

OPENACS AND TCL/TK CONFERENCE 2025, JULY 10-11

- [Andreas Kupries](#)
- [AKTIVE](#)
 - AK Tcl Image Vector Extension
 - MIT/BSD Licensed
 - Inspired by [VIPS](#)
 - Mixes C and Tcl via [Critcl](#)



AK TCL IMAGE VECTOR EXTENSION

- Inspired by VIPS
 - Library for the processing of large images
- Similarities
 - Demand-driven: Lazy construction
 - Horizontally Threaded Execution
- Differences
 - **double** is the only pixel value type
 - Wedded to Tcl, not GNOME (GObject)
 - Code Generation, also docs, examples



AK TCL IMAGE VECTOR EXTENSION

- Historical notes
 - Begun as experiment with code gen
 - Operator specs first translated to
 - implementations (C, Tcl)
 - Then also documentation, examples
- C, Tcl, Critcl - Each used for their strengths
 - C is fast
 - Tcl is high-level
 - Critcl mixes them easily



AK TCL IMAGE VECTOR EXTENSION

- I/O
 - Read/write Channels, Files, Tcl Values
 - Currently supported image formats:
 - PPM, PGM
 - AKTIVE (package's own format)
 - PPM/PGM values are the connection to Tk



AK TCL IMAGE VECTOR EXTENSION

```
operator op::math1::abs {
    section transform math unary

    note Applies the unary function `abs(I)`.

    input

    simplify for    src/type @self    returns src
    simplify for    constant abs

    state -setup {
        #define IN_GEOM aktive_image_get_geometry (srcs->v[0])
            aktive_geometry_copy (domain, IN_GEOM);
        }

    pixels {
        #define FETCH aktive_region_fetch_area (srcs->v[0], request)
            aktive_blit_unary0 (block, dst, fabs, FETCH);
        }
    }
```

AK TCL IMAGE VECTOR EXTENSION

```
proc aktive::op::math1::abs {src} {  
    ::aktive simplify do \  
        src/type op::math1::abs \  
        /src  
    ::aktive simplify do \  
        src/type image::from::value \  
        /fold/constant/0 abs  
    Iabs $src  
}
```

AK TCL IMAGE VECTOR EXTENSION

```
critcl::cproc aktive::op::math1::Iabs {  
    Tcl_Interp*  ip  
    aktive_image src  
} aktive_image {  
    /* src :: keep */  
    /* no parameters */  
    aktive_image _r = aktive_image_check (ip,  
        aktive_op_math1_abs_new (ip, src));  
    return _r;  
}
```

AK TCL IMAGE VECTOR EXTENSION

```
extern aktive_image
aktive_op_math1_abs_new (Tcl_Interp* ip, aktive_image src) {
    TRACE_FUNC("", 0);

    static aktive_image_type aktive_op_math1_abs_opspec = {
        .name          = "op::math1::abs"
    ,   .sz_param      = 0
    ,   .setup         = (aktive_image_setup) aktive_op_math1_abs_setup
    ,   .region_fetch  = (aktive_region_fetch) aktive_op_math1_abs_region_fetch
    };

    aktive_image_vector srcs = {
        .c = 1, .v = &src
    };

    aktive_image r = aktive_image_new (&aktive_op_math1_abs_opspec,
                                       NULL, &srcs);
    TRACE_RETURN ("(aktive_image) %p", r);
}
```

AK TCL IMAGE VECTOR EXTENSION

```
static int
aktive_op_math1_abs_setup (
    aktive_image_info* info
,   Tcl_Obj**          meta
) {
    TRACE_FUNC("((aktive_image_info*) %p)", info);
    aktive_image_vector* srcs    = &info->srcs;
    aktive_geometry*      domain = &info->domain;
#define                      state  (info->state)
    // - - -- --- -----
    #define IN_GEOM aktive_image_get_geometry (srcs->v[0])
    aktive_geometry_copy (domain, IN_GEOM);
    // - - -- --- -----
    TRACE_GEOMETRY (domain);
#undef state
    TRACE_RETURN ("(ok) %d", 1);
}
```

AK TCL IMAGE VECTOR EXTENSION

```
static void
aktive_op_math1_abs_region_fetch (
    aktive_region_info* info      // Params, inputs, (image) state
, aktive_rectangle* request      // Area to fetch
, aktive_rectangle* dst          // Destination in `block`
, aktive_block* block           // Pixel storage
) {
    [...]
    aktive_region_vector* srcs    = &info->srcs;
    aktive_geometry* idomain = info->domain;
    [...]
    // - - -- --- -----
    #define FETCH aktive_region_fetch_area (srcs->v[0], request)
    aktive_blit_unary0 (block, dst, fabs, FETCH);

    // - - -- --- -----
    TRACE_RETURN_VOID;
}
```

AK TCL IMAGE VECTOR EXTENSION

Section	Lines	Percent
Runtime	9617	9.42
DSL	5100	5.00
Operators	15414	15.10
Generated	69504	68.08
Doc Source	2455	2.40
Total	102090	100.00



AK TCL IMAGE VECTOR EXTENSION

Demo

The images and graphs seen in the coming slides were all created by AKTIVE



Our task: Given an image containing a document or book page, extract the area of the document or page, and rectify it

A complication: For book pages the image may not only contain the page of interest, but also part of the opposite page

