UNIVERSITAS DIPONEGORO

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D A F T A R P U S T A K A

A P P E N D I X

L A M P I R A N

APPENDIX

K O N V O L U S I

A. OPERASI KONVOLUSI

Suatu pengolahan Citra untuk menentukan keluaran g(x) dari suatu filter digital untuk suatu masukan f(x) yang sebagian dapat dinyatakan dalam bentuk integral konvolusi dari respon impuls h(x) sebagai :

$$g(x) = f(x) * h(x) \qquad \text{.....A-1}$$

$$= \int_{-\infty}^{\infty} f(\alpha)\, h\,(x-\alpha)\, d\alpha \qquad \text{.....A-2}$$

Dimana :

* adalah operasi konvolusi

h(x) adalah kernel konvolusi atau kernel filter.

α adalah variabel integrasi.

kernel h(x) merupakan suatu jendela yang dioperasikan secara bergeser pada sinyal masukan f(x) dimana jumlah perkalian kedua fungsi pada setiap titik merupakan hasil konvolusi yang dinyatakan dengan keluaran g(x).

B. INTEGRAL KONVOLUSI KONTINU

Konvolusi dari dua fungsi f(x) dan h(x)

dalam bentuk integralnya adalah :

$$\int_{-\infty}^{\infty} f(\alpha)\, h\,(x-\alpha)\, d\alpha \qquad \text{.....A-3}$$

Gambar 2.9 berikut ini akan menjelaskan makna konvolusi diatas.

Pada gambar 2.9 a :Variabel x dipindah ke dalam variabel α

$f(x) \longrightarrow f(\alpha)$

2.9b :Begitu pula untuk fungsi h(x), variabel x dipindah ke variabel α.

$h(x) \longrightarrow h(\alpha)$

2.9c :Bayangan dari $h(\alpha)$ adalah $h(-\alpha)$ dari pusat ordinat.

2.9d :$h(x-\alpha)$ adalah penyerdehanaan fungsi $h(-\alpha)$ dengan pemasukan variabel x.

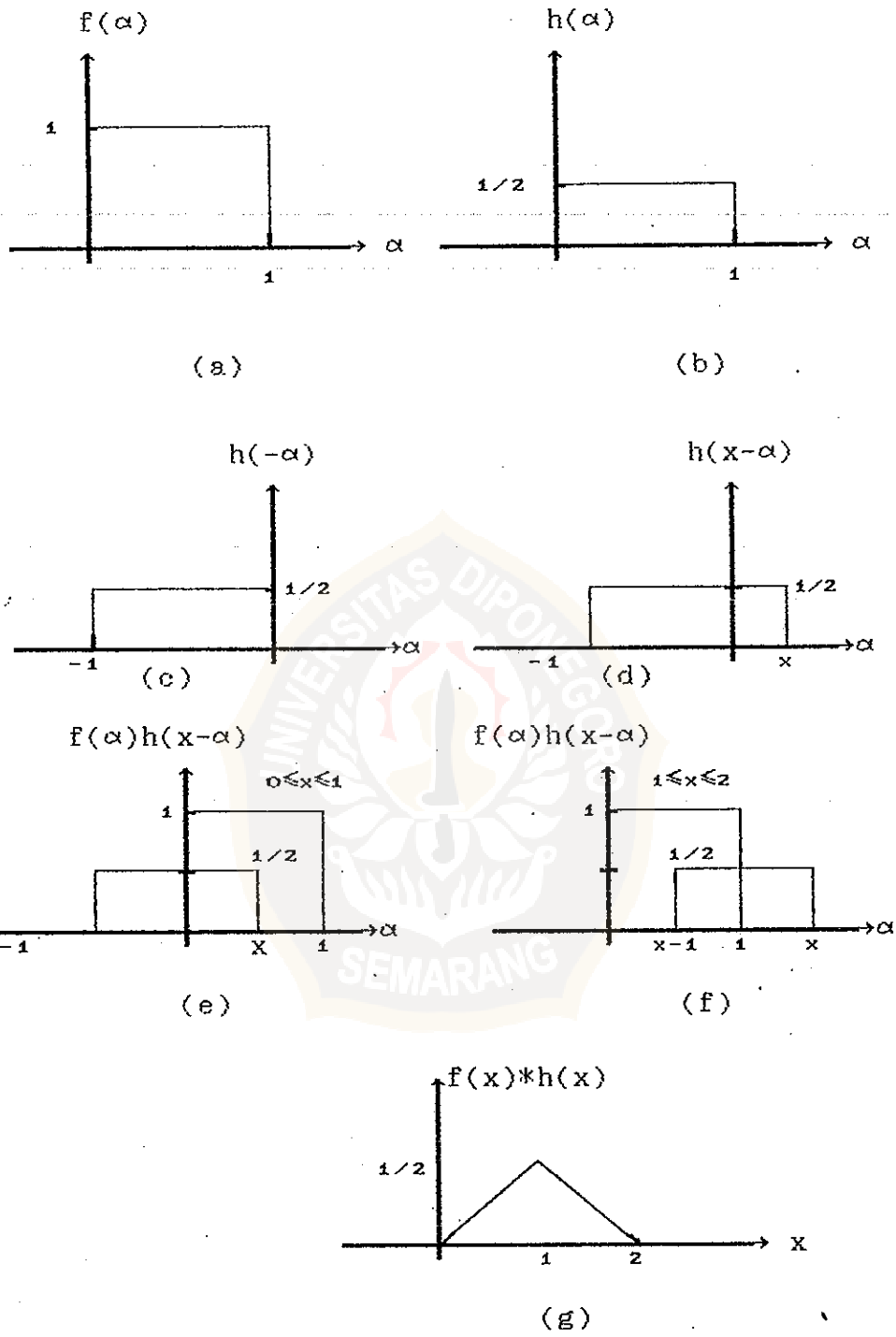
2.9e :Untuk setiap harga x $f(\alpha)$ dikalikan dengan $h(x-\alpha)$, hasil tersebut diintegralkan dari $-\infty$ sampai ∞ . Ini berlaku untuk $0 \leq x \leq 1$ sehingga untuk selang [0,x] diperoleh :$f(x)*h(x) = x/2$ dan diluar selang [0,x] hasilnya 0.

2.9f :Untuk selang [1,2], didapat $f(x)*h(x)=(1-x/2)$.

Secara keseluruhan dapat dituliskan :

$$f(x)*h(x)= \begin{cases} x/2 \text{ untuk } 0 \leq x \leq 1 \\ 1-x/2 \text{ untuk } 1 \leq x \leq 2 \\ 0 \text{ untuk lainnya} \end{cases}$$

2.9g :Hasil konvolusi diatas.

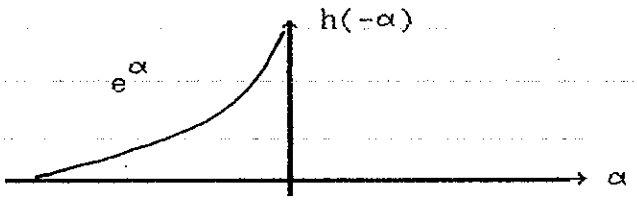


Gambar 2.9. Ilustrasi suatu konvolusi

Secara umum ilustrasi integral konvolusi melalui langkah-langkah :

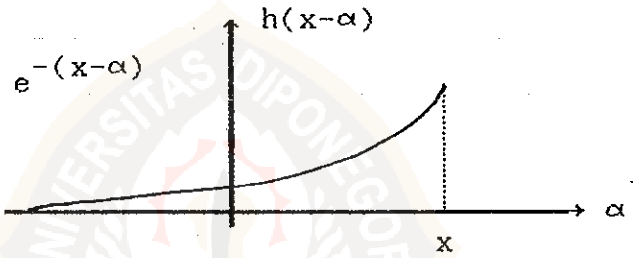
1. Folding (pembalikan).

