B4 6H O@ J8

NX3T>pJs$+$i$N%+%a%i$NF0$-$N8!=P

;a L> !’?">>98;K

3X@RHV9f !’2210950034-1

;XF3650w !’;3:j>!9065<x

Ds =P F| !’1999G/27n16F|

N)L?4[Bg3XM}9)3XIt>pJs3X2J

!!

35MW

:G6a%3%s%T%e!<%?$N9b@-G=2=!"Dc2A3J2=$KH<$$2hA|=hM}5;=Q$,H/E8$7F-$?!#$=lKHb$J$$CG $b1GA|%a%G%#%"$GB?MQ5lkh$&$KJj!"CG $H<B<L$r9g@.7?:nIJ$b1GA|%a%G%#%"$Gh/8+ilkh$&$KJGF-$?!#$7$+$7!"CG $H<B<L$N9g@.$OBgJQ:$FqG"$k!#$=lO!"CG $r<B<L$K9g@.9kH-$K%+%a%i$NF0$-$d>HL@$N6/EY$r9MN8$7$F!"<B<L>e$KCG %b%G%k$r9g@.$;$MPJiJ$$$+iG$"$k!#3lKO=QN}5l$?5;=Q$HBgJQ$J<j4V!"G|Bg$J;~4V$,$+$+$k!#

$=$3$GK\8&5f$G$O!"NX3TFCD'$N0LCV$NUQ2=$+$i%+%a%i$NF0$-$r8!=P9k3H$G!"CG $H<B<L$N9g@.$r4JC1$KC;;~4V$G9T$(kh$&$K9k3H$rL\E*$H7F$$$k!#D^$j862hA|$NNX3TFCD'$H<!2hA|$NNX3TFCD'$N0LCV$NUQ2=$KCmL\$9k3HKhj!"%+%a%i$NF0$-$r8!=P$7h&$H$$$&bNG"$k!#NX3T$rCj=P9kNK$O !PPrewitt K!!W":Y@~2=$K$O !HHilditch K!!W$rMQ$$!"$=$3$+$i2DNFCD'%Q%i%a!<%?$rCj=P$7!"$=$NFCD'F1;N$rHf3S$9k3HG0LCV$NUQ2=$rH/8+9k!#

K\O@J8GO!"2hA|=hM}$N4pK\$+$i%+%a%i$N4pK\E*$JF0$-!"$=$7$F<B:]$KINh&$J<jK!$G!"%+%a%i$NF0$-$r8!=P$9$k%=%U%H%&%'%"$r<B8=7?$+!"$=$N%=%U%H%&%'%"$N<B8 37k2L$H9M;!$^Gr=RYk!#

L\ <!

1 O8aK **1**

2 F02hA|=hM} **3**

2.1 CG $H<B<L$N9g@.5;=Q 3

2.2 %+%a%i%b!<%7%g%s 3

2.2.1 %Q%s 3

2.2.2 %I%j!< 3

2.2.3 %:!<%` 4

2.2.4 $=$NB> 4

2.3 2hA|=hM} 6

2.3.1 2hA|$NJQ49 7

2.3.2 2hA|$N2r@O 7

2.3.3 2hA|$NG'<1 7

3 NX3T>pJsKh$kF02hA|$+iN%+%a%i$NF0$-$N8!=PK! **8**

3.1 NX3TCj=P$+$i$NF0$-8!=P$NN.$l 8

3.2 NX3TCj=PK! 8

3.3 2CM2=$H:Y@~2= 9

3.4 FCD'Cj=P 12

3.5 FCD'Hf3S 14

3.6 %W%m%0%i%` 16

4 <B83$H9M;! **18**

5 $*$ojK **21**

<UK- **22**

;29MJ88% **23**

IUD? **24**

1 O8aK

:G6a$N2hA|=hM}5;=Q$O!"%3%s%T%e!<%?$N9b@-G=2=$KHbJC$FHtLvE*$K?JJb7F$-$?!#J<2hA|=hM} !CComputerGraphics(CG)!K$,CmL\$5lkh&KJC?N+!#3l$O!"?M4V$N;k3P8z2LKh$j!">pJs$rF@kNKO<*$GJ9$/hjL\$G8+$kJ}$,!"$^$?J8;zKHfY$F?^7A$NJ}$,M}2r$7d9$$H$$&3H$,$"2ilk!#7+$72hA|$r%3%s%T%e!<%?$G=hM}$9kH!"%W%m%0%i%`$K*$1$k=@Fp@- !M;DL@-!K$@1GJ/!":F8=@-!"@:EYNLLGM%0L@-$,$"kbNN!"BgNL$N%G!<%?$rI,MWH9k?$aB?$/$N%a%b%j$rI,MWH9k3HH!"=hM}B.EYNCY5!"=hM}%3%9%HNBg-5,<g$K%G%#%8%?%k=hM}$GNBg-$JLdBj$HJCF/$k!#

%3%s%T%e!<%?$N9b@-G=2=!"Dc2A3J2=$,?J$_%3%s%T%e!<%?%0%i%U%#%/%9$,IQHK$K1G2h$dTVEy$N1GA|%a%G%#"$KMQ$$$ilkh&KJCF$-$?!#1973G/$K%^%$%1%k!&/%i%$%H%s4FFD$N1G2h!%&%(%9%H%o!<%k%I!W$G=i$a$F1G2h$KCG$,;H$olF0JMh!"CG$OSF1G2h$G<B:]K"j(JJ*;v$rI=8=$9kN$K;H$olF$-$?!#7+$7!":G6a$G$O<B<L$rhj%j%"%k%9%F%#%C%/$KI=8=$9k?aK!"CG$,;H$olkh&KJCF$-$F$$k!#%8%'!<%:!&-%c&a%m%s4FFD$N!%&?%$%?%K%C%/!WJI$,$=$NBeI=:n$G$"$k!#

3lKhCFCG@):n;~K*1k;~4VE*!"6bA,E*IiC4$,A}2C$7F-$?!#$3lOCG$r<B<L$N2hA|$K9g@.$9kH$-$K!"CG$r<B<L$N2hA|$r;#1F$7$?;~$N%+%a%i$NF0$-$d;#1FCOE@$N>HL@$N6/EY!"U}8~!"3QEY$r9MN8$7$F#1%U%l!<%`Kh$K9g@.$;$M$P$J$i$J$$?$a$G$"$k!#DL>o!"<B<L2hA|$O1IC4V$K20%U%l!<%`$+$i30%U%l!<%`$G;#1F$5$l$k!#$=$7$F0lHIE*$K<B<L$HCG$N9g@.2hA|$O5J,4VDxEY$ND9$5$G$"$k!#$3$N5J,$@$1$G$b!"$=$NAm%U%l!<%`$?t$O6000%U%l!<%`$+$i9000%U%l!<%`KJCF$"!"1G2h$dCMEy$N1GA|%a%G%#"$G$O8GDj%+%a%i$Khk<B<L2hA|XNCG9g@.$,B?$/8+ilkh$&$KJCF-$?!#8GDj%+%a%i$N>l9g$O;#1FCOE@$N>HL@KN$_CmL\$9lP$$$N$GHf3SE*4JC1$K9T$($k$+$iG"$k!#$7$+$7!"8GDj%+%a%i$N1GA|$@1G$O%j%"%k5$r$@$9N,;FqJ$?$a!"1GA|@=:n2q<R$OAa5^$K@=:n;~4V$H@=:nHq$N:o8:$r<jCJ$rC5$7$F$$k!#

$=$7$F@):nHq:o8:$H@=:n;~4VC;=L$NJ}K!$H7F!"!¥VB<L1GA|K*1k%+%a%i$NF0$-$N8!=P!W$,$"$2il$k!#1G2h$JIGMQ$$$kCG$H<B<L1GA|$H$N9g@.$K$O!"<B<L1GA|$r%A%'%C%/7J$,$iCG%*%V%8%'%/%H$NF0$-$r"$o$;$k$?$a!"$+$JjN;~4V$H%F%/%K%C%/$rI,MWH9$k!#$b$7!"%+%a%i$NF0$-$K$"$o$;$FCG%b%G%i->e$N%P!<%A%c%k%+%a%i$,F1$8F0$-r9k3H,G-lP!"9g@.:n6HK*$$F$N;~4V$,BgI}$KC;=L$5lk3HKJ$k!#

K\8&5fGO!¥VB<L1GA|K*1k%+%a%i$NF0$-$N8!=P!W$r9T$&!#%+%a%i$NF0$-$rG'<1$9$kKO%+%a%iKHC?1GA|$rF02hA|$H$$$&7AGHi(!"$=$N2hA|$r=hM}$9kH$$$&7A$,$Hil$k!#2hA|$NFCD'G"$kE@$NF'=hM}$r9T$$!"?'$N>pJs$KhC$F%+%a%i$NF0$-$r8!=P9k

$H$$$&bNG"$k!#?'$N>pJs$O2hA|$r%G%#%8%?%k2hA|H7$F<h$j9~s@H-$K!"2<!85J?LL>e!#G%#%9%W%1%$>e!K$K$*$1$k3F2hAG!E@!K$,bDG;C8$N>pJs$N3H$G!"$=$N>pJs$+$i2hA|$NCfK"$kJ*BN$NFCD'$rG'<1$7!"F'02hA|$rHf3S$9k3HKhC$F!"%+%a%i$NF0$-$H7FG'<1$9$k!#%+%a%i$NF0$-$r%3%s%T%e!<%?$,G'<1$9$k3H$,$G$-!"$=$NF0$-$K9g$o$;$F#C#G%b%G%i->e$N%+%a%i$NF0$-$HF12=5;k3HKhC$F!"#C#G$H<B<L$N9g@.$KLrN)Fh$&$H9kbNG"$k!#

8=:_!"2hA|$NFCD'$rG'<1$7$F$=$l$rMxMQ$7h&H9$k8&5f$O?tB?$/9T$olF$$$k!#7+$7F02hA|$NFCD'$rG'<1$9k3HO8=;~E@K*$$$F$O!"><r7o$,$=$moJ$$$8B$jIT2DG=$H5l$F$$$k!#$^$?$=$N>r7o$b8=<B$N@$3&$K$*$$$F$O!"$[$\4V0c$$J$/:n$kNOIT2DG=H5$($$$olF$$$kN,8=>uG"$k!#