AK TCL IMAGE VECTOR EXTENSION

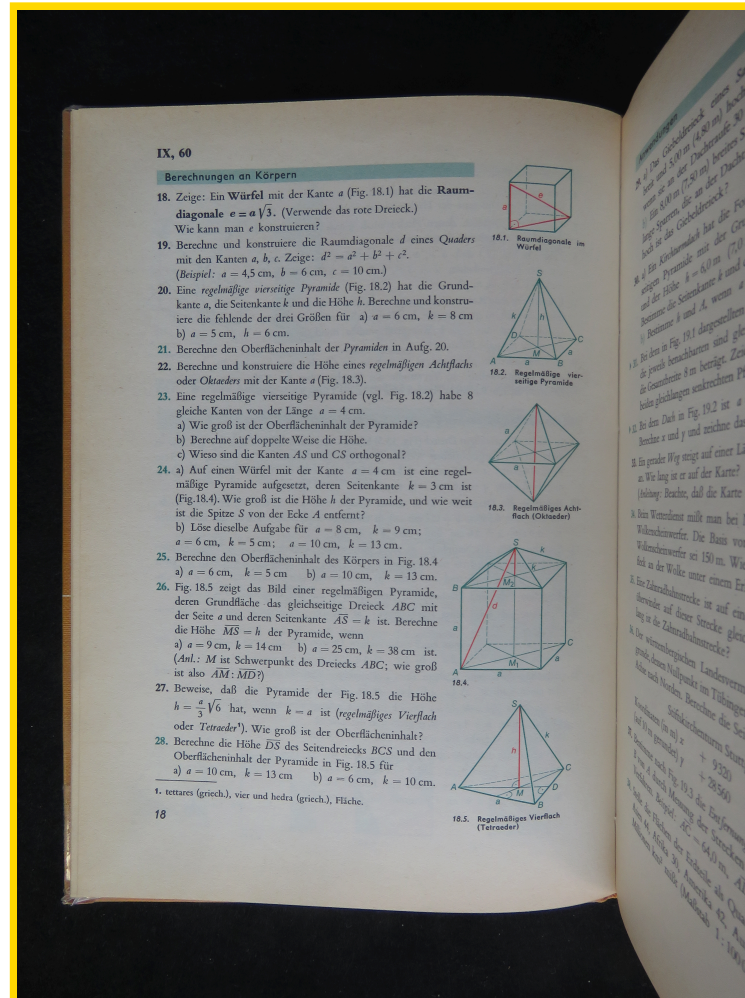
Book data; origin of the page image

General

Prop	title	Geometry 2
Prop	author	Lambacher Schweizer
Prop	pubdate	1970
Prop	publisher	Ernst Klett Verlag Stuttgart
Prop	language	de
Prop	binding	hardcover
Prop	mmwidth	162
Prop	mmheight	232
Prop	editshotorder	odd/even
Prop	editsize	800
Prop	exportmode	space
Prop	exportsize	dpi best

AK TCL IMAGE VECTOR EXTENSION

INPUT 3456 X 4608



AK TCL IMAGE VECTOR EXTENSION

DO-SCALE-DOWN

```
param pnm src

lassign [active query domain $src] _ _ w h
set w    [expr {$w / [factor]}]
set h    [expr {$h / [factor]}]

result wtxt geo [list $w $h]
result ppm  dst [active op resize $src width $w height $h]
```

AK TCL IMAGE VECTOR EXTENSION

AKTIVE OP RESIZE

```
::aktive parameter validate          interpolate 0 width 0 height 0
::aktive parameter collect required width height
set interpolate bilinear
::aktive parameter collect optional interpolate

lassign [aktive query domain $src] _ _ w h

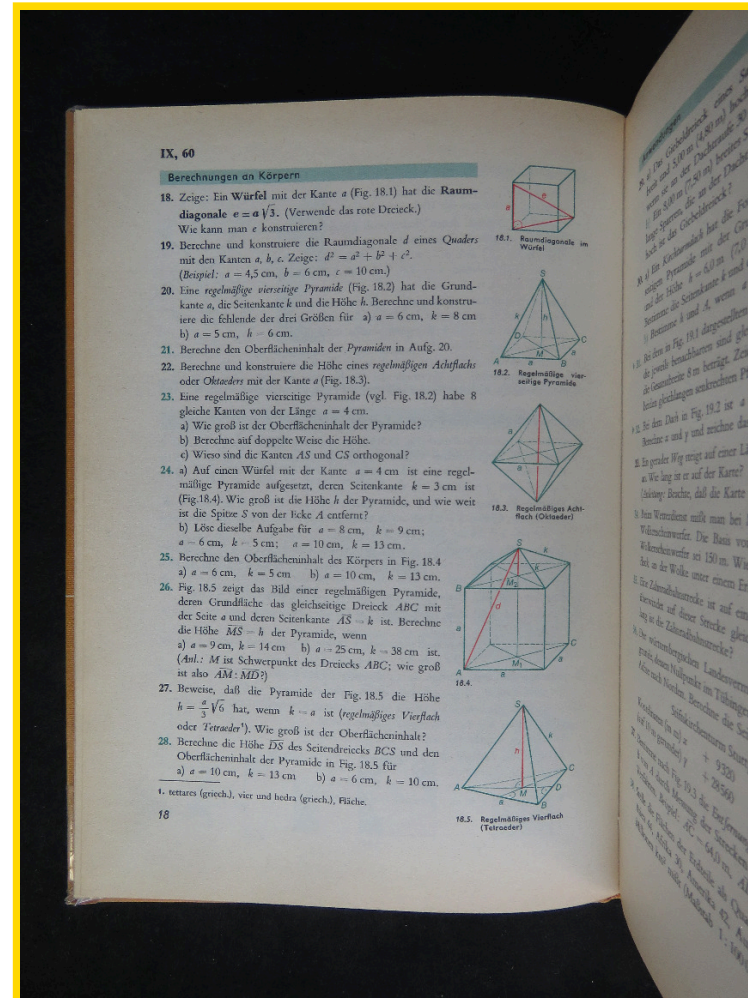
set xscale [expr {double($width) / $w}]
set yscale [expr {double($height) / $h}]
set trafo  [aktive transform scale x $xscale y $yscale]
set resized [aktive op transform by $trafo $src interpolate $interpolate]

lassign [aktive query geometry $resized] x y rw rh
if {($rw != $width) || ($h != $height)} {
    set resized [aktive op view $resized port [list $x $y $width $height]]
}

return $resized
```

