/*---------------------------------------------------------------------------*/
   red_colormap_entries = visual_info.red_mask;
   red_offset           = 0;
   while ((red_colormap_entries & 0x00000001) == 0)
   {
      red_offset           = red_offset + 1;
      red_colormap_entries = (red_colormap_entries >> 1);
   }
   red_colormap_entries = red_colormap_entries + 1;
/*---------------------------------------------------------------------------*/
/* Green component                                                           */
/*---------------------------------------------------------------------------*/
   green_colormap_entries = visual_info.green_mask;
   green_offset           = 0;
   while ((green_colormap_entries & 0x00000001) == 0)
   {
      green_offset           = green_offset + 1;
      green_colormap_entries = (green_colormap_entries >> 1);
   }
   green_colormap_entries = green_colormap_entries + 1;
/*---------------------------------------------------------------------------*/
/* Blue component                                                            */
/*---------------------------------------------------------------------------*/
   blue_colormap_entries = visual_info.blue_mask;
   blue_offset           = 0;
   while ((blue_colormap_entries & 0x00000001) == 0)
   {
      blue_offset           = blue_offset + 1;
      blue_colormap_entries = (blue_colormap_entries >> 1);
   }
   blue_colormap_entries = blue_colormap_entries + 1;
/*****************************************************************************/
/* Get names of data files and open them                                     */
/*****************************************************************************/
/* RED file name                                                             */
/*=========================================================================*/
   if (argc >= 2)
      strcpy(file_name_red,argv[1]);
   else
   {
      printf("Nom du fichier image: ROUGE  : ");
      scanf ("%s",file_name_red);
   }
/*---------------------------------------------------------------------------*/
/* Open input file                                                           */
/*---------------------------------------------------------------------------*/
   if ((fp_red=fopen(file_name_red,"r")) == NULL)
   {
      fprintf (stderr,"visual_true_color : can't open \"%s\"\n",file_name_red);
      exit (1);
   }
/*=========================================================================*/
```

```c
/* GREEN file name                                                            */
/*============================================================================*/
   if (argc >= 3)
      strcpy(file_name_green,argv[2]);
   else
   {
      printf("Nom du fichier image: VERT   : ");
      scanf ("%s",file_name_green);
   }
/*----------------------------------------------------------------------------*/
/* Open input file                                                            */
/*----------------------------------------------------------------------------*/
   if ((fp_green=fopen(file_name_green,"r")) == NULL)
   {
      fprintf(stderr,"visual_true_color : can't open \"%s\"\n",file_name_green);
      exit (1);
   }
/*============================================================================*/
/* BLUE file name                                                             */
/*============================================================================*/
   if (argc >= 4)
      strcpy(file_name_blue,argv[3]);
   else
   {
      printf("Nom du fichier image: BLEU   : ");
      scanf ("%s",file_name_blue);
   }
/*----------------------------------------------------------------------------*/
/* Open input file                                                            */
/*----------------------------------------------------------------------------*/
   if ((fp_blue=fopen(file_name_blue,"r")) == NULL)
   {
      fprintf (stderr,"visual_true_color : can't open \"%s\"\n",file_name_blue);
      exit (1);
   }
/******************************************************************************/
/* Get size of input image                                                    */
/******************************************************************************/
   if ((argc < 5) || (sscanf(argv[4],"%d",&nliin) <= 0))
   {
      printf("Nombre de lignes en entree   : ");
      scanf ("%d",&nliin);
   }
   if ((argc < 6) || (sscanf(argv[5],"%d",&npxin) <= 0))
   {
      printf("Nombre de pixels en entree   : ");
      scanf ("%d",&npxin);
   }
/******************************************************************************/
/* Allocate memory for the internal frame buffer : "datimage"                 */
/******************************************************************************/
   if ((datimage=(unsigned char*)malloc((npxin*nliin*bytes_per_rgb)*
        sizeof(char))) == NULL)
   {
      fprintf (stderr,
         "visual_true_color : Cannot allocate internal frame buffer \n");
      exit (1);
   }
/******************************************************************************/
/* Allocate memory for the buffers used to get image lines                    */
/******************************************************************************/
   if (((buf_red=(unsigned char*)malloc((npxin*nliin)*sizeof(char))) == NULL) ||
      ((buf_green=(unsigned char*)malloc((npxin*nliin)*sizeof(char)))==NULL) ||
      ((buf_blue=(unsigned char*)malloc((npxin*nliin)*sizeof(char))) ==NULL))
   {
      fprintf (stderr,
         "visual_true_color : Cannot allocate memory for the buffers \n");
      exit (1);
   }
/******************************************************************************/
/* Initialise the frame buffer                                                */
/******************************************************************************/
/* Analyze order inside an integer                                            */
/*----------------------------------------------------------------------------*/
   icolor_rgb = 0x01020304;
   memcpy (byte_order,&icolor_rgb,4);
   if (byte_order[0] == 0x01)
      int_MSB_first = True;
   else
      int_MSB_first = False;
/*----------------------------------------------------------------------------*/
/* Loop on lines                                                              */
/*----------------------------------------------------------------------------*/
   for (ili=0; ili<nliin; ili++)
   {
/*----------------------------------------------------------------------------*/
/*    Read Red, Green and Blue line from files                                */
/*----------------------------------------------------------------------------*/
      if (((nread=fread(&(buf_red[ili*npxin]),  sizeof(char),npxin,fp_red))   <
            npxin)                                                            ||
          ((nread=fread(&(buf_green[ili*npxin]),sizeof(char),npxin,fp_green)) <