K\O@J8GO!"Bh2>OGCGH<B<L$N9g@.5;=Q!"%+%a%i%b!<%7%g%s!"2hA|=hM}$N4pK\$N$D$$F=RYk!#Bh3>OGOINh&$KNX3T$rCj=P$7!"$=$N>pJs$+$i%+%a%i$NF0$-$r8!=P9k$+$r=RYk!#Bh4>OGO:n@.7?=%U%H%&%'%"$N<B8 37k2L$H!"$=$3$+$i9M$($ilk9M;!$r=R$Y$k!#Bh5>O$OK\O@J8N^Ha$H:#8e$N2]BjKD$$F<($9!#

2 F02hA|=hM}

2.1 CG $H<B<L$N9g@.5;=Q

%3%s%T%e!<%?%0%i%U%#%/%9$H9g@.$K$*$$F!"1G2h$dTV $GMQ$$$ilF$$$kbGHb0lHL E*$J<jK!$O!"%"%J%m%0b7$/$O%G%8%?%k%S%G%*%+%a%i$G<B:]$N1GA|$r;#1F$7!"$=$l$r%-%c %W%A%c!<%\!<%I$JIrDL$7!"%3%s%T%e!<%?>e$K<h$j9~$_JT=8G-$k%G%8%?%k%G!<%?$KCV$- 49$($k!#$=7F$=$l$K@):n$7$?CG $r%+%a%i$NF0$-$d>HL@$N6/EY!"3QEY!"J}8~Ey$r9MN8$7 $F1%U%l!<%'Kh$K9g@.7F$$/NG$"$k!#0lHLE*$K!"1IC4V$K%S%G%*$O20%U%l!<%'$+$i30 %U%l!<%'DxEY$G$"$k!#DL>o$N1G2h$dTV GOCG $H<B<L$N9g@.2hA|$,>o$K=P$F$$k$H$$&3H$O>/$J$/!"J?6Q$G5J,4VDxEY$ND9$5G"$k!#$7$+$7$=$N5J,GbAm%U%l!<%'?t$O6000 %U%l!<%'$+$i9000%U%l!<%'$KbJ$j!"9g@.;~4V$,$+$JjND9$5$KJk!#$=$N$?$a%-!<%U %l!<%'"%K%a!<%7%g%sEy$N5;=Q$,9M0F5l$?$3HKhj!"B?>/$O9g@.;~4V$,C;=L5l$F$$ k,!"$^$@$^$@?M$N<j$Khk=hM}$,B?$$N$,8=>u$G!"4vDb?7$7$<jK!$,9M$(il$F$$k!#

2.2 %+%a%i%b!<%7%g%s

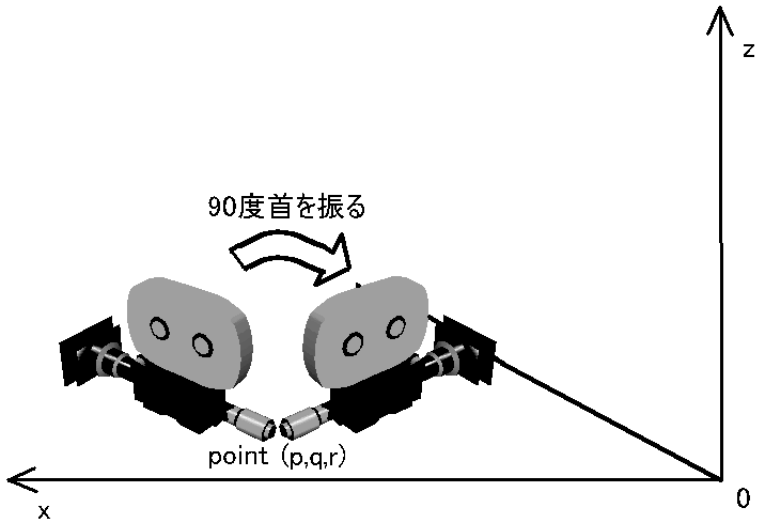
%+%a%i$O3<!85$KF0$/$3H,G-k?$a!"$=$NF0$-$Ox,y,z <4>e$rJ#;($KF0$/3HKJ $k!#$=li$N%+%a%i$NF0$-$K$b4pK\E*$JF0$-$NL>>N$,B8:_$9$k!#$=7F3N8&5fGOx,y,z <4>e$NF0$-$N%G!<%?$r8!=P9k3H$,K\5A$G$"$k$,!"$^$O:$O%G!<%?$N8!=P$NA0CJ3,H7$F 4pK\E*$J%+%a%i$NF0$-KN$_CmL\$7!"$=$N4pK\E*$JF0$-$N8!=P$rL\E*H7$F$$k!#

2.2.1 %Q%s

%+%a%i$N<s$r?6$kF0:n$r%Q%s$H$$$!"DL>o$O:81&$@1NF0$-$G$"$k$,!"0lHLE*$K$O<s$r >e2<$K?6$kF0:n!¤F%#%k%H!K$b4^$a$k!#<P$aJ}8~$K<s$r?6$kF0:n$b$"$k!#?^1$O%Q%s$NF0$- NNcG$"$k!#?^1$O%+%a%i$,90EY1&$K<s$r?6$kF0:nG"k,!"$=$N0LCV:BI8point(p,q,r) $OJQ2=$7$J$$!#3Nh&$K!"%Q%s$H$$&F0:n$O%+%a%i$=Nb$NHo<LBN$KBP9k3QEY$,JQ$o k@1G!"$=$N%+%a%i$N3<!856u4V>e$N:BI80LCVOJQoiJ$$!#

2.2.2 %I%j!<

%I%j!<ObHb$H%+%a%i$N;05S$N2<$KD1$k%3^$N3HG"$k!#$D$^$j!"$=$N%3^$r;H$C $F%*%V%8%'%/%H$KBP$7J?9T0\F0$9$kF0:n$N3H$r%I%j!<$H$$&!#$^$?!"%*%V%8%'%/%H$rCf ?4$K1_1?F0$9$kF0$-$N3H$b5$9!#?^2$O%I%j!<$NF0$-$NNcG"$k!#?^2$O%+%a%i$rxJ}8~ $Ka $@$1F0$+$7$?!#$3lKhj!"%+%a%i$N0LCV:BI8$Opoint(p,q,r) $+$ipoint(p+a.q.r) $K



?^1: %Q%s

JQ2=9k!#D^$j%+%a%i$N3QEYOJQ(B:$K%+%a%i$N0LCV$rHo<IBN$KBP7F?hD>!"J?9T!"<P$aJ}8~$KF0$+$9$3$HG"$k!#

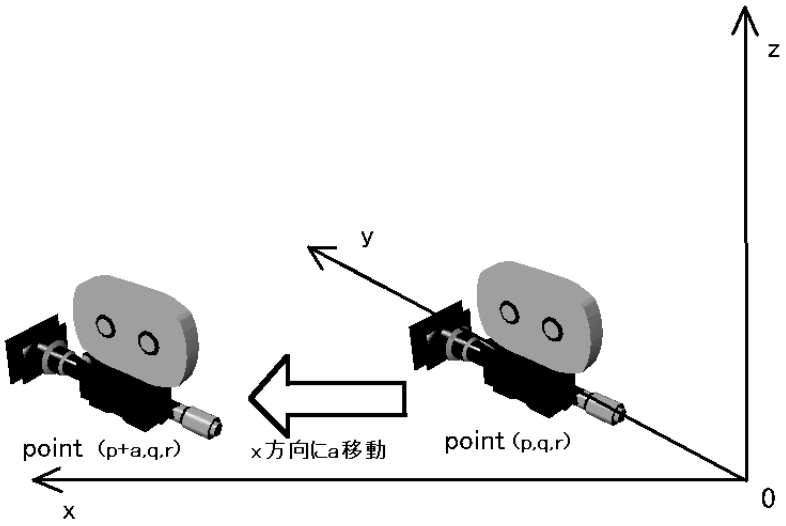
2.2.3 %:!<%`

%:!<%`$O%+%a%i$N%l%s%:%5%$%:$rJQ$(B:F!"2hLL$r%o%$%I$K$7$?$j%?%$%H$K$7$?$j$9$k$3$H$G$"$k!#?^3$O%:!<%`%"%C%W7?H-NNcG$"$k!#=i4|>uBVGOG;C8$NGv$$$H3m$^$G%U%l!<%`$KF~$k$,!"%:!<%`%"%C%W9k$HG;$$ItJ,7+%U%l!<%`Fb$K<}$^$i$J$$!#$D$^$j%+%a%i$N%l%s%:3QEY$rJQ$(Bk$3$H$G!"%+%a%i$N;kLn$r9-$2$?$j69$a$?$j$9$k$3$H$,%:!<%`G"$k!#

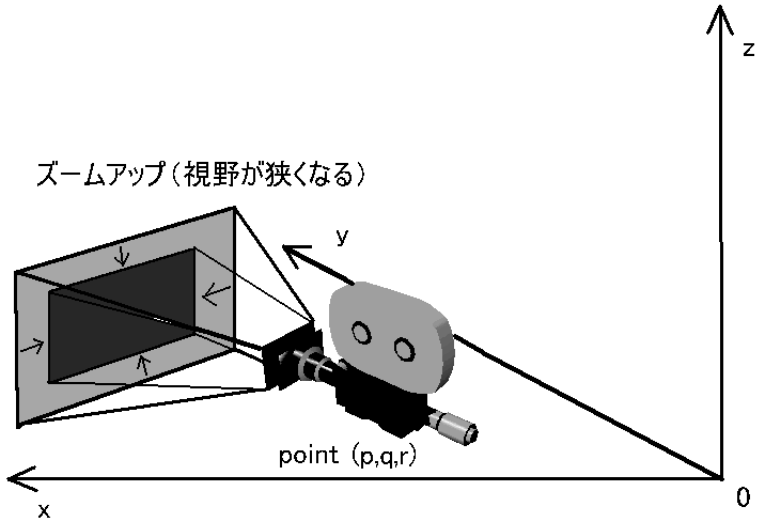
2.2.4 $=$NB>

%+%a%i$NF0$-KOB>$K%l!<%k!"%/%l!<%s!"%9%M!<%/JI$,$"$k!#%l!<%k$O%l!<%k$N>e$rAvi;k3HG%I%j!<0J>e$K9bB.$G0BDj5;$?J?9T0\F0$N3H$r8@$&!#%/%l!<%s$O%/%l!<%s$r;H$&$3HG3<!85$NU#;(BJF0$-N3HG$"$k!#%9%M!<%/$OCOLL$rGg$&$h$&$KDc$$0LCV$+$i;#1F9k3H$G!"Dc$$0LCV$r9bB.$G;#1F9k3H$,B?$$!#