AK TCL IMAGE VECTOR EXTENSION

SCALED 864 X 1152

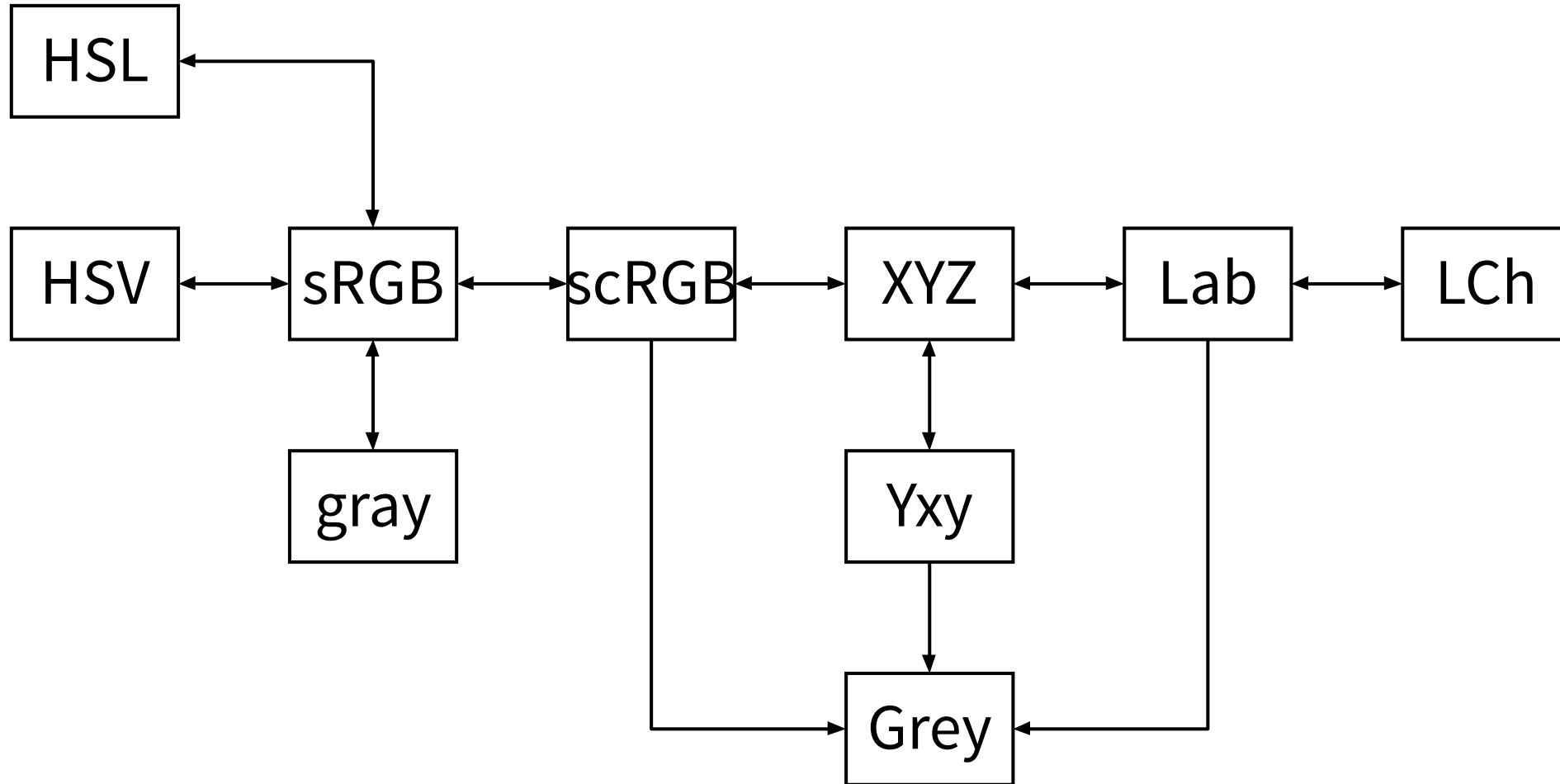


AK TCL IMAGE VECTOR EXTENSION

DO-CONVERT-TO-GREY

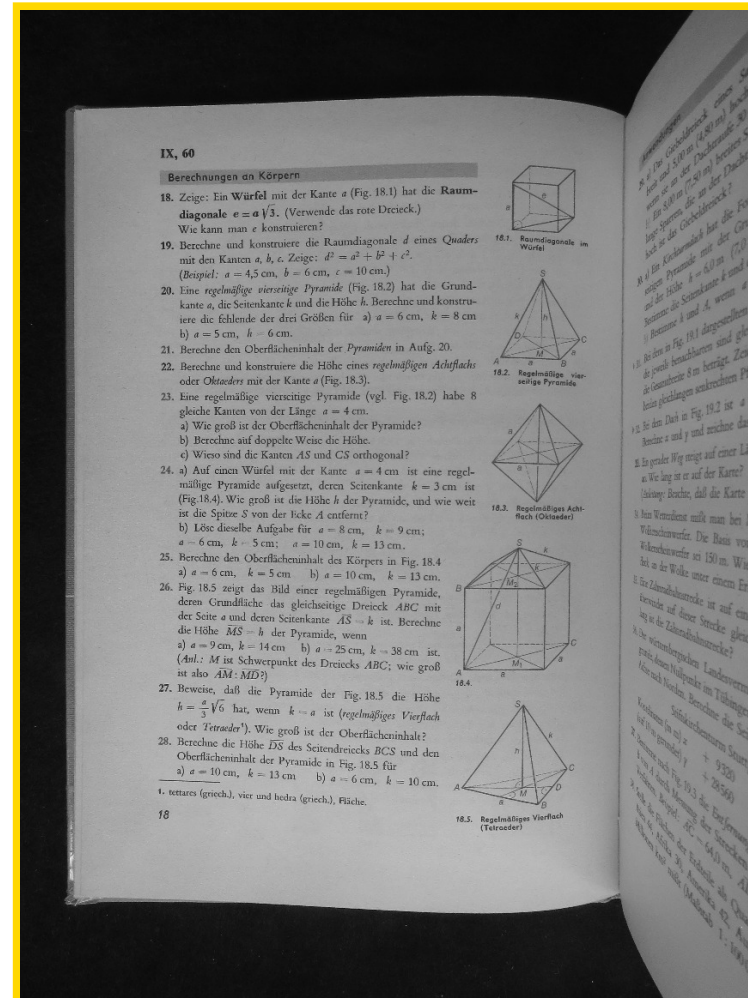
```
param    pnm src  
  
result pgm dst [aktive op color sRGB to gray $src]
```