   Diambil bayangan h(α) pada pusat koordinat



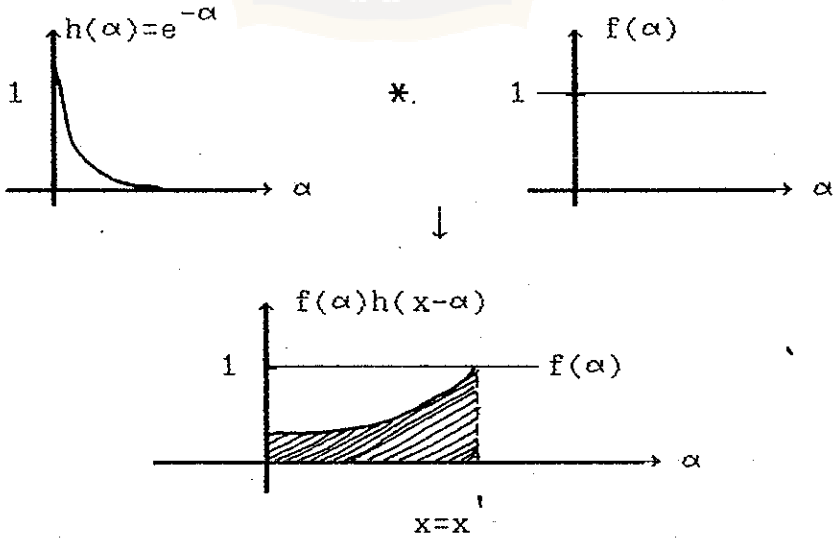
2. Displacement (pemindahan)

   Pergantian h(-α) dengan x



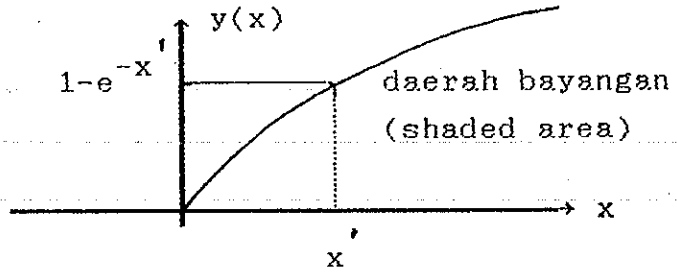
3. Multiplication (perkalian)

   Perkalian h(x-α) dengan f(α)



4. Integration (penggabungan)

Daerah dibawah hasil dari $h(X-\alpha)$ dan $f(\alpha)$ adalah nilai konvolusi pada waktu t.



Hasil ini dihitung dari :

$$y(x) = \int f(\alpha)\, h\,(x-\alpha)\, d\alpha$$

$$= \int_0^t 1 \quad e^{-(x-\alpha)}\, d\alpha \quad = e^{-x}(e^{\alpha}|_0^x = e^{-x}[e^{-x}-1]$$

$$= 1 - e^{-x} \qquad \ldots\ldots A\text{-}4$$

C. KONVOLUSI DISKRIT

Konvolusi diskrit didifinisikan sebagai jumlahan yang dituliskan :

$$Y(kX_o) = \sum_{i=0}^{N-1} g(iX_o)\, h(k-i)X_o \qquad \ldots\ldots A\text{-}5$$

Dimana $g(kX_o)$ dan $h(kX_o)$ adalah Fungsi periodik dengan perioda N :

$$g(kX_o) = g\left[(\, k + r\, N\,)\, X_o\right] \quad r = 0,+1,+2,.. \qquad \ldots\ldots A\text{-}6$$

$$h(kXo) = h\left[(k + r N) Xo \right] \quad r = 0,+1,+2,.. \quad ....A-7$$

Konvolusi diskrit dituliskan sebagai:

$$y(kXo) = g(kXo) * h(kXo) \quad .....A-8$$

D. KONVOLUSI DUA DIMENSI

Untuk menghitung konvolusi dua dimensi dalam bentuk integarl konvolusi sebagai :

$$y(i,j)=\int\int f(\alpha,\beta)h(i-\alpha,j-\beta)d\alpha d\beta \quad .....A-9$$

$$= f(i,j) * h(i,j) \quad .....A-10$$

Pada konvolusi diskrit untuk dua dimensi f(i,j) dan h(i,j) merupakan larik (array) AxB dan CxD. Seperti pada satu dimensi, larik ini mempunyai perioda M dalam arah x dan perioda N dalam arah y.

Bila dipergunakan fe(i,j) dan he(i,j) sebagai berikut:

$$fe(i,j) = \begin{cases} f(i,j) & ; 0 \leq x \leq A-1 \text{ dan } 0 \leq y \leq B1 \\ \vdots & \\ 0 & ; A \leq x \leq M-1 \text{ dan } B \leq y \leq N-1 \end{cases}$$

$$h(i,j) = \begin{cases} h(i,j) & ; 0 \leq x \leq C-1 \text{ dan } 0 \leq y \leq D-1 \\ 0 & ; C \leq x \leq M-1 \text{ dan } D \leq y \leq N-1 \end{cases}$$

maka konvolusinya adalah :

$$\sum_{i=0}^{M-1} \sum_{j=0}^{N-1} f_e(i,j) h_e(i-\alpha, j-\beta) \qquad \text{.....A-11}$$