0lHIE*KRHD$NF0:n$N$_$G;#1F5lk3HOJ/!"DL>o$O>e5-$NF0$-$,J#;(BKMm$_9g$C$?F0$-r9$k!#


z
y
point (p+a,q,r)
x方向にa移動
point (p,q,r)
0
x

?^2: %I%j!<


z
ズームアップ(視野が狭くなる)
y
point (p,q,r)
0
x

?^3: %:!<%`

2.3 2hA|=hM}

olol$,303&$+$iF@$k>pJs$NLs7 3d$,;k3PKhkbNG$"$j!";k3PKhCFF@il$k >pJs$O<gH7$F2 <!85$N>pJsG"$k!#2 <!85$N>pJs$r2hA|$H$$$!"5!3#$KG'<1$7d9$$7A KJQ($k<jCJ$r2hA|=hM}$H$$$&!#2hA|$r%G%8%?%kNL$GI=<($7!"$3lrMQ$$$F9T$&2hA|=hM} $r%G%8%?%k2hA|=hM}$H$$$&!#

2hA|=hM}$NNr;K$O!"%3%s%T%e!<%?$,2@$Be!1958!<1966!K$KF~$k3m;O$^$j!"7W;;5!$N9b @-G=2=$H6&$K2hA|=hM}$b?JJb7F$-$?!#:G=i$O1'ChC5:$GF@il$?2hA|$N6/D4d=$N2hA|$N ;(2;$N=|5n$KMxMQ5lF-$?$,!"1970G/Be$KF~$C$F!"7W;;5!CGAX;#1F5!!(CT,Coputerized Tomography!K$,<BMQ2=$5$l!"0eNE$N?GCG$K9W8%$7$?$3HO2hA|=hM}NBg-$J@.2L$H$$($k $@$m$&!#1980G/Be$KJk$H%O!<%I%&%'%"$ND6Bg5,LO=8@Q2=Kh$j!"2hA|=hM}@lLg$NCPU $d<g5-21$,@=:n5lkh$&$KJj!"2hA|=hM}$,DL?.!"5$>]!"0eNE!";:6HJI$N3FJ,Ln$GMx MQ5l$F$$k!#

0lHL$K2hA|=hM}$O!"

(1) 2hA|$N4QB,

- ;#A|$K4X$9k3$H!#
- ;#A|KhCFF@il$?%"%J%m%02hA|$r%G%8%?%k$KJQ49$9k3$H!#

(2) 2hA|$NJQ49

- %G%8%?%k2hA|?.9f$+$i>iD9ItJ,$r<h$j=|$-!"$h$jC;$$?.9f$KJQ49$9k3$H!#
- 2hA|N\$1$d!"2hA|$K4^$^$l$k;(2;$Khk2h<A$NNt2=$r2~A1$9$k3H!#

(3) 2hA|$N2r@O

- 2hA|$rC1=c$J7A$KJQ49$7!"$=$NFCD'$rCj=P$9k3$H!#

(4) 2hA|$NG'<1

- 2hA|$rFCD'$Khj=jK>NN'KJ,N'9k3H!#

$NN.$l$G9T$olk!#3N8&5fGO2hA|$NJQ49!"2hA|$N2r@O!"2hA|$NG'<1$N3 Dr9T$&$3$H KJ$k!#[10]

2.3.1 2hA|$NJQ49

2hA|$NJQ49$G$O4QB,$5l?2hA|KBP7$F!"3,D4Jd@5!"%7%'!<%G%#%s%0Jd@5!"6aK5=hM}!"%F%/%9%A%c2r@O!"2<!85JQ49!"%U%#%k%?%j%s%0JI$N=hM}$,9Tol$k!#6qBNE*$K$O2hA|$K4^$^$l$F$$$k;(2;$N=|5n!";HMQL\E*$K1~8F2hA|$NFCD'$,8=ld$9$$h$&$K9k6/D4=hM}!"$"$k$$O4QB,2aDx$G@8$8$?2hA|$N$\$1$rI|85$5$;$k=hM}JI$,<g$G$"$k!#3liO>e$K=R$Y$?=hM}$NAH$_9g$o$;$Khj9Tol$k!#$^$?!"2hA|$N>iD9ItJ,$r<h$j=|$-!"$G$-$k$@$1C;$$Id9f$KJQ49$9k3H,I,MWG"$k!#[10]

K\8&5fGO<g$K;(2;$N=|5n!"%U%k%+%i!<2hA|$N2CM2=$JIrMQ$$$F$$k!#

2.3.2 2hA|$N2r@O

2hA|$N2r@O$O!"2hA|Nb$D>pJs$r@Q6KE*$KCj=P$9$k=hM}$G$"$k!#6qBNE*KO2hA|$rBP>]J*$HGX7J$KJ,3d$9$kNN0hJ,3d!"J,3d$5l?NN0h$NB0@-$NCj=PH=$N7WNL!"NN0h$N5-=R!"NN0h4V$N4X78$N5-=RJI$,<g$G$"$k!#[10]

K\8&5fGO!"NX3T$NCj=P$KhkNN0hJ,3d$HJ,3d$5l?NN0h$NB0@-$NCj=PH=$N7WNL$r9TCF$$$k!#

2.3.3 2hA|$NG'<1

2hA|$NG'<1$O2hA|$+$iCj=P5l$?FCD'$H,7W;;5!Fb$K5-21$5lF$$$k2hA|$N9=B$2=5l$?CN<1$rHf3S9k3HKh$j9T$olk!#FCD'$NCj=PJ}K!$K$O2r@OE*J}K!$H!"9=J82r@OE*J}K!JI$,$"$j!"FCD'$rDjNIE*$KI=8=$9kN$KFCD'NL$,MQ$$$ilk!#2hA|$NFCD'$OBP>]HJ$k2hA|$K6/$/0MB8$9k?$a!"2hA|$N@-<Arh$/D4$Y!"$h$$FCD'NL$r8+$$=P$9$3H,I,MWG"$k!#FCD'NL$,7hailk$H!"L$CN$N2hA|$KBP9k%+%F%4%j$N7hDj$OE}7WE*7hDjM}O@$^$?$O8@8lM}O@$JIrE,MQ7F9Tol$k!#$^$?!"J*BN$d>p7J$NG'<1$O2hA|M}2r$^$?$O%3%s%T%e!<%?%t%#%8%g%s$H$b$$$o$l!"Fs$D$N2<!852hA|$+$i3<!859=B$$rF1Dj$7!"J*BN$^$?$O>p7J$N<1JL$r9T$&$bNG$"$k!#[10]

K\8&5fGO2r@OE*J}K!KhCFF@il$?BP>]J*$N<~0CD9!"LI@Q!"J#;(EY$r5a$a$F$$k!#

3 NX3T>pJsKh$kF02hA|$+iN%+%a%i$NF0$-$N8!=PK!

3.1 NX3TCj=P$+$i$NF0$-8!=P$NN.$l

F02hA|$+$i$NNX3T>pJs$KhkF0$-8!=P$NN.lO<!Nh$&$KJk!#

1. %"%J%m%0b7$/$O%G%8%?%k%S%G%*$NF02hA|$r%3%s%T%e!<%?>e$K%G%8%?%k%G!<%?$H7F<h$j9~$`!#
2. <h$j9~$s$@%G%8%?%k2hA|$r@E;_2hA|$N=89gBN$H7F5-21$9$k!#
3. $=$NCf$+$i0lKg!"@E;_2hA|$rCj=P$7G;C8>pJsJI$r85$KNX3T$rCj=P$9$k!#
4. F@il$?NX3T>pJs$NG;EY%R%9%H%0%i%`$r:n@.$7!"$"$kDjail?ogCMrbHK2CM2=9k!#
5. 2CM2=5l$?NX3T>pJs$r:Y@~2=9k!#
6. :Y@~2=5l$?NX3T>pJs$NLL@Q!"<~0CD9!"J#;(EYEy$NFCD'$rD4Yk!#
7. ;~7CNs>e!"<!$N2hA|$rFI$_9~$_3,4,5,6$N=hM}$r9T$&!#
8. $=$NFCD'F1;NrHfY$=$N0LCV$NUQ2=$r$_$k!#
9. $=$N0LCV$NUQ2=$KCmL\$7!"%+%a%i$NF0$-$r8!=P$9$k!#

>e5-$N=hM}$N$&$A1,2$OCANOUPS<R$N!ÐVRaptor!W$rMQ$$$F<B8=7?!#

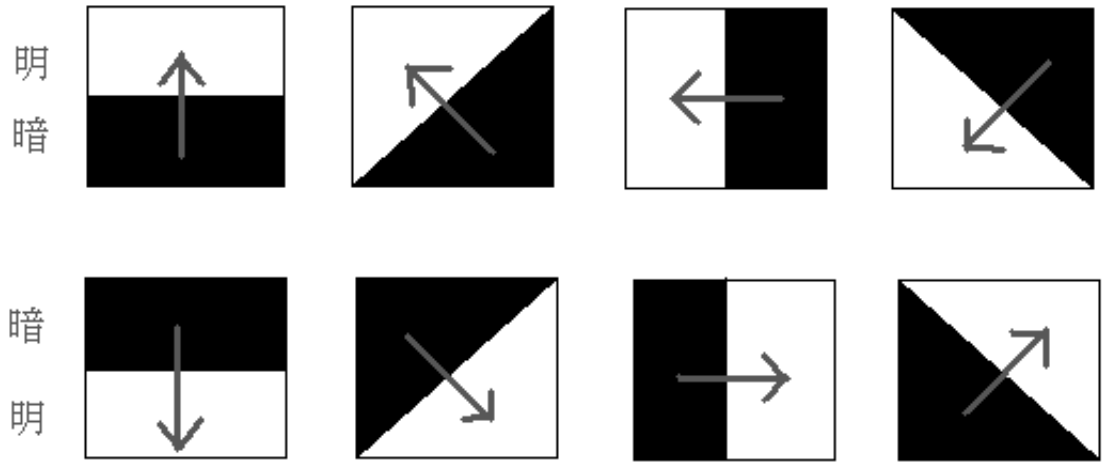
3.2 NX3TCj=PK!