AK TCL IMAGE VECTOR EXTENSION



AK TCL IMAGE VECTOR EXTENSION

GREY



AK TCL IMAGE VECTOR EXTENSION

DO-BINARIZE

```
param    pnm src  
  
set bw [active image mask per phansalkar $src radius 7]  
  
result pgm dst [active op math1 invert $bw]
```

AK TCL IMAGE VECTOR EXTENSION

AKTIVE IMAGE THRESHOLD PHANSALKAR

```
::aktive parameter validate          k 0 R 0 p 0 q 0 radius 0
::aktive parameter collect required radius
set k 0.25
set R 0.5
set p 3
set q 10
::aktive parameter collect optional k R p q

set e      [aktive op embed mirror $src left $radius right $radius top $radius b
set mean   [aktive op tile mean    $e radius $radius]
set std    [aktive op tile stddev $e radius $radius]

return [aktive op math mul    $mean [aktive op math add [aktive op math1 scale
```

AK TCL IMAGE VECTOR EXTENSION

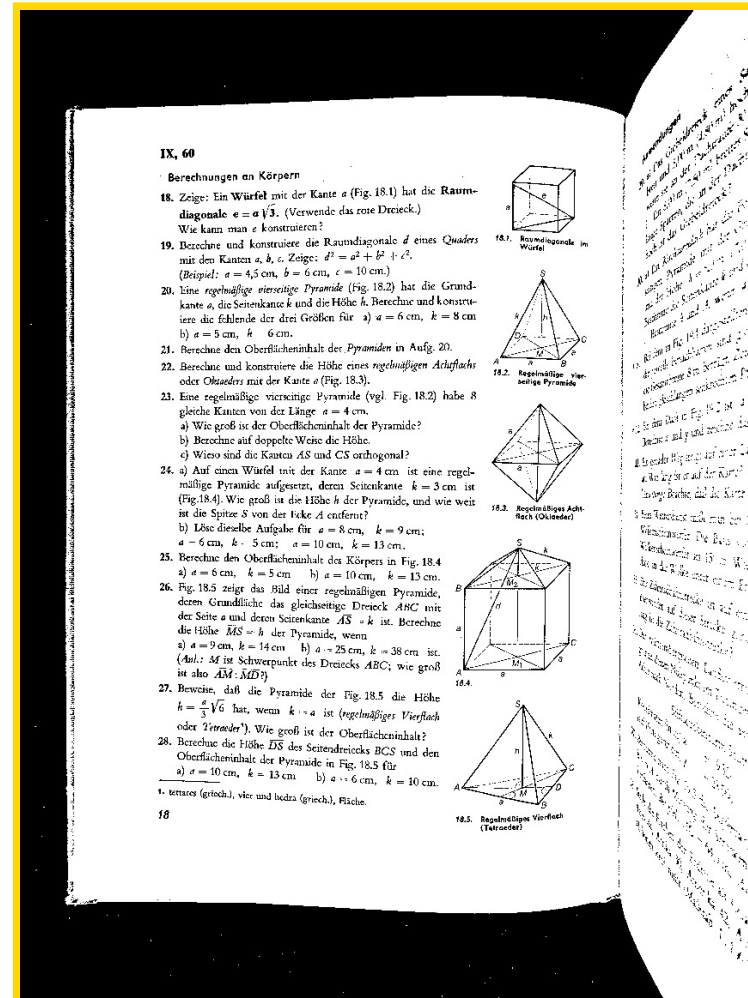
Phansalkar is an extension of Sauvola.

Which is a modification of Niblack.

See the [Craft Of Coding Blog Post](#)

AK TCL IMAGE VECTOR EXTENSION

BINARIZED



AK TCL IMAGE VECTOR EXTENSION

DO-GET-BORDERS

```
param    pnm src  
  
result  pgm dst [aktive op morph gradient internal $src]
```

AK TCL IMAGE VECTOR EXTENSION

AKTIVE OP MORPH GRADIENT INTERNAL

```
::aktive parameter validate          radius 0 embed 0
set radius 1
set embed black
::aktive parameter collect optional radius embed

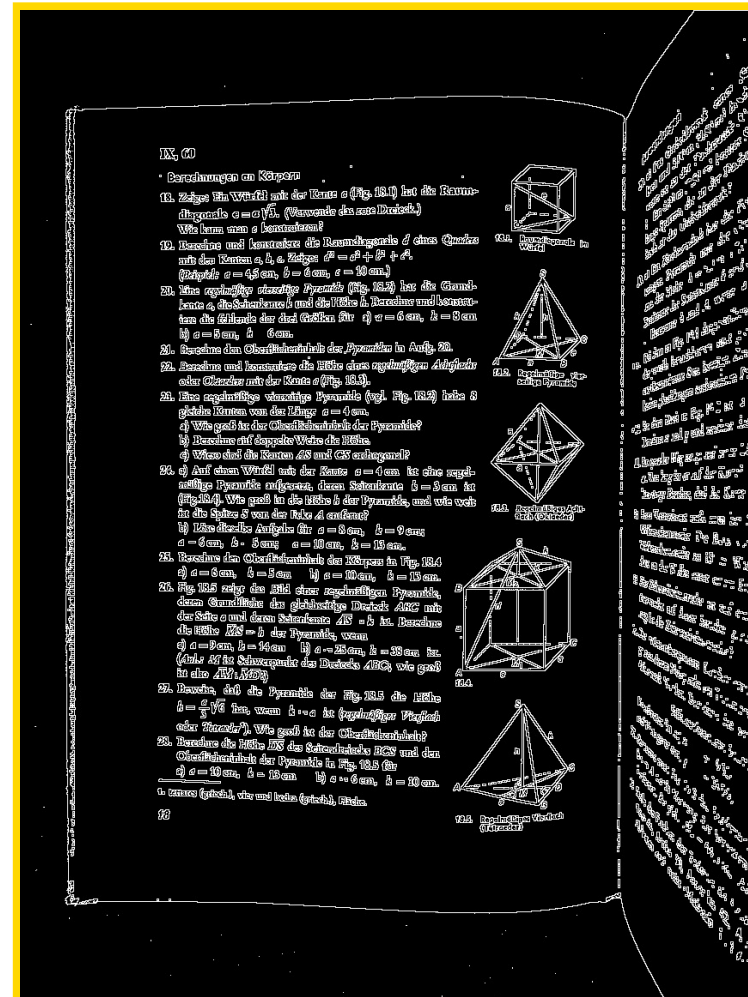
set e    [aktive op morph erode $src radius $radius embed $embed]
set src  [aktive op math sub $src $e]
```