Dimana

$i = 1,2, \ldots, M-1$

$j = 1,2, \ldots, N-1$

Penggunaan teorema konvolusi akan lebih jelas pada teorema pencuplikan. Dan juga akan lebih mudah menghitung konvolusi diskrit, akan lebih efisien dengan menghitung transformasi Fourier masing-masing fungsi dari pada menghitung secara langsung seperti pada persamaam diatas.

```
PROGRAM TEKSTUR;
USES
   CRT,GRAPH;
VAR
  I,J,GD,GM :  INTEGER;
  TIK: ARRAY[1..100] OF BYTE;
  BEGIN
    GD:=CGACO;GM:=CGACO;
  INITGRAPH(GD,GM,'');
  SETGRAPHMODE (CGACO);

for i:= 1 to  3000 do begin
putpixel(random(100),random(100),1);end;
for i:= 1 to  3000 do begin
putpixel(random(100)+100,random(100),2);end;
for i:= 1 to  3000 do begin
putpixel(random(100)+200,random(100),3);end;


FOR I:= 1 TO 100 DO  BEGIN
FOR J := 1 TO 100 DO BEGIN
  PUTPIXEL(I,J+100,1);END;END;
  FOR I:= 1 TO 100 DO  BEGIN
FOR J := 1 TO 100 DO BEGIN
  PUTPIXEL(I+100,J+100,2);END;END;
  FOR I:= 1 TO 100 DO  BEGIN
FOR J := 1 TO 100 DO BEGIN
  PUTPIXEL(I+200,J+100,3);END;END;
  REPEAT UNTIL KEYPRESSED;
  CLOSEGRAPH;
  END.
```

```
PROGRAM CITRA III;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4)); end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,1);
putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);
putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);
putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);
putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);
putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
```

```
 for i:= 20 to 40 do begin putpixel(65,i,3);end;
 for i:= 63 to 90 do begin putpixel(67,i,2);end;
 for i:= 41 to 47 do begin putpixel(67,i,3);end;
 for i:= 65 to 90 do begin putpixel(69,i,2);end;
 for i:= 66 to 90 do begin putpixel(71,i,2);end;
 for i:= 67 to 90 do begin putpixel(73,i,2);end;
 for i:= 67 to 90 do begin putpixel(75,i,2);end;
 for i:= 69 to 90 do begin putpixel(77,i,2);end;
 for i:= 70 to 90 do begin putpixel(79,i,2);end;
 for i:= 72 to 90 do begin putpixel(81,i,2);end;
 for i:= 73 to 90 do begin putpixel(83,i,2);end;
 for i:= 75 to 90 do begin putpixel(85,i,2);end;
 for i:= 76 to 90 do begin putpixel(87,i,2);end;
 for i:= 77 to 90 do begin putpixel(89,i,2);end;
 for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          if tik[i,j] =1 then
                putpixel(i+130,j,1);
          if tik[i,j] = 2 then
                putpixel(i,j+110,2);
          if tik[i,j] = 3 then
                putpixel(i+130,j+110,3);end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRA IV;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm2,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
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  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
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  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
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for i:= 58 to 62 do begin putpixel(39,i,2);end;
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for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);
putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);
putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);
putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
```

```
  for i:= 20 to 40 do begin putpixel(65,i,3);end;
  for i:= 63 to 90 do begin putpixel(67,i,2);end;
  for i:= 41 to 47 do begin putpixel(67,i,3);end;
  for i:= 65 to 90 do begin putpixel(69,i,2);end;
  for i:= 66 to 90 do begin putpixel(71,i,2);end;
  for i:= 67 to 90 do begin putpixel(73,i,2);end;
  for i:= 67 to 90 do begin putpixel(75,i,2);end;
  for i:= 69 to 90 do begin putpixel(77,i,2);end;
  for i:= 70 to 90 do begin putpixel(79,i,2);end;
  for i:= 72 to 90 do begin putpixel(81,i,2);end;
  for i:= 73 to 90 do begin putpixel(83,i,2);end;
  for i:= 75 to 90 do begin putpixel(85,i,2);end;
  for i:= 76 to 90 do begin putpixel(87,i,2);end;
  for i:= 77 to 90 do begin putpixel(89,i,2);end;
  for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          if tik[i,j] = 1 then
                putpixel(i+130,j,1) ;
          if tik[i,j] = 2 then
                putpixel(i+130,j,2);
          if tik[i,j] = 2 then
                putpixel(i,j+110,2);
          if tik[i,j] = 3 then
                putpixel(i,j+110,3);
          if tik[i,j] = 1  then
                putpixel(i+130,j+110,1);
          if tik[i,j] = 3 then
                putpixel(i+130,j+110,3);end;end;
repeat until keypressed;
closegraph;

end;
```

```
PROGRAM CITRA V;
uses
  graph,crt;
var
  i,gd,gm,j:integer;
  tik: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,1);
putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);
putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);
putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);
putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);
putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
```

```
 for i:= 20 to 40 do begin putpixel(65,i,3);end;
 for i:= 63 to 90 do begin putpixel(67,i,2);end;
 for i:= 41 to 47 do begin putpixel(67,i,3);end;
 for i:= 65 to 90 do begin putpixel(69,i,2);end;
 for i:= 66 to 90 do begin putpixel(71,i,2);end;
 for i:= 67 to 90 do begin putpixel(73,i,2);end;
 for i:= 67 to 90 do begin putpixel(75,i,2);end;
 for i:= 69 to 90 do begin putpixel(77,i,2);end;
 for i:= 70 to 90 do begin putpixel(79,i,2);end;
 for i:= 72 to 90 do begin putpixel(81,i,2);end;
 for i:= 73 to 90 do begin putpixel(83,i,2);end;
 for i:= 75 to 90 do begin putpixel(85,i,2);end;
 for i:= 76 to 90 do begin putpixel(87,i,2);end;
 for i:= 77 to 90 do begin putpixel(89,i,2);end;
 for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          if tik[i,j] >=0 then
                putpixel(i+100,j,tik[i,j]+1);
                putpixel(i+200,j,tik[i,j]+2);
                putpixel(i,j+100,tik[i,j]+3);
                putpixel(i+100,j+100,tik[i,j]-1);
                putpixel(i+200,j+100,tik[i,j]-2);end;end;

repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRA VI;
uses
  graph,crt;
var
  i,gd,gm,j:integer;
  tik: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,1);
putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);
putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);
putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);
putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);
putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
```

```
    for i:= 20 to 40 do begin putpixel(65,i,3);end;
    for i:= 63 to 90 do begin putpixel(67,i,2);end;
    for i:= 41 to 47 do begin putpixel(67,i,3);end;
    for i:= 65 to 90 do begin putpixel(69,i,2);end;
    for i:= 66 to 90 do begin putpixel(71,i,2);end;
    for i:= 67 to 90 do begin putpixel(73,i,2);end;
    for i:= 67 to 90 do begin putpixel(75,i,2);end;
    for i:= 69 to 90 do begin putpixel(77,i,2);end;
    for i:= 70 to 90 do begin putpixel(79,i,2);end;
    for i:= 72 to 90 do begin putpixel(81,i,2);end;
    for i:= 73 to 90 do begin putpixel(83,i,2);end;
    for i:= 75 to 90 do begin putpixel(85,i,2);end;
    for i:= 76 to 90 do begin putpixel(87,i,2);end;
    for i:= 77 to 90 do begin putpixel(89,i,2);end;
    for i:= 80 to 90 do begin putpixel(90,i,2);end;

  for i:= 1 to 100 do begin
  for j:= 1 to 100 do begin
             tik[i,j]:= getpixel(i,j);end;end;
  for i:= 1 to 100 do begin
  for j:= 1 to 100 do begin
             if tik[i,j] >=0 then
                  putpixel(i+100,j,tik[i,j]-3);
                  putpixel(i+200,j,tik[i,j]*2);
                  putpixel(i,j+100,tik[i,j]*3);
                  putpixel(i+100,j+100,tik[i,j] div 2);
                  putpixel(i+200,j+100,tik[i,j] div 3);end;end;

  repeat until keypressed;
  closegraph;

  end.
```

```
PROGRAM CITRA VII;
uses
  graph,crt;
var
  i,gd,gm,j:integer;
  tik,dat: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);  putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
```

```