NX3TOolol,!"%b%N$r8+$EM}2r9k!W>eGBg-$J<j$,$+$jKJCF$$$k!#2hA|=hM}$K*$$$F$bNX3T$rCj=P9k3H$,=EMW$J4pK\A`:n$N0l$DKJCF$$$k!#<h$j=P$7$?NX3T$r;HCF!"FCDj$NJ*BN$rH4$-=P$7$?$j!"$=$NLL@Q$d<~0CD9$r7WB,7?$j!"Fs$D$N2hA|$NBP1~E@$r5a$a$?$j!"bC$HJ#;($J2hA|G'<1!"2hA|M}2rN?a$N<j$,$+$jKb;Hol$k!#

2hA|$NJ*BN$HJ*BN!"$"$k$$$OJ*BN$HGX7J$N6-L\$,NX3TJN$G!ØhA|$NG;EY$d?'$K5^7c$KJQ2=$,$"$k$H3$m!W$,NX3T$K8+$($k!"$H$$&3H$,9M$(il$k!#<+A32hA|$K$O!"?'$NJQ2=$,$"lP!"G;EYJQ2=$bI,$:$"$kNG!"NX3TCj=PKOG;EY$@$1$KCmL\$9lP$h$$!#[9]

<B:]$N2hA|$G$O!"?M$,L\$G8+$FNX3T$H7F<h$j=P$7$?$$$ItJ,Gb!"B?$+$l>/J+lJ$^$C$F$$$?jG;EY$NJQ2=NI$,>/J+C?9k!#3N$?a!"$-$l$$$KNX3T$rCj=P$9k3HO0U30KFq7$/!"$$m$$m$J%"%k4%j:%`$,9M0F5l$F$$$k!#$=$NJ+$GK\&5f$GMQ$$$?<jK!$O!"%F%s%W%l!<%H%^%C%A%s%0Kh$kNX3TCj=PK!$NJ+$N!ÐrewittK!!W$H$$&NG$"$k!#

%F%s%W%l!<%H%^%C%A%s%0HO!"%F%s%W%l!<%H!ØJ?;f!KHN%^%C%A%s%0!ØlCW6q9g$$!K$rD4$Yk3Hr$$$!"NX3T$rI=$9I8=`%Q%?!<%s$r4v$D$+MQ0U$7F*$-!"2hA|$N0lItJ,$HHf3S



?^4: %F%s%W%l!<%H%^%C%A%s%0$KMQ$$$k%^%9%/74 !Prewitt %*%Z%l!<%?!K

7F:G$b;w$?bN$rA*$V<jK!G"$k!#$3NJ$+$G !Prewitt K!!W$O?^4$Nh&$K%(%C%8$NU}8~$KBP1~$9$k8 <dN'$N%^%9%/$rMQ0U$9$k!#F~NO2hAG$H$=$N<~0O$N2hAG$K%^%9%/NCMr>h8FOBrHk3HG!"0lCW$NEY9g$$$r7W;;7FHf3S$r9T$&!#

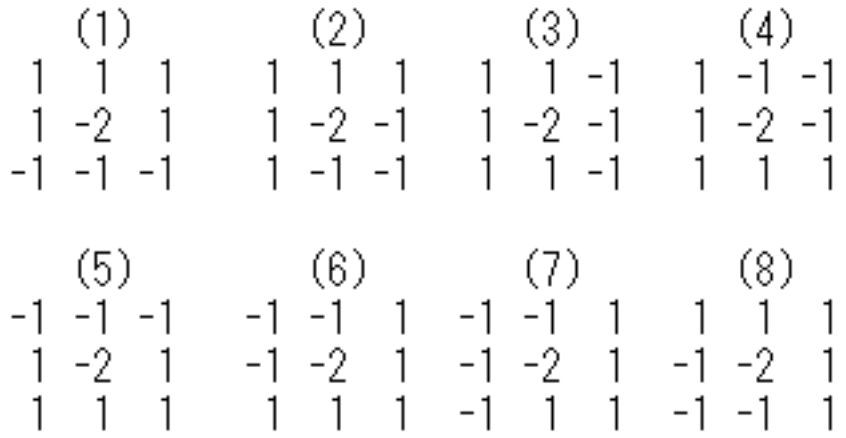
8 DN%^%9%/4HK3$N7W;;$r9T$$!"$=$NJ+$G:GBg$NCM$r<($9%^%9%/$N8~$-$,%(%C%8$NU}8~!"$=$N7W;;CM$,%(%C%8$N6/5KJk!#

<B:]$K !Prewitt K!!W$rVisualBasic Kh$j:n@.$7$?!#$=NH$-$KMQ$$$?8 <dN'$NPrewitt %*%Z%l!<%?$r?^5KN$;$k!#

%W%m%0%i%'GO!"Prewitt %*%Z%l!<%?$HCmL\2hAG$N8 6aK5KBP7$F!"3F%^%9%/$H$N0lCW6q9g$$$r7W;;7F$$k!#NX3T>pJs$NFCD'$rHkH-$K2hLIA4BN$NNX3TJD6u4V$NLL@Q$H<~0CD9rHkN$@$,NX3T>pJs$,B?$$$HFCD'$NCj=P;~4V$,D9$/$Jk3Hr9MN8$7!"<!2hA|$H$NFCD'Hf3S;~4V$bD9$/$J$k!#!#$7O8a$K!W$G$b=R$Y$?DL$j!"9g@.K+$+$k;~4V$NC;=L$bL\E*$N0l$DKJkN$G!"%Q%i%a!<%?$NCM$r9b$a$K@_Dj$7!"Cj=P5l$kNX3T>pJs$,>/J/Jkh&K7$F$$k!#:n@.7?%W%m%0%i%'KhCFF@il$?7k2L2hA|$r?^7$K!"862hA|$r?^6KN$;$k!#

3.3 2 CM2=$H:Y@~2=

2 CM2=$O!"ogCM$h$j2hAG$NG;C8G;EY$,Bg$-$$$+!">.$5$$$+$G0-2hAG$+1-2hAG$+$KJ,1k=hM}N3Hr$$$&!#$=$NH-$KB?$/$N>l9g$,G;EY%R%9%H%0%i%'$r:n@.$7!"$=$N;3$N0LCV$H



?^5: Prewitt %*%Z%l!<%?

C+$N0LCV$+$iBP>]J*$rCj=P9kogCM$r7hDj$7$9$k!#3NogCM$N7hDjK!$K$b$$$m$$m$JK<jK!$,$"$j!"%R%9%H%0%i%`$NC+$r;HCF!"ogCM$r7hDj$9$kJ}K!$r%b!<%IK!!"A42hA|$N0E$$J}!IJ@$k$$J}!K$+$i2?!sNH3m$rogCM$H9k<jK!$rP%?%$%kK!!"$[$+KbH=JLJ,@CK!!"2DJQogCMK!JI$,$"$k!#$3NJ$+$G3N8&5f$G;H$C$?<jK!$OP%?%$%kK!$G0E$$J}$+$i20!sNH3m$rogCM$H$7!"2CM2=$r9TC?!#

0J>e$N=hM}$GF@il$k2CM2=$5l?NX3T>pJs$r:Y@~2=$r9T$$!"FCD'$rCj=P$7d9$$h$&$K9k!#:Y@~2=HOM?$($il??^7A$+$i@~I}$r:Y$a$FI}1$NCf?4@~$rCj=P$9$kA`:n$N3H$r$$$$!"86?^7A$OO"7k@-$rJQ$($J$$!#9JoA?^7A$,@Z$l$?$j9&$,@8@.$7$?$j7J$$G@~?^7A2=9k3H$,MW5a$5lk!#:Y@~2=$N7k2L$+iO?^7A$N7k9g4X78$NFCD'$,5a$ailkN$G!";z$d?^LLJI$N@~>u?^7A$+$i@~$N9=B$$r2r@O9kNKIT2D7g$J=hM}$HJC$F$$k!#

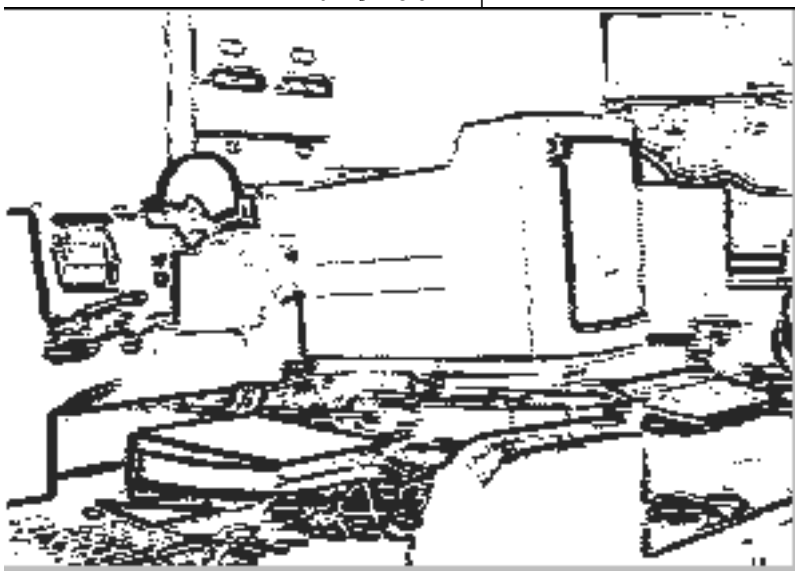
Cf?4@~$NIJ<A$dO"7k@-$N;H$$J,1K1~8F!"3l$^$G$KB?$/$N%"%k%4%j%:%`$,9M0F5l$F$$k$,,!"4pK\E*$K$O<!$N7ArH$k!#

!ØhA|Cf$N6-3&E@!Ø-6aK5$K1DG$b0-2hAG$rbD1-2hAG!KNCf+$i!">C5n2DG=MWAG$G$"$j!"$+$D@~$NC<E@$GOJ$$2hAG!ØJ?H($P8-6aK5$N1-2hAG$N8D?t$,20J2<!Kr9YF>C5n9k!#W