AK TCL IMAGE VECTOR EXTENSION

- Issues?
 - Edge loss in going to grey & binarization?
 - Example: Coffee table books
 - Color content up to the page border
 - Color edge algorithms ?

AK TCL IMAGE VECTOR EXTENSION

BORDERS



AK TCL IMAGE VECTOR EXTENSION

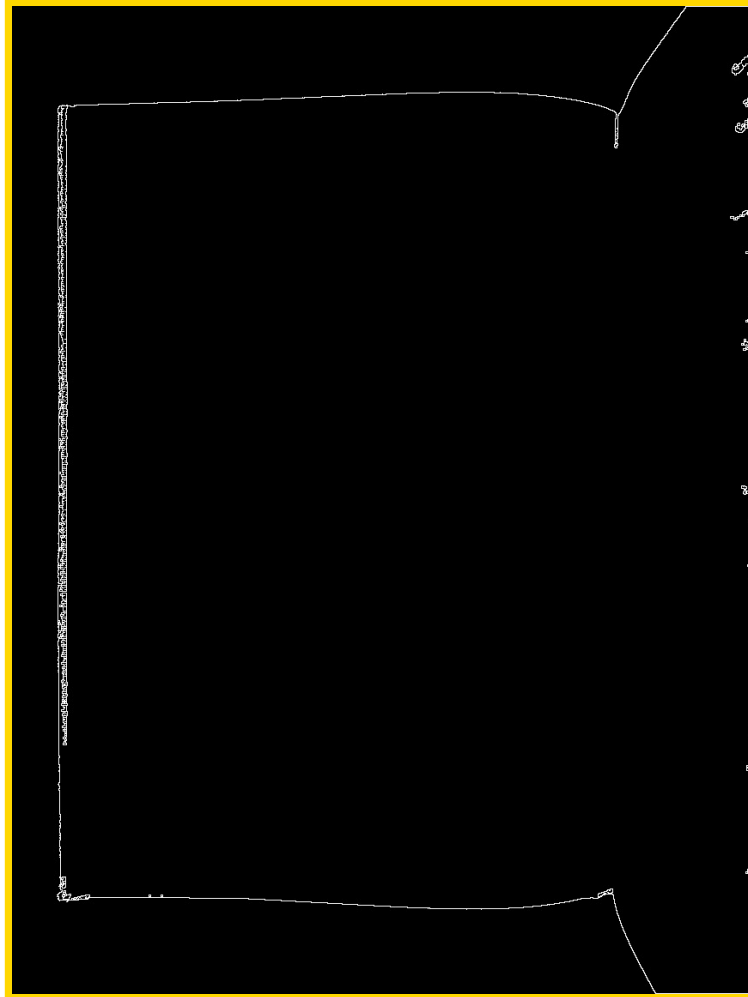
DO-SELECT

```
param pnm src

set ccs      [active op connected-components get $src]
set ccs      [region-bbox-max $ccs]
set ranges   [lsort -dict [lmap part [dict get $ccs 1 parts] {
    linsert $part end 1
}]]
set domain   [active query domain $src]
result pgm dst [active image from sparse ranges geometry $domain ranges {*} $ra
```

AK TCL IMAGE VECTOR EXTENSION

PRIMARY



AK TCL IMAGE VECTOR EXTENSION

DO-SHOW-BORDER

```
param pnm src  
param pnm border  
  
result ppm dst [overlay $src += $border yellow]
```

AK TCL IMAGE VECTOR EXTENSION

OVERLAY

```
lassign [aktive query domain $bg] _ _ w h  
  
set mask [aktive op morph dilate $mask radius 2]  
  
return [aktive op if-then-else $mask [{*}$color $w $h] $bg]
```

AK TCL IMAGE VECTOR EXTENSION

YELLOW

```
color $w $h yellow
```

AK TCL IMAGE VECTOR EXTENSION

COLOR

```
active image from color width $w height $h color $name
```

AK TCL IMAGE VECTOR EXTENSION

AKTIVE IMAGE FROM COLOR

```
::aktive parameter validate          x 0 y 0 width 0 height 0 color 0
::aktive parameter collect required width height color
set x 0
set y 0
::aktive parameter collect optional x y

set values [aktive color css $color]
band x $x y $y width $width height $height values {*} $values
```


AK TCL IMAGE VECTOR EXTENSION

DO-LEFT-PROFILE

```
param pnm  src
param rtxt geo

set profile [aktive op row profile $src]
set profile [aktive query values $profile]
set poly    [v-path-of $profile]

result      wtxt dstdata $poly
placeholder          dstshow
debugs {result pgm dstshow [draw-poly {*}$geo $poly]}
```