            npxin)                                                            ||
          ((nread=fread(&(buf_blue[ili*npxin]), sizeof(char),npxin,fp_blue))  <
            npxin))
      {
         fprintf (stderr,
            "visual_true_color : error while reading record nb. %d, ",ili);
         fprintf (stderr,"(returned=%d, status=%d)\n",nread,errno);
         perror ("visual_true_color");
         exit (1);
      }
/*----------------------------------------------------------------------------*/
/*    Interleave Red, Green and Blue components into frame buffer            */
/*----------------------------------------------------------------------------*/
      for (ipx=0; ipx<npxin; ipx++)
      {
/*----------------------------------------------------------------------------*/
/*       Set RGB values according to their colormap entries                   */
/*----------------------------------------------------------------------------*/
         icolor_red   = nint((float)red_colormap_entries  * buf_red[ipx] / 256);
         if (icolor_red >= red_colormap_entries)
            icolor_red = red_colormap_entries - 1;
         icolor_green = nint((float)green_colormap_entries* buf_green[ipx]/256);
         if (icolor_green >= green_colormap_entries)
            icolor_green = green_colormap_entries - 1;
         icolor_blue  = nint((float)blue_colormap_entries * buf_blue[ipx] /256);
         if (icolor_blue >= blue_colormap_entries)
            icolor_blue = blue_colormap_entries - 1;
/*----------------------------------------------------------------------------*/
/*       Combine the three components according to their masks                */
/*----------------------------------------------------------------------------*/
         icolor_rgb   = (icolor_red   << red_offset)    |
                        (icolor_green << green_offset)  |
                        (icolor_blue  << blue_offset);
/*-------------------------------------------------------------------------------*/
/*       Report value in frame buffer                                            */
/*-------------------------------------------------------------------------------*/
         if (int_MSB_first)
         {
            memcpy (&(datimage[(ili*npxin+ipx)*bytes_per_rgb]),
                 &(((unsigned char*)(&icolor_rgb))[sizeof(int)-bytes_per_rgb]),
                 bytes_per_rgb);
         }
         else
         {
            memcpy (&(datimage[(ili*npxin+ipx)*bytes_per_rgb]),
                 &icolor_rgb,bytes_per_rgb);
         }
      } /* Loop on pixels */
   } /* Loop on lines */
/*********************************************************************************/
/* Allocate memory for an XImage structure                                       */
/*********************************************************************************/
   visual = visual_info.visual;
   format = ZPixmap;
   offset = 0;
   bitmap_pad     = 8;
   bytes_per_line = 0;
   if ((ximage=XCreateImage(display,visual,display_planes,format,offset,
        (char*)datimage,npxin,nliin,bitmap_pad,bytes_per_line)) == NULL)
   {
      fprintf (stderr,"visual_true_color : cannot create ximage \n");
      exit (1);
   }
/*********************************************************************************/
/* Create a window                                                               */
/*********************************************************************************/
   if ((win=XCreateWindow (
           display,                     /* connection to X server */
           RootWindow(display,screen),  /* parent window */
           x,y,                         /* coord.of UL corner in parent window*/
           npxin,nliin,                 /* width/height of window */
           0,                           /* border width */
           required_depth,              /* depth of window in bits */
           InputOutput,                 /* class of this window */
           visual_info.visual,          /* visual to be used for the window */
           (unsigned long)0,            /* value mask within window_attributes*/
           &window_attributes)) == 0)
   {
      fprintf (stderr,"visual_true_color : Cannot create the window \n");
      exit (1);
   }
   sprintf (window_title,"%s / %s / %s",file_name_red,file_name_green,
      file_name_blue);
   XStoreName (display,win,window_title);
/*-------------------------------------------------------------------------------*/
/* Select events that will be received by window                                 */
/*-------------------------------------------------------------------------------*/
   XSelectInput (display,win,ExposureMask | ButtonPressMask);
/*--------------------------------------------------------------------*/
/* Display the window                                                 */
/*--------------------------------------------------------------------*/
   XMapWindow (display,win);
```

```
/*********************************************************************************/
/* Get graphic context                                                           */
/*********************************************************************************/
   gc = DefaultGC(display,screen);
   src_x = 0;
   src_y = 0;
   dst_x = 0;
   dst_y = 0;
/*********************************************************************************/
/* Events loop                                                                   */
/*********************************************************************************/
   while (True)
   {
/*-------------------------------------------------------------------------------*/
/*    Get next event                                                             */
/*-------------------------------------------------------------------------------*/
      XNextEvent (display,&event);
      switch (event.type) {
/*-------------------------------------------------------------------------------*/
/*       Expose => send image into the window                                    */
/*-------------------------------------------------------------------------------*/
         case Expose:
            XPutImage (display,win,gc,ximage,
                       src_x,src_y,dst_x,dst_y,npxin,nliin);
            break;
/*-------------------------------------------------------------------------------*/
/*       ButtonPress => close display and exit application                       */
/*-------------------------------------------------------------------------------*/
         case ButtonPress:
            XCloseDisplay (display);
            exit (0);
/*-------------------------------------------------------------------------------*/
/*       Any other event is not processed                                        */
/*-------------------------------------------------------------------------------*/
         default:
            break;
      }
   } /* event loop */
} /* Application core */
```