>e5-$N=hM}$r2hA|A4BN$N2hAG$K;\$9Nr12s$NA`:n$H$7!"$3lr>C5n5l$k2hAG$,J/Jk$^$GH?I|9k!#

:Y@~2=%"%k%4%j%:%`$K$bJBNs7?$HC`<!7?$,$"$j!"$=l>$l9)IW$,J5lF$$$k!#Am8F$$$($P5wN%JQ49$d=LB`$HF1MM!"86M}$OJBNs7?$NJ}$,9M$($d$9$$$,!"C`<!7?GO%W%m%0%i%_%s%05;K!$r6n;H$7F&$^$>r7orD$+$&3H$,$G$-$k!#FC$K:Y@~2=$G$O!"JBNs7?$N%"%k%4

?^6: 862hA



?^7: 7k2L

%j%:% `$rD>@\E,MQ$9$k$HI}2 2hAGJ,$N?^7A$,0lEY$K>CLG$7$F$7$^$&$H$$$&LdBj$,$"$k!#$3$l$O>r7o$rJ#;($K$7$F!"I}2 2hAGJ,$N$H$-$O$I$A$i$+0lJ}$@$1$,>C5n$5$l$k$h$&$K$9$k$+!"$"$k$$$O!">e2<:81&$K0-2hAG$r$b$D6-3&E@$N$"$k0lItJ,$@$1:Y$a=hM}$r9T$&Ey$NBP:v$K$hj!"I}2 $NItJ,$N>C<:$rKI$0$3$H$,$G$-$k!#C`<!7?%"%k%4%j%:%`GO!"3N>C<:rKI0>r7o@_Dj$OMF0W$G$"$k$,!"H?LL$I$&$7FbCf?4@~$N0LCV$,Av:J}8~$N0MB8$7$,$A$H$$$&7gE@$,$"$k!#[10]

K\8&5fGOHilditch K!$H$$$&C`<!7?$N%"%k%4%j%:%`$r;H$$:Y@~2=$r9T$G$?!#Hilditch K!$O3!v3 2hAG$N%^%9%/$r%i%9%?!&9%-%c&sJ}8~$KF0$+7J$,$i!"?^7A$N6-3&$r$N2hAG$rC`<!:o=|7F!"8O"7k$G@~I}1 $rF@$k<jK!G"$k!#$=$N:o=|$9$k>r7o$O

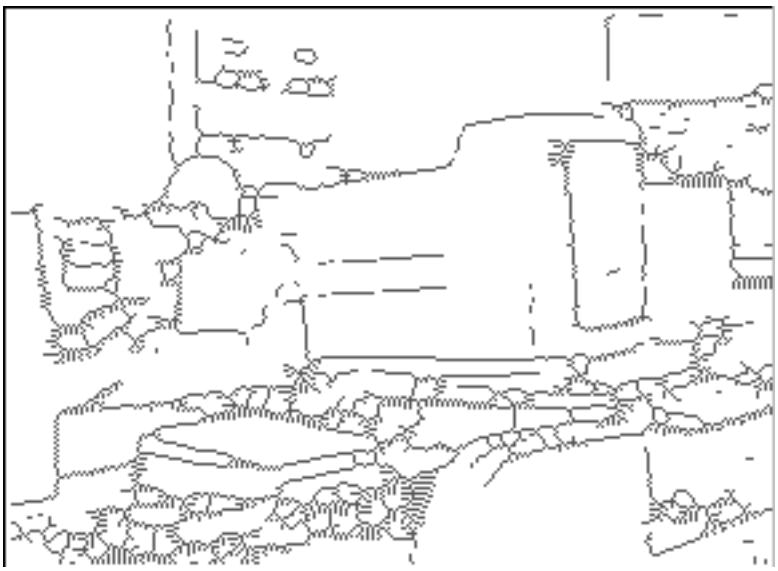
- CmL\2hAG$,?^7AItJ,$G$"$k3H
- CmL\2hAG$,GX7J$H$N6-3&2hAG$G$"$k3H
- @~$NC<E@$G$J$$$3$H
- 8IN)E@GJ$$$3$H
- :o=|7F$bO"7k@-$rJ]Fk3H

$N5 DG$"$k!#$=$7F3li>r7or9YFK~$?$9E@$r:o=|9k!#3N=hM}$r:o=|9kE@$,J/$Jk^$G9T$&!#:#2s!"I}2 2hAGJ,NH$-$OIAi+0lJ}$@1,>C5n$5lk>r7o$O!"CmL\2hAG$N8 6aK5$K:o=|$5lk2hAG$,$J$$$3H!"O"7k@-$,JQ$oi:$K>e2<:81&$K:o=|7J$$?^7A2hAG$,$"k3HrK7F9TG?!#3N%W%m%0%i%`KhCFF@il$?7k2L$r?^8KN$;$k!#3l$O?^6$N2hA|KBP7$F:Y@~2=$r9TG?7k2L2hA|G"$k!#

3.4 FCD'Cj=P

NX3T>pJsO?$/$5sNFCD'%Q%i%a!<%?$r;}$D!#$=$N4vD+r"2k$H!"

- LL@Q
- <~0CD9
- J#;(EY
- %b!<%a%s%HFCD'
- %U!<%j%(5-=R;R



?^8: 7k2L

JI$,$h$/;H$olF$$$k!#LL@Q$OC1=c$K3N?^7A$KB0$9$k2hAG?t$r?t$(B$k3H$GF@$ilk!#<~0CD9$O?^7A$N6-3&2hAG$r?t$(Bk3HKhj5aailk!#$^$?$O6-3&DI@W%"%k%4%j%:%'$N%9%F%C%W?tGb7W;;G-$k!#$3$N>l9g$O%G%8%?%kFCM-$N8m:9$,GkNG!"?bD>!&eJ?J}8~K?$$$7F<P$aJ}8~$O$\sqrt{2}$G\$9kJ$IJd@5$r;\$9I,MW$,$"$k!#

J#;(EY$O?^7A$N7A>u$NJ#;($5$rB,$kFCD'NLH7F!"<!<0$NJ#;(EYEy$,h/MQ$$$ilk!#

$$e = (<~0CD9)^2/(LL@Q)$$

e $O?^7A$,1_$K6a$$$H$-:G$b>.5/Jj!"?^7A7A>u$,J#;($KJk$[$IBg$-$$$CMrH$k!#

%b!<%a%s%HFCD'HO!"0lHIE*$K<!<0$GDj5A5l$kM(p,q)$H$=$NAH$_9g$o$;$Khj7hailk!#

$$M(\mathrm{p},\mathrm{q}) = \sum_{(\mathrm{ij})} \mathrm{i}^{\mathrm{p}}\,\mathrm{j}^{\mathrm{q}}\,\mathrm{f}_{\mathrm{ij}}$$

$3$3Gf_{ij}O?^7AFb$G1$rHj!"?^7A30$G0$rHk2CM2hA|G"$k!#(p,q)$NAHKh$j$$$m$$$m$JFCD'NL$,5aailk$,!"0J2<$N2<dN'$,:G$bh/MQ$$$ilk!#

=E?4(I_c, J_c):

$$I_c = M(1,0)/M(0,0)$$

$$J_c = M(0,1)/M(0,0)$$

<g<4J}8~$tan\theta$:

$$tan^2\theta + \frac{M(2,0) - M(0,2)}{M(1,1)} tan\theta - 1 = 0$$

%U!<%j%(5-=R;RHO!"JD6J@~$+$i!"$=$N6J@~$rI=8=$9$k2?$i$+$N4X?t!ȡ~4|4X?t!K$r5a$a!"3l$r%U!<%j%(5i?tE83+$7!"$=$NE83+78?tKhCFJD6J@~$NFCD'$rI=8=9kJ}K!G"$k!#[10]

3liNFCD'NJ$+$GHf3SE*4JC1,$+$DC;;~4V$G7W;;2DG=$JLL@Q!"<~0CD9!"U#;(EY$H6~@^2s?t$rMxMQ7?!#6~@^2s?tHO;d$,9M$($?FCD'$G?^9Nh$&$K1&>e!&8>e!&82<!&&2<$H7h$a!"9Y$F@~$NJ}8~@.J,r3$N4$DK5$@$a$k!#$=7F$=$NJ}8~@.J,$NUQ2=$r6~@^2s?tH7!"?t$($kbNG"$k!#

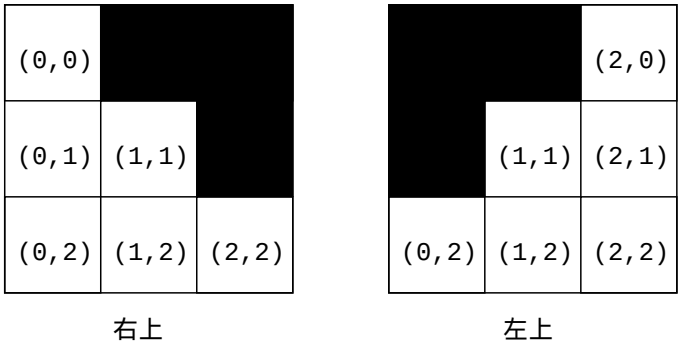
$?$H$($P?^10Nh$&$JJ}8~@.J,$NUQ2=$O6~@^2s?t$,$U$($k!#7+$7?^11$Nh&$J6~@^$O6~@^2s?t$,A}$(k3HO$J$$!#F02hA|$H$$$&NO$=$NF0$-$KhC$FBP>]%*%V%8%'%/%H$N7A$O!"%I%j!<Ey$NBP>]%*%V%8%'%/%HKBP7$FJ?9T$KF0$/F0$-GOHyL/$K!"%Q%sEy$Nh&$KBP>]%*%V%8%'%/%H$r0c$&3QEY$+$i;#$m$&$H$$$&F0$-$G$OBgI}$KJQok!#$=$N$?$a!"6~@^2s?t$r5^7c$KJ}8~@.J,$,JQ$okH3mN_K9k3HKhC$F!"5^7c$J7A$NUQ2=$K$bBP1~$5$;$h$&$H7?7k2LG"$k!#?^11$Nh&K4$/$o$:$+$JJ}8~@.J,$NUQ2=$O!"%+%a%i$NF0$-$KhC$F4JC1$KJQ2=9kNG!"?^10Nh$&$KOC$-$jH7$?J}8~@.J,$NUQ2=K@$1CmL\$9k3HG!"%+%a%i$NF0$-Kh$kBP>]%*%V%8%'%/%H$N7A$NUQ2=$K$bBP1~$G$-$k$H9M$($k!#