AK TCL IMAGE VECTOR EXTENSION

DRAW-POLY

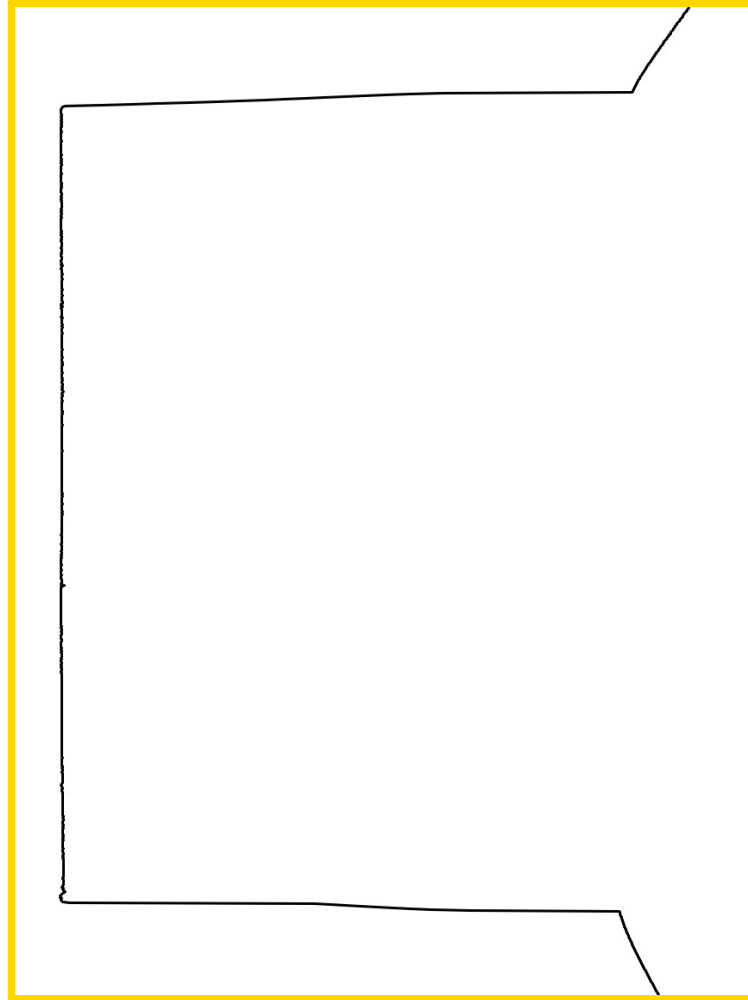
```
fat [aktive image sdf polyline width $w height $h points {*}$poly]
```

AK TCL IMAGE VECTOR EXTENSION

See Inigo Quilez's page about [2D distance functions](#)

AK TCL IMAGE VECTOR EXTENSION

LEFT PROFILE



AK TCL IMAGE VECTOR EXTENSION

DO-FIND-THRESHOLD

```
param rtxt profile
param rtxt geo

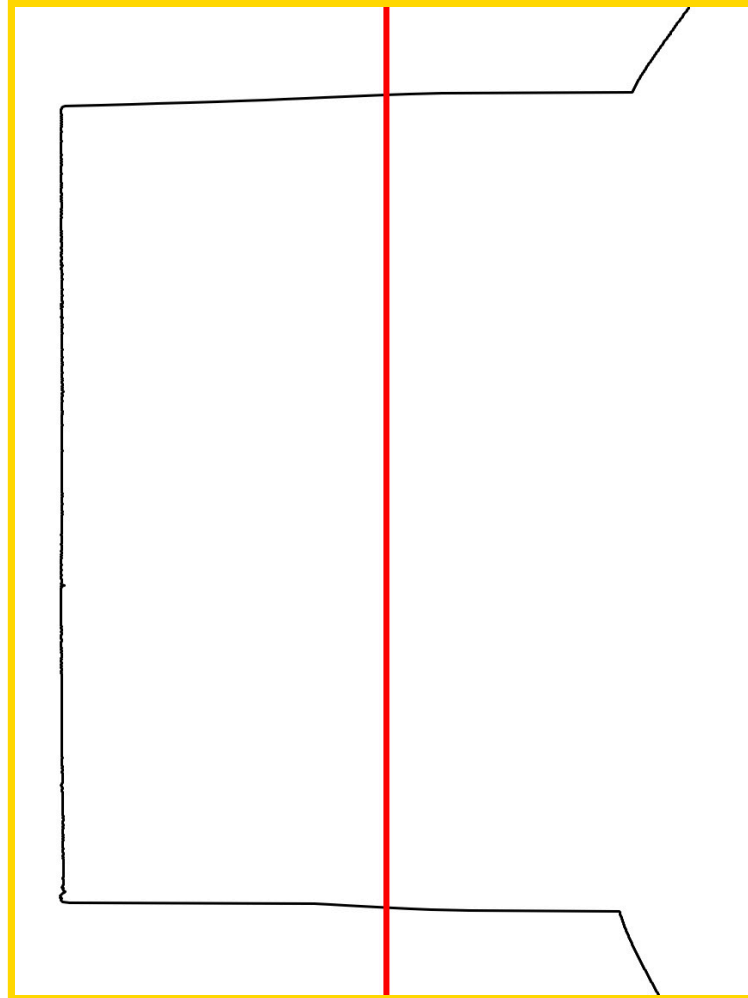
set threshold [expr {[lindex $geo 0]/2}]

if 0 {
    set xs [as-image [xs $profile]]
    set xs [active op math1 fit min-max $xs]
    set stretch [active meta get $xs stretch]
    set scale [dict get $stretch scale]
    set gain [dict get $stretch gain]
    set threshold [active image threshold global otsu $xs]
    set threshold [expr {($threshold - $gain)/double($scale)}]
}

result          wtxt dstdata $threshold
placeholder     dstshow
debugs {result pgm dstshow [draw-vertical {*}$geo $threshold]}
```