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);  putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);  putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);  putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
for i:= 20 to 40 do begin putpixel(65,i,3);end;
for i:= 63 to 90 do begin putpixel(67,i,2);end;
for i:= 41 to 47 do begin putpixel(67,i,3);end;
for i:= 65 to 90 do begin putpixel(69,i,2);end;
for i:= 66 to 90 do begin putpixel(71,i,2);end;
for i:= 67 to 90 do begin putpixel(73,i,2);end;
```

```
  for i:= 67 to 90 do begin putpixel(75,i,2);end;
  for i:= 69 to 90 do begin putpixel(77,i,2);end;
  for i:= 70 to 90 do begin putpixel(79,i,2);end;
  for i:= 72 to 90 do begin putpixel(81,i,2);end;
  for i:= 73 to 90 do begin putpixel(83,i,2);end;
  for i:= 75 to 90 do begin putpixel(85,i,2);end;
  for i:= 76 to 90 do begin putpixel(87,i,2);end;
  for i:= 77 to 90 do begin putpixel(89,i,2);end;
  for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
           tik[i,j]:= getpixel(i,j);end;end;
           cleardevice;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
           if tik[i,j] = 1 then putpixel(i,j,1);
           if tik[i,j] = 2 then putpixel(i,j,2);
           dat[i,j]:= getpixel(i,j);
        end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
           if dat[i,j] >=0 then
           end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
                putpixel(i+100,j,dat[i,j]+1*2);
                putpixel(i+200,j,dat[i,j]+1*3);
                putpixel(i,j+100,dat[i,j]* 3 div 2);
                putpixel(i+100,j+100,dat[i,j]* 3 -2);
                putpixel(i+200,j+100,dat[i,j] * 2 div 3);
                end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRAM VIII;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik,dat,gus,sap,yon,owi: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,1);
putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);
putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);
putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);
putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);
putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
```

```
  for i:= 20 to 40 do begin putpixel(65,i,3);end;
  for i:= 63 to 90 do begin putpixel(67,i,2);end;
  for i:= 41 to 47 do begin putpixel(67,i,3);end;
  for i:= 65 to 90 do begin putpixel(69,i,2);end;
  for i:= 66 to 90 do begin putpixel(71,i,2);end;
  for i:= 67 to 90 do begin putpixel(73,i,2);end;
  for i:= 67 to 90 do begin putpixel(75,i,2);end;
  for i:= 69 to 90 do begin putpixel(77,i,2);end;
  for i:= 70 to 90 do begin putpixel(79,i,2);end;
  for i:= 72 to 90 do begin putpixel(81,i,2);end;
  for i:= 73 to 90 do begin putpixel(83,i,2);end;
  for i:= 75 to 90 do begin putpixel(85,i,2);end;
  for i:= 76 to 90 do begin putpixel(87,i,2);end;
  for i:= 77 to 90 do begin putpixel(89,i,2);end;
  for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
           tik[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
                putpixel(i+100,j,tik[i,j]+1*2);
                putpixel(i+200,j,tik[i,j]+1*3);
                putpixel(i,j+100,tik[i,j]* 3 div 2);
                putpixel(i+100,j+100,tik[i,j]* 3 -2);
                putpixel(i+200,j+100,tik[i,j] * 2 div 3);

                end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRA IX;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik,dat,gus,sap,yon,owi: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,' ');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,2);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,2);
putpixel(29,43,2);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,2);
for i:= 41 to 44 do begin putpixel(30,i,2);end;
for i:= 41 to 44 do begin putpixel(29,i,2);end;
for i:= 41 to 44 do begin putpixel(31,i,2); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,2);
for i:= 40 to 45 do begin putpixel(33,i,2); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,2);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,2);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,2);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,2);
putpixel(39,53,2);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,2);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,2);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,2);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
```

```
  for i:= 4 to 20  do begin putpixel(45,i,3);end;
  for i:= 58 to 62 do begin putpixel(45,i,2);end;
  putpixel(47,53,2);
  for i:= 70 to 90 do begin putpixel(47,i,2);end;
  for i:= 4 to 20  do begin putpixel(47,i,3);end;
  for i:= 59 to 61 do begin putpixel(47,i,2);end;
  putpixel(49,36,2);
  for i:= 69 to 90 do begin putpixel(49,i,2);end;
  for i:= 4  to 21 do begin putpixel(49,i,3);end;
  for i:= 40 to 42 do begin putpixel(49,i,2);end;
  putpixel(51,35,2);
  for i:= 68 to 90 do begin putpixel(51,i,2);end;
  for i:= 4  to 20 do begin putpixel(51,i,3);end;
  for i:= 40 to 44 do begin putpixel(51,i,2);end;
  putpixel(53,35,2);
  for i:= 67 to 90 do begin putpixel(53,i,2);end;
  for i:= 7  to 21 do begin putpixel(53,i,3);end;
  for i:= 39 to 44 do begin putpixel(53,i,2);end;
  putpixel(55,36,2);
for i:= 39 to 44 do begin putpixel(52,i,2);end;
for i:= 39 to 44 do begin putpixel(54,i,2);end;
  for i:= 65 to 90 do begin putpixel(55,i,2);end;
  for i:= 7  to 22 do begin putpixel(55,i,3);end;
  for i:= 40 to 43 do begin putpixel(55,i,2);end;
  putpixel(57,37,2);
  putpixel(57,41,2);
  putpixel(57,42,2);
  for i:= 63 to 90 do begin putpixel(57,i,2);end;
  for i:= 8  to 23 do begin putpixel(57,i,3);end;
  for i:= 60 to 90 do begin putpixel(59,i,2);end;
  for i:= 10 to 24 do begin putpixel(59,i,3);end;
  putpixel(61,55,3);
  for i:= 60 to 90 do begin putpixel(61,i,2);end;
  for i:= 12 to 27 do begin putpixel(61,i,3);end;
  putpixel(63,45,3);
  putpixel(63,52,3);
  putpixel(63,55,3);
  for i:= 61 to 90 do begin putpixel(63,i,2);end;
  for i:= 16 to 42 do begin putpixel(63,i,3);end;
```

```
 putpixel(65,44,3);
 putpixel(65,50,3);
 putpixel(65,52,3);
 for i:= 62 to 90 do begin putpixel(65,i,2);end;
 for i:= 20 to 40 do begin putpixel(65,i,3);end;
 for i:= 63 to 90 do begin putpixel(67,i,2);end;
 for i:= 41 to 47 do begin putpixel(67,i,3);end;
 for i:= 65 to 90 do begin putpixel(69,i,2);end;
 for i:= 66 to 90 do begin putpixel(71,i,2);end;
 for i:= 67 to 90 do begin putpixel(73,i,2);end;
 for i:= 67 to 90 do begin putpixel(75,i,2);end;
 for i:= 69 to 90 do begin putpixel(77,i,2);end;
 for i:= 70 to 90 do begin putpixel(79,i,2);end;
 for i:= 72 to 90 do begin putpixel(81,i,2);end;
 for i:= 73 to 90 do begin putpixel(83,i,2);end;
 for i:= 75 to 90 do begin putpixel(85,i,2);end;
 for i:= 76 to 90 do begin putpixel(87,i,2);end;
 for i:= 77 to 90 do begin putpixel(89,i,2);end;
 for i:= 80 to 90 do begin putpixel(90,i,2);end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);
          if tik[i,j] = 2 then tik[i,j] := tik[i,j] + 1 ;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
sap[i,j]:= (((tik[i-1,j+1]+tik[i,j+1]+tik[i+1,j+1]+
           tik[i-1,j]+tik[i,j]+tik[i+1,j]+tik[i-1,j-1]+
           tik[i,j-1]+tik[i+1,j-1]) div 9)mod 4);
                        end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j,sap[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          dat[i,j]:= getpixel(i+100,j);
          if dat[i,j] = 2 then dat[i,j] := dat[i,j]+1 ;
```

```
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
yon[i,j]:= (((dat[i-1,j+1]+dat[i,j+1]+dat[i+1,j+1]+
           dat[i-1,j]+dat[i,j]+dat[i+1,j]+ dat[i-1,j-1]+
           dat[i,j-1]+dat[i+1,j-1]) div 9)mod 4);
           end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j,yon[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j);
          if gus[i,j] = 2  then gus[i,j]:= gus[i,j] +1 ;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((gus[i-1,j+1]+gus[i,j+1]+gus[i+1,j+1]+
           gus[i-1,j]+gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9)mod 4);