3.5 FCD'Hf3S

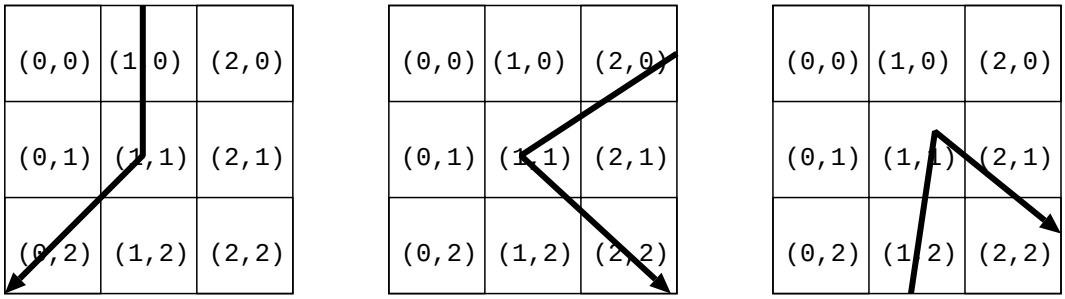
;~7ONs>e$N8=2hA|$HA02hA|HNFCD'rHfYk3HG!"%+%a%i$NF0$-$r8!=P$9kN$@$,!"FCD'Cj=PKh$jCj=P$5l?!"LL@Q!"<~0CD9!"U#;(EY!"6~@^2s?t$rHf3S$9k3HKJk!#7+$7A0=R$NH*$j!"%+%a%i$NF0$-$KhC$FBP>]%*%V%8%'%/%H$N7A$,JQ$o$k!#$3N3HKhj!"LL@Q!"<~0CD9bJQok3HKJk!#U#;(EY$OLL@Q!"<~0CD9$,JQok3HKh$jB?>/JQ2=$9k,!"<0Kh$j5a$ailkN$G=$l$[$I$NUQ2=$O$J$$$H9M$($ilk!#$=$3$GBP>]%*%V%8%'%/%H$rH/8+9k$?$a$NFCD'$NM%@h=g0L$H$$$&N,I,MWKJ$k!#d$,9M$($?M%@h=g0L$O!"

1. 6~@^2s?t
2. J#;(EY
3. <~0CD9
4. LL@Q

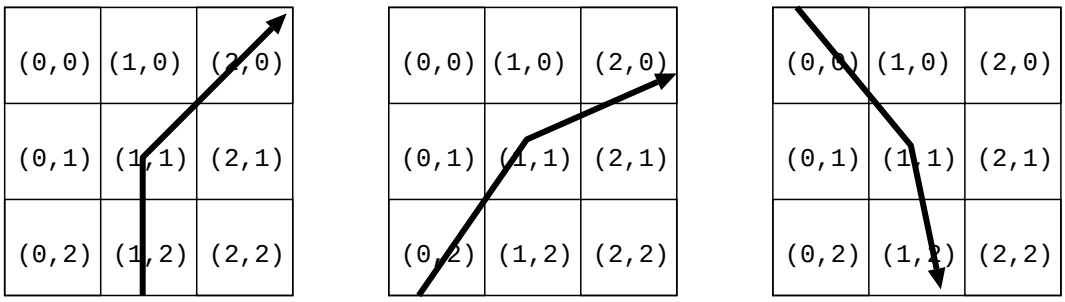
$N=g$G$"$k!#3l$O%+%a%i$NF0$-$KhkJQ2=NL$,>/$J$$$@m&$H9M$(il$k=g$G$"$k!#l$N6~@^2s?t$O?^7A$N7A$K0MB8$9$k$,$h$[$IBg$-$/7A$,JQ$ok3H,$J$$$+$.$j!"$=$N?t$,Bg$-$/$+ok3HOJ$$$H9M$($ilk!#2$NU#;(EY$b?^7A$N7A$K0MB8$9$k!#7+$7!"$3$l



?^9: 6~@^2s?t



?^10: 6~@^2s?t$,A}$($k6~@^



?^11: 6~@^2s?t$,A}$($J$$6~@^

?^12: <B9T2hLL

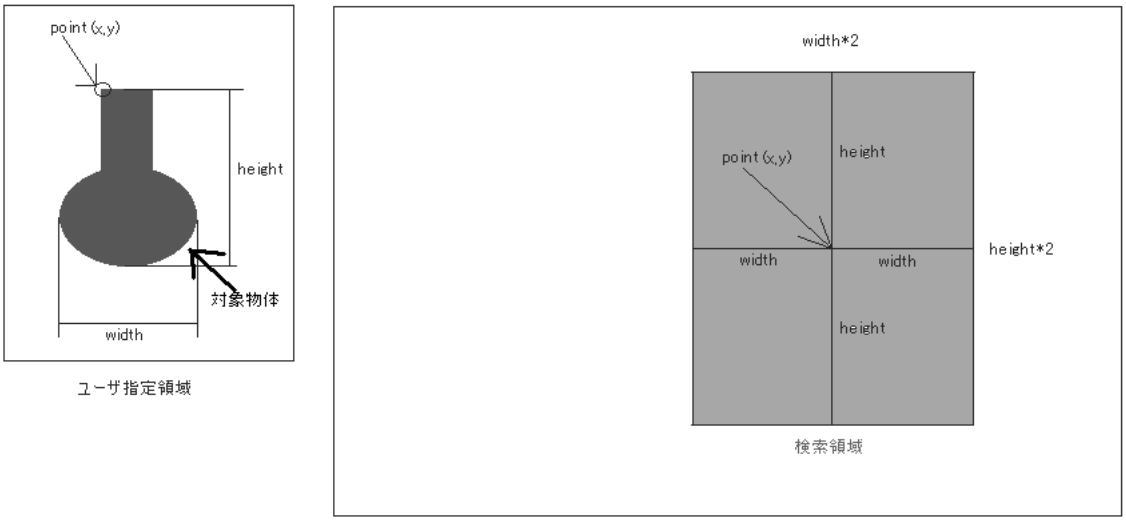
$OLL@Q$H<~0CD9$NUQ2=$OBg$-$$$H9M$ (ilk,!"LL@Q$H<~0CD9$NHfNcKhGF5aakNG!"B?>/$NUQ2=$O$"$k$@$m$&$,Bg$-$/JQok3HOJ$$$H;Wol$k!#3 $H4 $O7A$NUQ2=KhCEFBg$-$/JQok$@$1GJ$/!"7A$,A4$/0c$&?^7AGbF1$8CM$rHk3H$,$"kH9M$ (ilkN$G!"Hf3SM%@h=g0L$,6KaFDc$/$7$?!#2DG=@-$H7F$O1,2,3,4 $,A4$/F1$8?^7A$,B8:_9kNG!"K\Mh$J$iPI$NU}8~@.J,$,INU}8~@.J,$KJQ2=$7$?$H$$&FCD'$bJ];}$7!"$=$l$rHf3S>r7o$K$/$o$ (kH$$&N,K|A4$@$H9M$ (ilkN$@$,!"$=$&9k3HKh$j!"=hM};~4V$,G\A}9kNGOJ$$$+$H;W$ol?$?$a!"3N4 DN$_$KCmL\$7$?!#

2 DNFCD'$NHf3S;~$K$O!"%G%8%?%kE*$K$^$C$?$/F1$8$H$-$KN_0lCWH9kNGOJ/$"$kDxEY$N8m:9$OG'akh&K9$k!#$=$&$9k3HG$^$C$?$/0c$&%*%V%8%'%/%H$r0lCW$HG'<1$9$k62$lb"k,!"4 DNFCD'$rHf3S$7$=$NFCD'$N0lCWEY9g$$,0lHV9b$$bNrF101%*%V%8%'%/%H$HG'<1$9$k!#

3.6 %W%m%0%i%`

:n@.7?%W%m%0%i%`$G$O!"?^12$N<B9T2hLL$N$h$&$K!"1 $D$N2hA|$r%f!<%6$,@E;_J*$r4^$`#4DNG$0U$NNN0h$KJ,$1$k!#$=7F$=$NJ,1il?NN0hKN$_!"NX3T$rCj=P$7FCD'$rD4Yk$H$$&=hM}$r9T$&!#

NN0h$NFCD'$O!"$=$NNN0hFb$NNX3T$NFCD'9YFGOJ$/!"$=$NNN0h$NJ+$G0lHVLL@Q$NBg$-$$NX3T$NFCD'$N$_$H7?!#3lO9YFNNX3T$NFCD'$rD4Yk$H!"FCD'$Nf3SNH$-$K;~4V$,$+$+$k$H9M$ (ilk?aG$"$k!#$=$7F=$NNN0h$NFCD'$rH/8+$7$?$H$-$K!"$=$NNX3T@.J,$N0lHV:8>e$N:BI8$r:BI8%]%$s%HH7!"$=$NNX3T$N:GBgI}$H:GBg$N9b$5$N>pJs$H6&$KJ];}$7F*$/!#<!2hA|$+iO!"<+F0GFI_9~$_A02hA|$G$N:BI8%]%$s%H!"I}!"9b5N



?^13: 8!:wNN0h

>pJshj?^13Nh$&$K8!:wNN0h$r7hDj$7!"$=$N8!:wNN0hFbNK$D$$$FNX3TCj=P!"2 CM2=!":Y@~2=!"FCD'Cj=Pr*3J$&!#$=$NCj=P$5l?FCD'$HA02hA|$NFCD'$rHf3S$9$k!#F10lFCD'$,$"$l$P!"<!2hA|$NFI$_9~$_rO8a$k!#0c$&JiJi8!:wNN0h$N0LCV$r>e2<:81&K:i9$3$H$GF10lFCD'$rH/8+9k$^$G3N=hM}$r7+$jJV$9!#

F0$-$r8!=P9kA`:n$H$7$F$O!"%f!<%6$,;XDj$7$?4 $D$NBP>]J*$N0LCV4X78$+$i8!=P$9$k!#6qBNE*$K8@$&$H!"4 $D$NBP>]J*$r$`9V4 3Q7A$N7A$NJQ2=$H2hLL>e$N0LCV$NJQ2=$Khj8!=P9k!#$?$H$($P4 DNBP>]J*r`9V4 3Q7A$N7A$,D9J}7A$@$H9k!"<!2hA|G=$N7A$,>eJU$,C;$$Bf7A$KJQ2=$7$?$H9k!#$=$N7A$NJQ2=$+$i?dB,$5lk!#%+%a%i$NF0$-$O>eIt$KB8:_9k2 DNBP>]J*$,1|$N$[$&$K8~$+CFF0$$$?$+!"2<It$KB8:_9k2 DNBP>]J*$,<jA0$KF0$$$?$+!"$=$NN>J}$+G"k?$a!"%+%a%i$,2<8~$-$K<s$r?6$C$?$NGO$J$$$+$H?dB,$5lk!#$^$?O7A$,JQ$oi:$=$NOLCV$@$1$,JQ$oC?H9kH!"$=$l$O%+%a%i$,<s$r?6$i$:$KOLCVN_JQ2=5;$?$H$$$&$&$3HKJk!#3Nh&$K4 3Q7A$N7A$HOLCV$NJQ2=$G%+%a%i$NF0$-$r?dB,9k!#

4 <B83$H9M;!