AK TCL IMAGE VECTOR EXTENSION

FIXED THRESHOLD



AK TCL IMAGE VECTOR EXTENSION

DO-APPLY-THRESHOLD

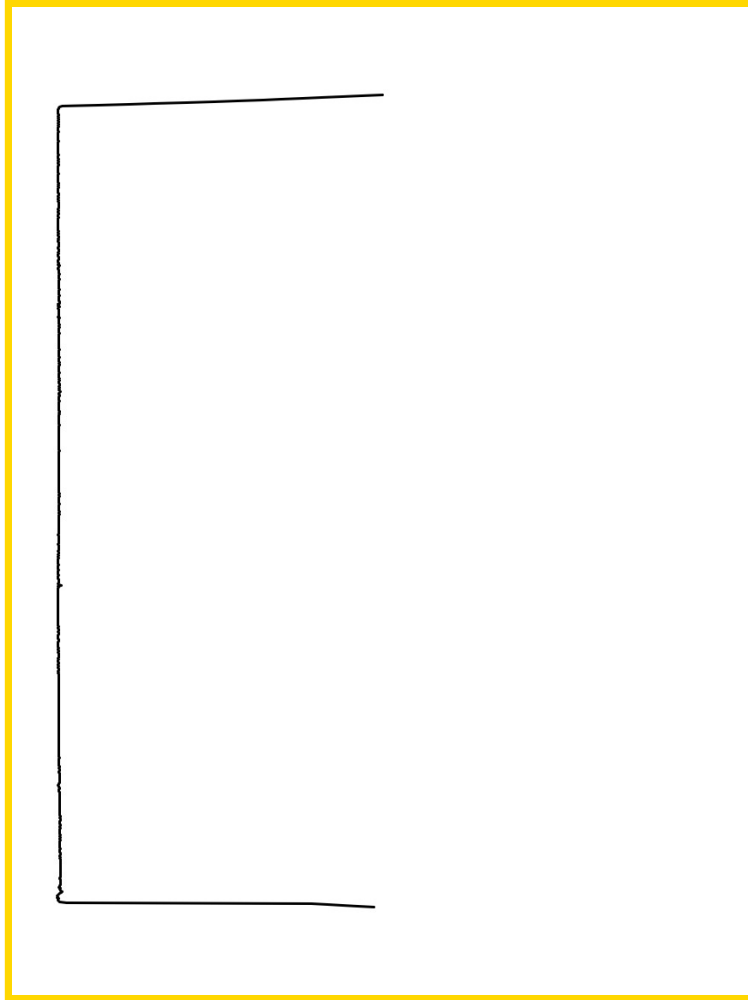
```
param rtxt profile
param rtxt geo
param rtxt threshold

set poly [{*}$selector $threshold $profile]

result          wtxt dstdata $poly
placeholder          dstshow
debugs {result pgm dstshow [draw-poly {*}$geo $poly]}
```

AK TCL IMAGE VECTOR EXTENSION

PROFILE INLIER



AK TCL IMAGE VECTOR EXTENSION

DO-FIT-VERTICAL-LINE

```
param rtxt profile
param rtxt geo

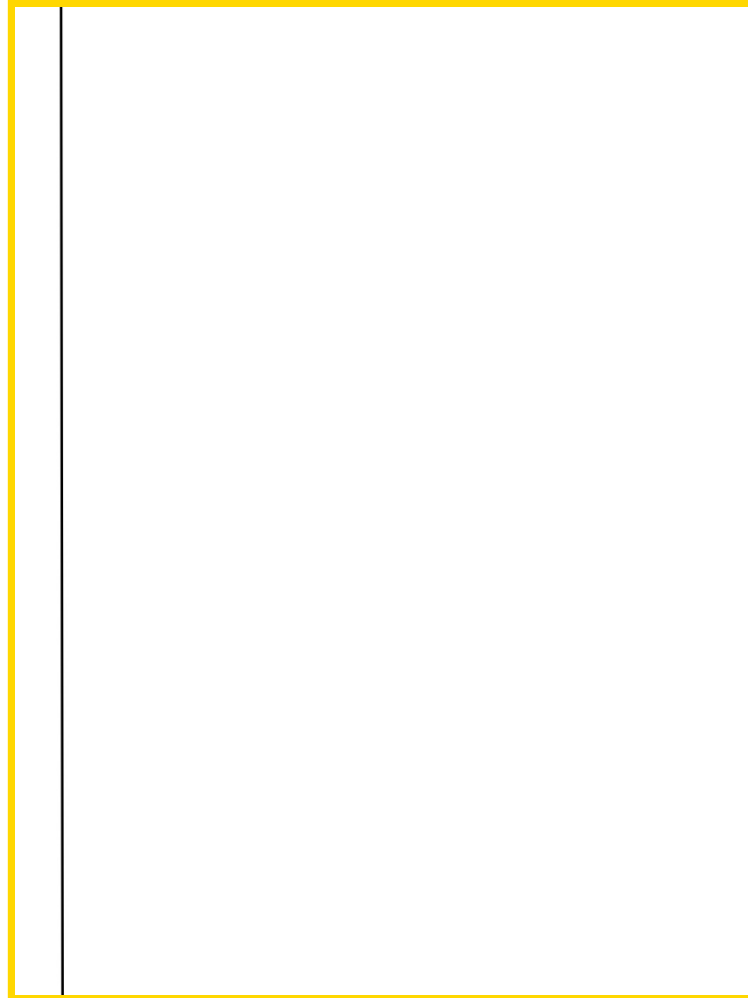
lassign $geo w h
lassign [linreg-v $profile] slope intercept

set a [lerp-pv $slope $intercept 0]
set b [lerp-pv $slope $intercept [expr {$h-1}]]
set hug [hugs-image-border $edge $w $a $b]

result          wtxt dstdata [list $slope $intercept $hug]
placeholder          dstshow
debugs {result pgm dstshow [draw-line $w $h $a $b]}
```