                    end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i,j+100,owi[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j+100);
          if gus[i,j] =2 then gus[i,j] := gus[i,j] -3 ;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((gus[i-1,j+1]+gus[i,j+1]+gus[i+1,j+1]+
           gus[i-1,j]+gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9)mod 4);
           end;end;
for i:= 1 to 100 do begin
```

```
for j:= 1 to 100 do begin
          putpixel(i+100,j+100,owi[i,j]); end;end;
   ;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+100,j+100);
          if gus [i,j] = 2 then gus[i,j] := gus[i,j]-2;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((gus[i-1,j+1]+gus[i,j+1]+gus[i+1,j+1]+
           gus[i-1,j]+gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9)mod 4);
           end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j+100);
          if gus[i,j] = 2 then gus[i,j] :=  gus[i,j] +1;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((gus[i-1,j+1]+gus[i,j+1]+gus[i+1,j+1]+
           gus[i-1,j]+gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9)mod 4);
           end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j+100);
          if gus[i,j] = 2 then gus[i,j] :=  gus[i,j] +1;
          end;end;
```

```
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((gus[i-1,j+1]+gus[i,j+1]+gus[i+1,j+1]+
           gus[i-1,j]+gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9)mod 4);
                      end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRA X;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik,dat,gus,sap,yon,owi: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
putpixel(29,37,1);
putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,2); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,2); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,2);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,2);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);
putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,2);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,2);end;
putpixel(53,35,1);
for i:= 39 to 44 do begin putpixel(52,i,2);end;
for i:= 41 to 44 do begin putpixel(54,i,2);end;
for i:= 41 to 44 do begin putpixel(55,i,2);end;
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,2);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,2);end;
putpixel(57,37,1);  putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);  putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);  putpixel(65,50,3);
putpixel(65,52,3);
```

```
 for i:= 62 to 90 do begin putpixel(65,i,2);end;
 for i:= 20 to 40 do begin putpixel(65,i,3);end;
 for i:= 63 to 90 do begin putpixel(67,i,2);end;
 for i:= 41 to 47 do begin putpixel(67,i,3);end;
 for i:= 65 to 90 do begin putpixel(69,i,2);end;
 for i:= 66 to 90 do begin putpixel(71,i,2);end;
 for i:= 67 to 90 do begin putpixel(73,i,2);end;
 for i:= 67 to 90 do begin putpixel(75,i,2);end;
 for i:= 69 to 90 do begin putpixel(77,i,2);end;
 for i:= 70 to 90 do begin putpixel(79,i,2);end;
 for i:= 72 to 90 do begin putpixel(81,i,2);end;
 for i:= 73 to 90 do begin putpixel(83,i,2);end;
 for i:= 75 to 90 do begin putpixel(85,i,2);end;
 for i:= 76 to 90 do begin putpixel(87,i,2);end;
 for i:= 77 to 90 do begin putpixel(89,i,2);end;
 for i:= 80 to 90 do begin putpixel(90,i,2);end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
 if tik[i,j] = 2 then
        tik[i,j] := tik[i,j]+1;end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
sap[i,j]:= (((4*tik[i,j]-tik[i+1,j]-tik[i-1,j]
           -tik[i,j-1]-tik[i,j+1])+ tik[i-1,j+1]
            +tik[i,j+1]+tik[i+1,j+1]+tik[i-1,j]+
            tik[i,j]+tik[i+i,j]+tik[i-1,j-1]+
            tik[i,j-1]+tik[i+1,j-1]) div 9);
                        end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j,sap[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          dat[i,j]:= getpixel(i+100,j);end;end;
for i:= 1 to 100 do begin
```

```
for j:= 1 to 100 do begin
yon [i,j]:= (((4*dat[i,j]-dat[i+1,j]-dat[i-1,j]
            -dat[i,j-1]-dat[i,j+1])+ dat[i-1,j+1]
            +dat[i,j+1]+dat[i+1,j+1]+dat[i-1,j]+
            dat[i,j]+dat[i+1,j]+dat[i-1,j-1]+
            dat[i,j-1]+dat[i+1,j-1]) div 9);
                        end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j,yon[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= ((-(4*gus[i,j]-gus[i+1,j]-gus[i-1,j]
            -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
            +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
            gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
            gus[i,j-1]+gus[i+1,j-1]) div 9);
            end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= (((4*gus[i,j]-gus[i+1,j]-gus[i-1,j]
            -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
            +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
            gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
            gus[i,j-1]+gus[i+1,j-1]) div 9); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
```

```
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+100,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= -(((4*gus[i,j]-gus[i+1,j]-gus[i-1,j]
           -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
           +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
           gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9);
           end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:=(-(-(gus[i,j]-gus[i+1,j]-gus[i-1,j]
           -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
           +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
           gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9);
                    end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:=(-(-(gus[i,j]-gus[i+1,j]-gus[i-1,j]
           -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
           +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
           gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9);
           end;end;
```

```
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:=(-(-(gus[i,j]-gus[i+1,j]-gus[i-1,j]
           -gus[i,j-1]-gus[i,j+1])+ gus[i-1,j+1]
           +gus[i,j+1]+gus[i+1,j+1]+gus[i-1,j]+
           gus[i,j]+gus[i+1,j]+gus[i-1,j-1]+
           gus[i,j-1]+gus[i+1,j-1]) div 9);
                      end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRAM XI;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik,dat,gus,sap,yon,owi: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
for i:= 7 to 27  do begin putpixel(27,i,3); end;
putpixel(29,37,1);  putpixel(29,43,1);
for i:= 65 to 90 do begin putpixel(29,i,2); end;
for i:= 5 to 25  do begin putpixel(29,i,3); end;
putpixel(31,36,1);
for i:= 41 to 44 do begin putpixel(31,i,1); end;
for i:= 67 to 90 do begin putpixel(31,i,2); end;
for i:= 5 to 23  do begin putpixel(31,i,3); end;
putpixel(33,36,1);
for i:= 40 to 45 do begin putpixel(33,i,1); end;
for i:= 70 to 90 do begin putpixel(33,i,2); end;
for i:= 4 to 22  do begin putpixel(33,i,3); end;
putpixel(35,36,1);
for i:= 40 to 45 do begin putpixel(35,i,1);end;
for i:= 71 to 90 do begin putpixel(35,i,2);end;
for i:= 4 to 21  do begin putpixel(35,i,3);end;
putpixel(37,37,1);
for i:= 41 to 44 do begin putpixel(37,i,1);end;
putpixel(37,42,1);
for i:= 59 to 61 do begin putpixel(37,i,2);end;
for i:= 72 to 90 do begin putpixel(37,i,2);end;
for i:= 3 to 21  do begin putpixel(37,i,3);end;
for i:= 58 to 62 do begin putpixel(39,i,2);end;
putpixel(39,50,1);  putpixel(39,53,1);
for i:= 73 to 90 do begin putpixel(39,i,2);end;
for i:= 3 to 21  do begin putpixel(39,i,3);end;
putpixel(41,53,1);
for i:= 73 to 90 do begin putpixel(41,i,2);end;
for i:= 3 to 20  do begin putpixel(41,i,3);end;
for i:= 57to 63  do begin putpixel(41,i,2);end;
putpixel(43,52,1);
for i:= 72 to 90 do begin putpixel(43,i,2);end;
for i:= 4 to 22  do begin putpixel(43,i,3);end;