!%V+%a%i$NF0$-$r8!=P$9$k%=%U%H%&%'%"!W$r:n@.7?$,!"A02hA|$H8=2hA|HNFCD'$NHf3S$^G7$+:n@.$G$-$J$+$C$?!#$=3G$=$3$^$G$NI>2A$r9T$&!#

0lHIE*$KF02hA|$+$iF0$-$r8!=P$9kK$O%*%W%F%#%+%k%U%m!<(8+$+1NB.EY>l!K$r;H$&!#7+$7!"%*%W%F%#%+%k%U%m!<$O%Q%?!<%s$NFCD'$rI=$92hA|4X?t!G;C8J,I[!K$,!"1?F0$K:]$7$FITJQ$G$"$k!"$H$$&2>DjNbHK@.$jN)$C$F$$k!#3N2>Dj$,$Il@$1<B:]E*$+$H9M$($?$H$-$K!"2030JIGO3N2>Dj$,@.$jN)$?$J$$H;WG?!#3l$O%*%W%F%#%+%k%U%m!<$,!"2D;k2=5l$?N.BN>l$d@E;_5$>]1R@12hA|$Nh&$KF02hA|$+iNJ*M}7WB,rI,MWH9kJ,Ln$G9M0F$5l?3H$,860x$G$"$k$H;W$&!#J*M}7WB,K*$$F$O!"0lHIE*$K4D6-$r0lMM$K7F7WB,9kNG3N2>Dj$,@.$jN)CF$$?N@!#7+$7!"2030$d4vDb>HL@N"$?$C$F$$k>l=jGO!"$=$N4D6-$,0lMM$GOJ$$N$G@.$jN)$?$J$$!#$=$N$?a!"4D6-$NJQ2=$*$hSK%+%a%i$NF0$-Kh$kJQ2=$,>/$J$$bNH9M$($?H-$!"%+%a%i$N%U%l!<%'Fb$N@E;_J*$,$=$l$rK~$?7F$$kNGOJ$$$+$H9M$(!"NX3T>pJsKh$k%+%a%i$NF0$-8!=P$r9M$($?!#

3N%W%m%0%i%'$N<B83$N7k2L!"3>O1@aG"2?NX3TCj=P$+$i$NF0$-8!=P$NN.$lN&AN!¥VY@~2=5l$?NX3T>pJs$NLI@Q!"<~0CD9!"J#;(EYEy$NFCD'$rD4Yk!#W$^$G$O!"9M$($F$$$?DLjN7k2L$,F@$il?!#:Y@~2=$OI}#22hAG$N@~J,NIA+0lJ}$@$1$r>C5n$9$k>r7o$,C1=c9.$?$N$+!"URJ}$@1,>C5n5lkN$@$,$&$^$/Cf?4@~$@1r;D$;$J$$$@~J,b"C?!#NX3TCj=PK*$$F$O%Q%i%a!<%?$r9baK@_Dj$7!"NX3T>pJs$r>/J/9k$H$$$&;n$_$O@.8y7?$H;W$&!#?^7$N7k2L2hA|$@1r8+lPNX3T$,$-$l$$$K=P$F$$J$$N$@$,!"NX3T$NFCD'>pJs$rCj=P9kNG$"$C$F!"NX3T$rCj=P9kNG$O%J$$N$G!"$3lG=J,G"$k!#$5iK<B83$O9T$C$F$$J$$N$@$,!"%Q%i%a!<%?rDc/@_Dj$7!"$-$l$$$KNX3T$rCj=P$7$?;~$HHfYFA4BN$N=hM};~4V$OC;$/$JCF$$k$O:$G$"$k!#

7+$7!"FCD'$NHf3SKh$jF10l%*%V%8%'%/%H$NH/+$O:$Fo$@$C$?!#%f!<%6$,;XDj7?NN0hFb$K@E;_J*BN!"1?F0J*BN$NB8:_$,>/$J$>l9g$OH/+O?d9$$N$@$,!"$=$&GJ$$H$-!"$D$^$jNN0hFb$KJ*BN$,B?$$H$-$O!"BP>]J*!NN0hFb$G0lHVLI@Q$,Bg$-$$J*BN!K$NH/+$^GK;~4V$,$+$+$j!"$=$NFCD'F1;N$NHf3S$NH-KOHf3SBP>]J*$,B?$9$.$k$?$a+Jj$N;~4V$rMW7?!#5i$KF10lJ*BNH/+>r7o$,4E$$N$+!"0c$&J*BN$rBP>]J*$HF10lJ*$HG'<1$7F7$^$&NG$"$k!#3l$O%+%a%i$NF0$-$KhkBP>]J*$N7A$NJQ2=$r9MN8$7!"$"$kDxEY$N8m:9$OA02hA|$NFCD'$HEy2AG"kH7?$a@$H9M$($ilk!#$=$3$GF10lJ*$HG'<1$9$k>r7o8m:9$r69$/9k$H!"F10lJ*BN$bH/+J/Jk;~$b=P$F$-$?!#D^$jNN0hFb$N>u67!"%+%a%i$NF0$/%T!<%'IKhCF=$NG'<1>r7o8m:9$rJQ2=5;kI,MW,=P$F/$kNG$"$k!#

$=$3$GFCD'>r7o$NDI2C$r9M$($?!#FCD'$N%Q%i%a!<%?O^s^Ha$F"6~@^2s?t!"J#;(EY!"

?^14: %F%9%H2hA|

LL@Q!"<~0CD9N[$+$K$b%b!<%a%s%HFCD'$d%U!<%j%(5-=R;R$,$"$k!#$7$+$7!"%U!<%j%(5-=R;R$QJD6J@~$+$i!"$=$N6J@~$rI=8=9k2?i+$N4X?t!ø~4|4X?t!K$r5a$a!"$3lr%U!<%j%(5i?tE83+7!"$=$NE83+78?tKhCFJD6J@~$NFCD'$rI=8=9kJ}K!JN$G!"7A$K0MB8$7$9$.$kNGOJ$$$+$H9M$(ilkN$G!"%+%a%i$NF0$-$KhkBP>]J*$N7A$NJQ2=$KBP1~$7$-$l$J$$2DG=@-$,9b$$$HH=CG7?0Y!";HMQ7J$+$C$?!#%b!<%a%s%HFCD'$N=E?4$d<g<4J}8~$b7A$N0MB8$9$kFCD'$@$H9M$(ilkN$G;HMQ$7J+C?!#D^$j!"%+%a%i$NF0$-$KhkBP>]J*$N7A$NJQ2=Kh$kJQ2=$N$J$$?^7A$NFCD'$r9M$($J1lPJiJ$$$N@$,!";W$IU$+$:CGG0$7$F7^C?!#

?^14$N%F%9%H2hA|$NA42hA|KBP7$FNX3T$NCj=P$r9T$$!"2CM2=!":Y@~2=!";(2;$N=|5n$r9T$&$NK+$+$C$?;~4V$O9J,58ICG"C?!#2hA|Fb$NJ*BN$NB?5d?'$NJ#;($5Kbhk$,J?6Q$G10J,DxEY$N;~4V$,$+$+$k!#$5iKFCD'$rD4$YkNO3$N2hA|$G$O17J,36IC$G$"$C$?!#FCD'$rD4YkNK$+$+$k;~4V$O2hA|Fb$NJ*BN$NB?5KNX3TCj=Phj0MB8$9$k$?$a!"@53NKO8@$($J$$$,!"%F%9%H2hA|DxEY$NJ#;($5$@$HJ?6Q20J,DxEYO+$+$k!#FCD'$NHf3S$@1K$+$+$k;~4V$OJ?6Q1;~4V40J,DxEYG"C?!#D^$jA02hA|$H8=2hA|HNHf3SK+$+$kAmJ?6Q;~4V$O2;~4V30J,DxEY$G$"$k!#3liN<B8378k2L$rI=1$K:\$;$k!#2hA|Fb$NJ*BN$NB?$5!"?'9g$$$KhC$F=hM};~4V$OBg$-$/JQokNG3l$OJ?6Q=hM};~4V$NI=$G"$k!#9JoA2hA|KhCF$O!"$3lhj+Jj=hM}$,Aa$/=*ok3Hb"k,!"G\0J>e$N;~4V$r

I=1: =hM};~4V

	NX3TCj=P,2 CM2=, :Y@~2=	FCD'Cj=P	FCD'Hf3S	9g7W;~4V
J?6Q=hM};~4V	10 J,	20 J,	1 ;~4V40 J,	2 ;~4V30 J,

I,MWH9k3Hb$"$k!#3N8&5f$OCG $H<B<L$N9g@.K+$+$k;~4V$r%+%a%i$NF0$-$r<+F0$G8!=P$9k3HG:o8:9k3HJN$@$,!"2 %U%l!<%'4V$NF0$-$N8!=P$K2 ;~4V30 J,b+$+$k$H!"5 J,4V$N%U%#%k%'$G6000 %U%l!<%'$+$i9000 %U%l!<%'$KJkNG!"3N%=%U%H$r;H$&3HKhCF;~4V$N:o8:$O9T$($J$$$NGO$J$$$+$H$$$&7kO@KJ$k!#%Y%F%i%s5;=Q<T$,9TC?$[$&$,05E]E*$KAa$$$@m&$H$$$&NO4V0cCF$$$J$$$7kO@$@$m$&!#

5 $*$ojK

K\8&5f$O !¥+%a%i$NF0$-8!=P!W$G$"$k!#3N%F!<%^KOMM!9$J%"%W%m!<%A$,B8:_9kJ+$GNX3T>pJs$H$$$&<jK!rMQ,$?M}M3$O!"3N<jK!$,0lHV=hM};~4V$,C;$$$G$"$m$&$H;Wol$?$+iG$"$k!#!¥O8a$K!W$G$b=R$Y$F$$k$,!"<B<L2hA|$HCG $N9g@.$K3]$k;~4V$NC;=L$,K\8&5f$NL\E*G"$k!#$7$+$7!"%j%"%k%?%$% `$G%+%a%i$NF0$-$r8!=P$9$k$3$H$,$G$-$l$P!"!¥+F0<V$N<+F01?9T%7%9%F% `!W$d!¥m%\%C%H$N;k3P!W$H7F;H$&$3H,G-$k!#$@$+$i!"=hM};~4V$rC;$/9k3H$r<g4c$K$*$$$F8&5fr7$?$,!":n@.7?%W%m%0%i%`$N<B83$N7k2L!"F10lJ*BNH/8+$N@:EY$bDc$/!"=hM}$K3]$k;~4V$bD9;~4V$@$C$?!#$3lK$O=hM};~4V$,5i$KA}Bg$9k@m&$,!"J*BN$NF'CD'%Q%i%a!<%?d9$3$H$G@:EY$O>e$,$k$H;W$olk!#

:#8e$N2]Bj$H7F$O!"F10lJ*BNH/8+$N@:EY$r>e$2k3HH6&$K!"=hM};~4V$NC;=L$,>e$2il$k!#

<UK-

K\8&5f$N5!2q$rM?$($F2<5j!"?t!9%N=u8@$rD:$-$^$7$?;3:j>!9065<x$K?4hj46<UCW7^$9!#$^$?!"K\8&5f$K$"$?$j!"$$m$$mJLLG5.=E$J8f0U8+$d!"Ne$^$7$rD:$-$^$7$?K\8&5f<<$N3'MMKb?4hj46<U7^$9!#

;29MJ88%

[1] ?9K\5H=U!%Q%=%3%s2hA|=hM}%O%s%I%V%C%/,6&N)=PHG (1998).

[2] C+?,K-<w!%Q%=%3%sKh$k:G?72hA|=hM}F~Lg,5;=QI>O@<R (1996).

[3] C+?,$+$*$j!$O8aFNVisual Basic 5,5;=QI>O@<R (1998).

[4]Rod Stephens!Visual Basic 2hA|=hM}%W%m%0%i%_%s%0 #2#DJT,%=%U%H%P%s%/(1998).

[5] D;OF=c0lO:!2hA|=hM}N?aN%G%#%8%?%k2hA|=hM} !#1!K,><98F2 (1993).

[6] D;OF=c0lO:!2hA|=hM}N?aN%G%#%8%?%k2hA|=hM} !#2!K,><98F2 (1993).

[7] EDB<=(9T!%3%s%T%e!<%?2hA|=hM}F~Lg,Am8&=PHG (1994).

[8] 0B5o1!LT,CfEh@5G7,D9HxCR=U:2hA|=hM}$N<B:],9)3X<R(1988).

[9] H,LZ?-9T,0f>e@?4n,NS@5<y,Cf?\1QJe,;0C+8xFs,1|0f@??M,NkLZ@50l,6b<!J]L@:C 8@8l$G3X$V<BA)2hA|=hM},%*!<%'<R !1992).

[10] Hx:j90,C+8}7D<#:2hA|=hM},0fN)=PHG !1983).

[11] 2#0fLP<y,0BED9'H~!%3%s%T%e!<%?%0%i%U%#%/%9!#1!K,EE;R>pJsDL?.3X2c;o,Vol.76,No.3, pp.277-283 (1993).

[12] 2#0fLP<y,0BED9'H~!%3%s%T%e!<%?%0%i%U%#%/%9!#2!K,EE;R>pJsDL?.3X2c;o,Vol.76,No.5, pp.529-537 (1993).

[13] 2#0fLP<y,0BED9'H~!%3%s%T%e!<%?%0%i%U%#%/%9!#3!K,EE;R>pJsDL?.3X2c;o,Vol.76,No.6, pp.626-633 (1993).

[14] >.H*7rFs:?'>pJsKh$kF02hA|$+iN%+%a%i$NF0$-$N8!=P,N)L?4[Bg3X>pJs3X2JB46H O@J8,(1999).

[15] 1sF#9@J?:NX3TCj=PKh$k%^%C%A%'!<%S%s%0,N)L?4[Bg3X>pJs3X2JB46HO@J8,(1999).

IUO?

$3$3$GK\8&5f$G3+H/7?%=%U%H%&%'%"$N30It;EMM$HFbIt;EMM$r@bL@$9$k!#

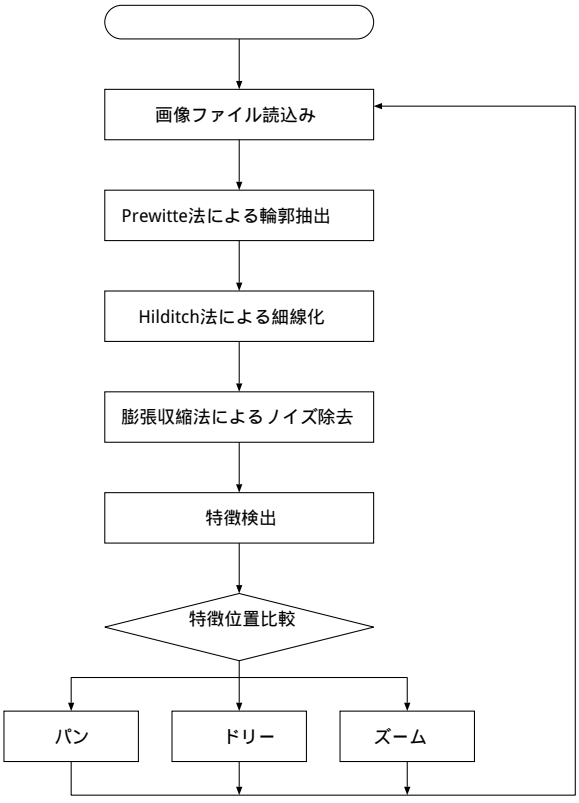
30It;EMM

!%U%!%$%k!W$N9'L\$N !'V+$/!W$r%/%j%C%/9k3H$G!"%U%!%$%k%*!<%W%s%@%$%"%m%0$,3+$+$l!"3+$/2hA|%U%!%$%k$r;XDj$9$k!#!'W02h=hM}!W$N%\%?%s$r%/%j%C%/$9kH!"NX3TCj=P!"FCD'8!=P$,<+F0$G9Tol$k!#$=$N=hM}$N=*N;8e!"!'Wf3S!W%\%?%s$r%/%j%C%/$9k3HG!"%U%!%$%k%*!<%W%s%@%$%"%m%0$,3+$+$l!"$3$3$G3+$/<!2hA|%U%!%$%k$r;XDj$9kH<+F0$G!"NX3TCj=P!"FCD'8!=P$,9Tol!"FCD'Hf3S$r9T$&!#

FbIt;EMM

%"%k%4%j%:%'

K\8&5f$G:n@.$7$?%=%U%H%&%'%"$N%"%k%4%j%:%'$O?^15$NDLjG$"$k!#



?^15: %"%k%4%j%:%'

4X?t

1. frmMain class

3F=hM}$N<B9T3+;O$N%?%$%_%s%0$H%U%)!<% `$N7A@.$r;J$k

!Form_Load

%U%)!<% `%b%8%e!<%k$N8F$S=P$7!"$*hS%\%?%sEy$N0LCVG[CV

!Hikaku_Click

!Nf3S!W%\%?%s%/%j%C%/9k$H!"%U%!%$%k%@%$%"%m%0$r3+$-!"2hA|$NNX3TCj=P!"

FCD'8!=P$HA02hA|$NFCD'Hf3S$r9T$&

!mnuFileOpen_Click

%U%!%$%k$r3+$/

!mnuFileQuit_Click

<B9T7A<0%U%!%$%k$rJD8k

!Retry

%$%a!<%8%\%C%/%9$K:FEY!"2hA|%U%!%$%k$rFI9~$`

!Start_Click

%$%a!<%8%\%C%/%9Fb$N2hA|KD$$$FNX3TCj=P!"FCD'8!=P$r9T$&

2. global class

NX3TCj=P4X?t$d!"FCD'8!=P4X?tEy!"%a%$%s$N=hM}$r;J$k

!GetTempFile

Temp %G%#%l%/%H%j$N%Q%9$r<hF@9k

!GetImagRGB

2hA|%a%b%j$N;XDj$7$?0LCV$+$i#RCM!"#GCM!"#BCM$r<hF@9k

!PutImgRGB

2hA|%a%b%j$N;XDj$7$?0LCV$+$i#RCM!"#GCM!"#BCM$r=PNO9k

!LongRGB

D9@0?t7?$N#R#G#BCM$r!"%P%$%H7?$N#RCM!"#GCM!"#BCM$KJ,2r$9$k

!ReadBitmapHeader

%S%C%H%^%C%W%U%!%$%k%X%C%@!<$N>pJs$r<hF@$9$k

!ReadGihHeader

#G#I#F%U%!%$%k%X%C%@!<$N>pJs$r<hF@$9$k

!ReadEx

%S%C%H%^%C%W, #G#I#F%U%!%$%k0J30$N%U%!%$%k%X%C%@!<>pJs$r<hF@9k

!FFileToMemory

2hA|%G!<%?$r%a%b%j$KFI9~$`

!RRinkaku

Prewitt K!$rMQ$$$FNX3TCj=P$r9T$&

!LLost_Noize

KDD%<}=IK!Kh$j2hA|Fb$N%N%$%:$r<h$k

!SSmart_Line

Hilditch K!Kh$j:Y@~2=$r9T$&

!TTokutyo

<~0CD9!"LI@Q!"6~@^2s?t!"J#;(EY$N#4$D$NFCD'$r8!=P9k