for i:= 57 to 63 do begin putpixel(43,i,2);end;
putpixel(45,53,1);
for i:= 72 to 90 do begin putpixel(45,i,2);end;
for i:= 4 to 20  do begin putpixel(45,i,3);end;
for i:= 58 to 62 do begin putpixel(45,i,2);end;
```

```
putpixel(47,53,1);
for i:= 70 to 90 do begin putpixel(47,i,2);end;
for i:= 4 to 20  do begin putpixel(47,i,3);end;
for i:= 59 to 61 do begin putpixel(47,i,2);end;
putpixel(49,36,1);
for i:= 69 to 90 do begin putpixel(49,i,2);end;
for i:= 4  to 21 do begin putpixel(49,i,3);end;
for i:= 40 to 42 do begin putpixel(49,i,1);end;
putpixel(51,35,1);
for i:= 68 to 90 do begin putpixel(51,i,2);end;
for i:= 4  to 20 do begin putpixel(51,i,3);end;
for i:= 40 to 44 do begin putpixel(51,i,1);end;
putpixel(53,35,1);
for i:= 67 to 90 do begin putpixel(53,i,2);end;
for i:= 7  to 21 do begin putpixel(53,i,3);end;
for i:= 39 to 44 do begin putpixel(53,i,1);end;
putpixel(55,36,1);
for i:= 65 to 90 do begin putpixel(55,i,2);end;
for i:= 7  to 22 do begin putpixel(55,i,3);end;
for i:= 40 to 43 do begin putpixel(55,i,1);end;
putpixel(57,37,1);  putpixel(57,41,1);
putpixel(57,42,1);
for i:= 63 to 90 do begin putpixel(57,i,2);end;
for i:= 8  to 23 do begin putpixel(57,i,3);end;
for i:= 60 to 90 do begin putpixel(59,i,2);end;
for i:= 10 to 24 do begin putpixel(59,i,3);end;
putpixel(61,55,3);
for i:= 60 to 90 do begin putpixel(61,i,2);end;
for i:= 12 to 27 do begin putpixel(61,i,3);end;
putpixel(63,45,3);  putpixel(63,52,3);
putpixel(63,55,3);
for i:= 61 to 90 do begin putpixel(63,i,2);end;
for i:= 16 to 42 do begin putpixel(63,i,3);end;
putpixel(65,44,3);  putpixel(65,50,3);
putpixel(65,52,3);
for i:= 62 to 90 do begin putpixel(65,i,2);end;
for i:= 20 to 40 do begin putpixel(65,i,3);end;
for i:= 63 to 90 do begin putpixel(67,i,2);end;
```

```
 for i:= 41 to 47 do begin putpixel(67,i,3);end;
 for i:= 65 to 90 do begin putpixel(69,i,2);end;
 for i:= 66 to 90 do begin putpixel(71,i,2);end;
 for i:= 67 to 90 do begin putpixel(73,i,2);end;
 for i:= 67 to 90 do begin putpixel(75,i,2);end;
 for i:= 69 to 90 do begin putpixel(77,i,2);end;
 for i:= 70 to 90 do begin putpixel(79,i,2);end;
 for i:= 72 to 90 do begin putpixel(81,i,2);end;
 for i:= 73 to 90 do begin putpixel(83,i,2);end;
 for i:= 75 to 90 do begin putpixel(85,i,2);end;
 for i:= 76 to 90 do begin putpixel(87,i,2);end;
 for i:= 77 to 90 do begin putpixel(89,i,2);end;
 for i:= 80 to 90 do begin putpixel(90,i,2);end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);
          if tik[i,j] = 2 then tik[i,j] := tik[i,j] +1;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          sap[i,j]:= (abs(tik[i,j] - tik[i+1,j+1]) *
                     abs(tik[i,j+1] - tik[i+1,j]));
                      end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j,sap[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          dat[i,j]:= getpixel(i+100,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          yon[i,j]:=  abs(dat[i,j] - dat[i+1,j+1])-
                      abs(dat[i,j+1] -dat[i+1,j]);
                       end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j,yon[i,j]); end;end;
for i:= 1 to 100 do begin
```

```
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+200,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i,j] - gus[i+1,j+1])*-
                      abs(gus[i,j+1] - gus[i+1,j]);
                       end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i,j] - gus[i+1,j+1])-
                      abs(gus[i,j+1]- gus[i+1,j]);
                       end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+100,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i,j] - gus[i+1,j+1])*
                      abs(gus[i,j+1] - gus[i+1,j]);
                       end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+100,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i,j] - gus[i+1,j+1])*-
```

```
                        abs(gus[i,j+1] - gus[i+1,j]);
                         end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i+100,j+100);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i,j] * gus[i+1,j+1])+
                      abs(gus[i,j+1]* gus[i+1,j]);
                       end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;
repeat until keypressed;
closegraph;
end.
```

```
PROGRAM CITRAM XII;
uses
  graph,crt,printer;
var
  i,gd,gm,j:integer;
  tik,dat,gus,sap,yon,owi: array[1..100,1..100] of byte;
begin
  gd:=cgac2;gm:=0;
  initgraph(gd,gm,'');setgraphmode(cgac0);
  for i:= 1 to 30000 do begin
  putpixel(random(100),random(100),random(4));end;
  for i:= 70 to 90 do begin putpixel(1,i,2) ; end;
  for i:= 68 to 90 do begin putpixel(3,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(5,i,2) ; end;
  for i:= 67 to 90 do begin putpixel(7,i,2) ; end;
  for i:= 66 to 90 do begin putpixel(9,i,2) ; end;
  for i:= 65 to 90 do begin putpixel(11,i,2); end;
  for i:= 65 to 90 do begin putpixel(13,i,2); end;
  for i:= 43 to 47 do begin putpixel(13,i,3); end;
  for i:= 64 to 90 do begin putpixel(15,i,2); end;
  for i:= 42 to 47 do begin putpixel(15,i,3); end;
  for i:= 25 to 32 do begin putpixel(15,i,3); end;
  for i:= 63 to 90 do begin putpixel(17,i,2); end;
  for i:= 42 to 51 do begin putpixel(17,i,3); end;
  for i:= 18 to 38 do begin putpixel(17,i,3); end;
  for i:= 62 to 90 do begin putpixel(19,i,2); end;
  for i:= 13 to 55 do begin putpixel(19,i,3); end;
  for i:= 61 to 90 do begin putpixel(21,i,2); end;
  for i:= 11 to 57 do begin putpixel(21,i,3); end;
  for i:= 60 to 90 do begin putpixel(23,i,2); end;
  for i:= 10 to 38 do begin putpixel(23,i,3); end;
  for i:= 53 to 56 do begin putpixel(23,i,3); end;
  for i:= 59 to 90 do begin putpixel(25,i,2); end;
  for i:= 7 to 32  do begin putpixel(25,i,3); end;
  putpixel(27,39,1);
  for i:= 63 to 90 do begin putpixel(27,i,2); end;
  for i:= 7 to 27  do begin putpixel(27,i,3); end;
```

```
for i:= 79 to 100 do begin putpixel(32,i,2);end;
for i:= 79 to 100 do begin putpixel(33,i,2);end;
for i:= 78 to 100 do begin putpixel(34,i,2);end;
for i:= 77 to 100 do begin putpixel(35,i,2);end;
for i:= 77 to 100 do begin putpixel(36,i,2);end;
for i:= 76 to 100 do begin putpixel(37,i,2);end;
for i:= 75 to 100 do begin putpixel(38,i,2);end;
for i:= 73 to 100 do begin putpixel(39,i,2);end;
for i:= 70 to 100 do begin putpixel(40,i,2);end;
for i:= 67 to 100 do begin putpixel(41,i,2);end;
for i:= 71 to 100 do begin putpixel(42,i,2);end;
for i:= 73 to 100 do begin putpixel(43,i,2);end;
for i:= 77 to 100 do begin putpixel(44,i,2);end;
for i:= 80 to 100 do begin putpixel(45,i,2);end;
for i:= 82 to 100 do begin putpixel(46,i,2);end;
for i:= 82 to 100 do begin putpixel(47,i,2);end;
for i:= 81 to 100 do begin putpixel(48,i,2);end;
for i:= 80 to 100 do begin putpixel(49,i,2);end;
for i:= 80 to 100 do begin putpixel(50,i,2);end;
for i:= 80 to 100 do begin putpixel(51,i,2);end;
for i:= 81 to 100 do begin putpixel(52,i,2);end;
for i:= 81 to 100 do begin putpixel(53,i,2);end;
for i:= 82 to 100 do begin putpixel(54,i,2);end;
for i:= 85 to 94  do begin putpixel(55,i,2);end;
for i:= 83 to 94  do begin putpixel(56,i,2);end;
for i:= 81 to 93  do begin putpixel(57,i,2);end;
for i:= 80 to 93  do begin putpixel(58,i,2);end;
for i:= 81 to 92  do begin putpixel(59,i,2);end;
for i:= 83 to 92  do begin putpixel(60,i,2);end;
for i:= 83 to 91  do begin putpixel(61,i,2);end;
for i:= 86 to 90  do begin putpixel(62,i,2);end;
for i:= 77 to 90  do begin putpixel(63,i,2);end;
for i:= 79 to 90  do begin putpixel(64,i,2);end;
for i:= 80 to 90  do begin putpixel(65,i,2);end;
for i:= 83 to 90  do begin putpixel(66,i,2);end;
for i:= 85 to 92  do begin putpixel(67,i,2);end;
for i:= 86 to 91  do begin putpixel(68,i,2);end;
for i:= 85 to 100 do begin putpixel(69,i,2);end;
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```
for i:= 84 to 100 do begin putpixel(70,i,2);end;
for i:= 81 to 100 do begin putpixel(71,i,2);end;
for i:= 85 to 100 do begin putpixel(72,i,2);end;
for i:= 86 to 100 do begin putpixel(73,i,2);end;
for i:= 86 to 100 do begin putpixel(74,i,2);end;
for i:= 87 to 100 do begin putpixel(75,i,2);end;
for i:= 88 to 100 do begin putpixel(76,i,2);end;
for i:= 89 to 100 do begin putpixel(77,i,2);end;
for i:= 90 to 100 do begin putpixel(78,i,2);end;
for i:= 92 to 100 do begin putpixel(79,i,2);end;
for i:= 93 to 100 do begin putpixel(80,i,2);end;
for i:= 94 to 100 do begin putpixel(81,i,2);end;
for i:= 95 to 100 do begin putpixel(82,i,2);end;
for i:= 96 to 100 do begin putpixel(83,i,2);end;
for i:= 97 to 100 do begin putpixel(84,i,2);end;
for i:= 40 to 52 do begin putpixel(34,i,3);end;
for i:= 31 to 51 do begin putpixel(35,i,3);end;
for i:= 32 to 50 do begin putpixel(36,i,3);end;
for i:= 52 to 53 do begin putpixel(37,i,3);end;
for i:= 51 to 55 do begin putpixel(38,i,3);end;
for i:= 52 to 56 do begin putpixel(39,i,3);end;
for i:= 51 to 58 do begin putpixel(40,i,3);end;
for i:= 51 to 58 do begin putpixel(41,i,3);end;
for i:= 51 to 63 do begin putpixel(42,i,3);end;
for i:= 55 to 64 do begin putpixel(43,i,3);end;
for i:= 45 to 70 do begin putpixel(44,i,3);end;
for i:= 48 to 71 do begin putpixel(45,i,3);end;
for i:= 60 to 72 do begin putpixel(46,i,3);end;
for i:= 64 to 74 do begin putpixel(47,i,3);end;
for i:= 66 to 75 do begin putpixel(48,i,3);end;
for i:= 64 to 75 do begin putpixel(49,i,3);end;
for i:= 64 to 77 do begin putpixel(50,i,3);end;
for i:= 65 to 77 do begin putpixel(51,i,3);end;
for i:= 64 to 78 do begin putpixel(52,i,3);end;
for i:= 65 to 79 do begin putpixel(53,i,3);end;
for i:= 66 to 79 do begin putpixel(54,i,3);end;
for i:= 66 to 79 do begin putpixel(55,i,3);end;
for i:= 66 to 79 do begin putpixel(56,i,3);end;
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```
for i:= 66 to 79 do begin putpixel(57,i,3);end;
for i:= 66 to 78 do begin putpixel(58,i,3);end;
for i:= 66 to 79 do begin putpixel(59,i,3);end;
for i:= 66 to 77 do begin putpixel(60,i,3);end;
for i:= 51 to 75 do begin putpixel(61,i,3);end;
for i:= 51 to 79 do begin putpixel(62,i,3);end;
for i:= 52 to 74 do begin putpixel(63,i,3);end;
for i:= 52 to 72 do begin putpixel(64,i,3);end;
for i:= 51 to 71 do begin putpixel(65,i,3);end;
for i:= 50 to 55 do begin putpixel(66,i,3);end;
for i:= 48 to 52 do begin putpixel(67,i,3);end;
for i:= 47 to 48 do begin putpixel(68,i,1);end;
for i:= 24 to 39 do begin putpixel(69,i,3);end;
for i:= 28 to 38 do begin putpixel(70,i,3);end;
for i:= 23 to 38 do begin putpixel(71,i,3);end;
for i:= 33 to 40 do begin putpixel(37,i,1);end;
for i:= 22 to 38 do begin putpixel(38,i,1);end;
for i:= 20 to 43 do begin putpixel(39,i,1);end;
for i:= 16 to 42 do begin putpixel(40,i,1);end;
for i:= 13 to 38 do begin putpixel(41,i,1);end;
for i:= 12 to 41 do begin putpixel(42,i,1);end;
for i:= 33 to 50 do begin putpixel(43,i,3);end;
for i:= 33 to 40 do begin putpixel(44,i,3);end;
for i:= 35 to 40 do begin putpixel(45,i,3);end;
for i:= 48 to 51 do begin putpixel(46,i,3);end;
for i:= 50 to 52 do begin putpixel(47,i,3);end;
for i:= 50 to 54 do begin putpixel(48,i,3);end;
for i:= 50 to 55 do begin putpixel(49,i,3);end;
for i:= 52 to 55 do begin putpixel(50,i,3);end;
for i:= 36 to 37 do begin putpixel(51,i,3);end;
for i:= 33 to 42 do begin putpixel(52,i,3);end;
for i:= 33 to 41 do begin putpixel(53,i,3);end;
for i:= 34 to 42 do begin putpixel(54,i,3);end;
for i:= 61 to 63 do begin putpixel(55,i,3);end;
for i:= 61 to 63 do begin putpixel(56,i,3);end;
for i:= 62 to 65 do begin putpixel(57,i,3);end;
for i:= 61 to 64 do begin putpixel(58,i,3);end;
for i:= 61 to 64 do begin putpixel(59,i,3);end;
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```
for i:= 61 to 64 do begin putpixel(60,i,3);end;
for i:= 7  to 22 do begin putpixel(61,i,1);end;
for i:= 38 to 41 do begin putpixel(62,i,3);end;
for i:= 36 to 41 do begin putpixel(63,i,3);end;
for i:= 36 to 42 do begin putpixel(64,i,3);end;
for i:= 36 to 46 do begin putpixel(65,i,3);end;
for i:= 36 to 43 do begin putpixel(66,i,3);end;
for i:= 36 to 43 do begin putpixel(67,i,3);end;
for i:= 35 to 41 do begin putpixel(68,i,3);end;
for i:= 11 to 22 do begin putpixel(43,i,1);end;
for i:= 10 to 22 do begin putpixel(44,i,1);end;
for i:= 10 to 18 do begin putpixel(45,i,1);end;
for i:= 10 to 15 do begin putpixel(46,i,1);end;
for i:=  9 to 13 do begin putpixel(47,i,1);end;
for i:= 38 to 41 do begin putpixel(48,i,3);end;
for i:= 37 to 43 do begin putpixel(49,i,3);end;
for i:= 36 to 41 do begin putpixel(50,i,3);end;
for i:=  4 to 13 do begin putpixel(51,i,1);end;
for i:=  5 to 15 do begin putpixel(52,i,1);end;
for i:=  5 to 16 do begin putpixel(53,i,1);end;
for i:=  4 to 18 do begin putpixel(54,i,1);end;
for i:= 34 to 41 do begin putpixel(55,i,3);end;
for i:= 35 to 41 do begin putpixel(56,i,3);end;
for i:= 51 to 55 do begin putpixel(57,i,3);end;
for i:= 52 to 55 do begin putpixel(58,i,3);end;
for i:=  6 to 20 do begin putpixel(59,i,1);end;
for i:= 52 to 56 do begin putpixel(60,i,3);end;
for i:=  8 to 21 do begin putpixel(62,i,1);end;
for i:= 10 to 26 do begin putpixel(63,i,1);end;
for i:= 12 to 25 do begin putpixel(64,i,1);end;
for i:= 14 to 24 do begin putpixel(65,i,1);end;
for i:= 18 to 21 do begin putpixel(66,i,1);end;
for i:= 17 to 22 do begin putpixel(67,i,1);end;
for i:= 21 to 28 do begin putpixel(68,i,1);end;
for i:=  6 to 12 do begin putpixel(48,i,1);end;
for i:=  6 to 13 do begin putpixel(49,i,1);end;
for i:=  5 to 11 do begin putpixel(50,i,1);end;
for i:=  4 to 18 do begin putpixel(55,i,1);end;
```

```
  for i:=  5 to 17 do begin putpixel(56,i,1);end;
  for i:=  5 to 19 do begin putpixel(57,i,1);end;
  for i:=  5 to 18 do begin putpixel(58,i,1);end;
 for i:= 52 to 55 do begin putpixel(59,i,3);end;
  for i:=  7 to 20 do begin putpixel(60,i,1);end;
  for i:= 34 to 41 do begin putpixel(57,i,3);end;
  for i:= 35 to 40 do begin putpixel(58,i,3);end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          tik[i,j]:= getpixel(i,j);
          if tik[i,j]= 2 then tik[i,j]:= tik[i,j]+ 1;
          end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          sap[i,j]:= (abs(tik[i,j] - tik[i+1,j+1]) +
                      abs(tik[i+1,j] - tik[i,j+1]));
                      end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j,sap[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          dat[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          yon[i,j]:= abs(dat[i-1,j+1]  + 2*dat[i,j+1] +
                     dat[i+1,j+1]      - dat[i-1,j-1] -
                     2*dat[i,j+1]      - dat[i+1,j-1])-
                     abs(-dat[i-1,j+1] - 2*dat[i-1,j] -
                     dat[i-1,j-1]      + dat[i+1,j+1] +
                     2*dat[i+1,j]      + dat[i+1,j-1]);
                     end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j,yon[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j);end;end;
```

```
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          owi[i,j]:=  abs(gus[i-1,j-1]+gus[i,j-1]+gus[i+1,j-1]
                    - gus[i-1,j+1]-gus[i,j+1]-gus[i+1,j+1])-
                    abs(-gus[i-1,j+1] - gus[i-1,j]-gus[i-1,j-1]
                    +gus[i+1,j+1]+gus[i+1,j]+gus[i+1,j-1]);
                     end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i,j+100,owi[i,j]); end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
owi[i,j]:= -(-gus[i-1,j+1]-gus[i,j+1]-gus[i+1,j+1]-
            gus[i-1,j]+8*gus[i,j] - gus[i+1,j]-
            gus[i-1,j-1]- gus[i,j-1]-gus[i+1,j-1]);
                    end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+100,j+100,owi[i,j]); end;end;

for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          gus[i,j]:= getpixel(i,j);end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
        owi[i,j]:= -(-gus[i,j+1] - gus[i-1,j]+4*gus[i,j]
                    -gus[i+1,j]-gus[i,j-1]);
                    end;end;
for i:= 1 to 100 do begin
for j:= 1 to 100 do begin
          putpixel(i+200,j+100,owi[i,j]); end;end;

repeat until keypressed;
closegraph;
end.
```

KAMUS ISTILAH DALAM PENGOLAHAN CITRA

ANALISA CITRA, merupakan proses untuk menggali informasi tentang karakteristik citra.

CITRA BINER, gambar yang hanya terdiri dari dua intensitas tingkat keabuan.

DIGITALISASI, proses perubahan fungsi intensitas citra kontinu menjadi array pixel, masing-masing pixel dinyatakan dalam nilai keabuan diskrit.

CITRA DIGITAL, citra yang elemen-elemennya dinyatakan dengan suatu besaran numerik yang membentuk suatu array.

DOMAIN FREKUENSI, signal satu dimensional (bentuk gelombang) atau signal dua dimensional (citra) yang dapat diubah ke representasi domain frekuensi dengan transformasi Fourier. Penggambaran domain frekuensi lebih mudah implementasinya dalam proses citra.

DOMAIN SPATIAL, suatu proses pengolahan citra dengan cara memanipulasi secara langsung terhadap pixel. Baik pixel secara individu maupun ortientasi tetangga terdekat.

ELEMEN GAMBAR/PIXEL, merupakan bagian terkecil dari citra yang mengandung informasi.

INTENSITAS TINGKAT KEABUAN, suatu besaran numerik yang menyatakan tingkat keabuan/warna yang terkandung pada suatu citra.

KUALITAS CITRA, merupakan karakteristik dari suatu citra dimana distribusi intensitas tingkat keabuan mengandung detail citra dengan mutu tertentu.

PENINGKATAN KUALITAS CITRA, merupakan segala proses awal yang bertujuan untuk meningkatkan kualitas citra baik untuk keperluan menghilangkan noise, interpretasi, maupun untuk keindahan gambar.

PENGOLAHAN CITRA, merupakan bidang studi yang mempelajari proses pengolahan citra, dengan masukan dan keluaran berupa berkas citra digital.

PROSES PER SATU CITRA, merupakan proses pengolahan citra yang orientasinya citra tersebut secara keseluruhan.

PROSES PER PIXELSATU CITRA, merupakan proses dimana manipulasi data citra dilakukan terhadap setiap pixel secara individu.

PROSES PER KELOMPOK PIXEL SATU CITRA, merupakan proses manipulasi data citra yang dilakukan terhadap setiap kelompok pixel, dimana setiap kelompok pixel terdiri dari suatu pixel dan tetangga-tetangganya.

RESOLUSI SPATIAL, derajat kehalusan dari proses pembuatan kisi-kisi arah horisontal dan vertikal yang memebagi suatu citra menjadi sejumlah pixel, makin kecil ukuran setiap pixel dikatakan makin tinggi resolusi spatialnya.

RESOLUSI TINGKAT KEABUAN, besarnya jumlah bit yang digunakan untuk menyimpan informasi numerik dari tingkat keabuan yang terkandung pada pixel-pixel dari suatu citra.