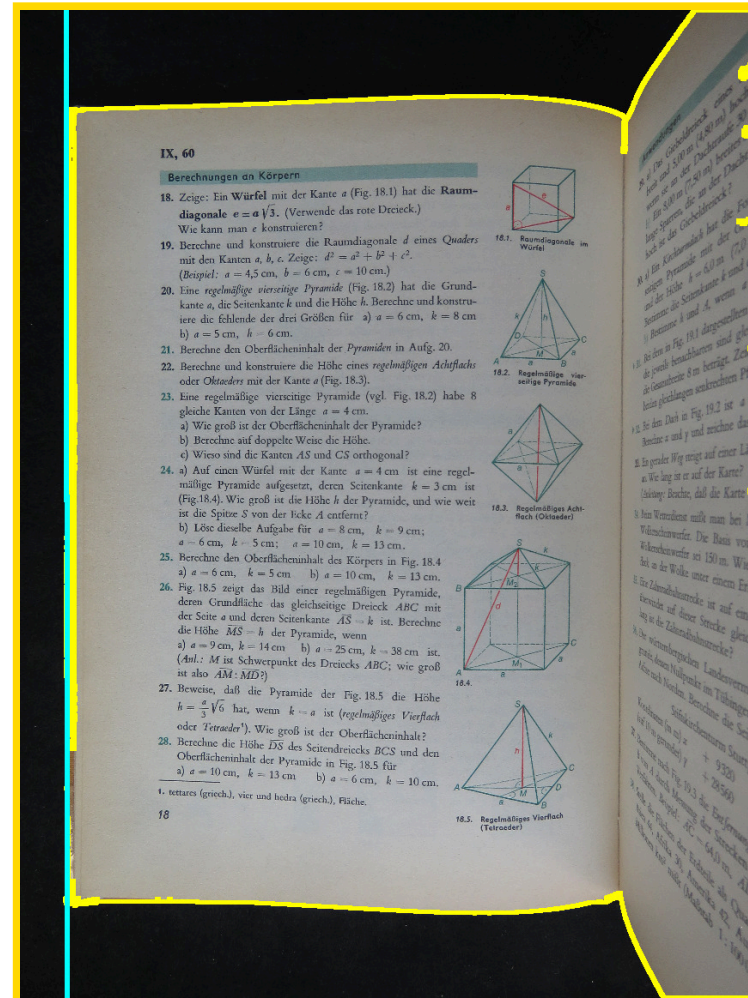
AK TCL IMAGE VECTOR EXTENSION

LEFT BORDER



AK TCL IMAGE VECTOR EXTENSION

SCALED + PRIMARY + LEFT BORDER



AK TCL IMAGE VECTOR EXTENSION

DO-TOP-PROFILE

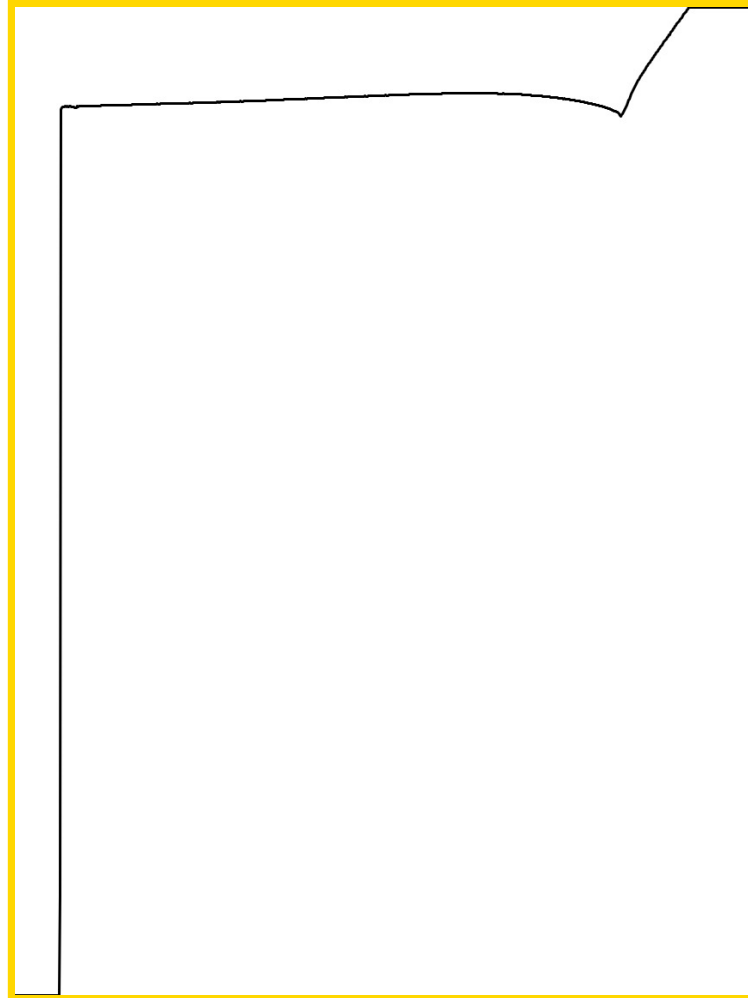
```
param pnm  src
param rtxt geo

set profile [aktive op column profile $src]
set profile [aktive query values $profile]
set poly    [h-path-of $profile]

result      wtxt dstdata $poly
placeholder          dstshow
debugs {result pgm dstshow [draw-poly {*}$geo $poly]}
```

AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE



AK TCL IMAGE VECTOR EXTENSION

DO-CUT-HORIZ

```
param rtxt geo
param rtxt top
param rtxt left
param rtxt right

lassign $left  lslope lintercept lhug
lassign $right rslope rintercept rhug
lassign [$cliffs $lhug $rhug $lslope $rslope] lcliff rcliff

set top  [limit-left  $lcliff $lslope $lintercept $top]
set top  [limit-right $rcliff $rslope $rintercept $top]

result          wtxt dstdata $top
placeholder          dstshow
debugs {result pgm dstshow [draw-poly {*}$geo $top]}
```

AK TCL IMAGE VECTOR EXTENSION

TOP-CLIFF

```
set lcliff [expr {!$lhug && ($lslope < 0)}]  
set rcliff [expr {!$rhug && ($rslope > 0)}]  
list $lcliff $rcliff
```

AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE L/R LIMITED



AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE + BASE LINE



AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE + BASE + SHEARED



AK TCL IMAGE VECTOR EXTENSION

DO-REFINE-HORIZ

```
param rtxt geo
param rtxt profile
param rtxt left
param rtxt right

lassign $left  lslope lintercept lhug
lassign $right rslope rintercept rhug

if {[llength $profile] > 10} {
    set profile [dehug $lhug $rhug $isbetter $profile]
}

result          wtxt dstdata $profile
placeholder          dstshow
debugs {result pgm dstshow [draw-poly {*}$geo $profile]}
```

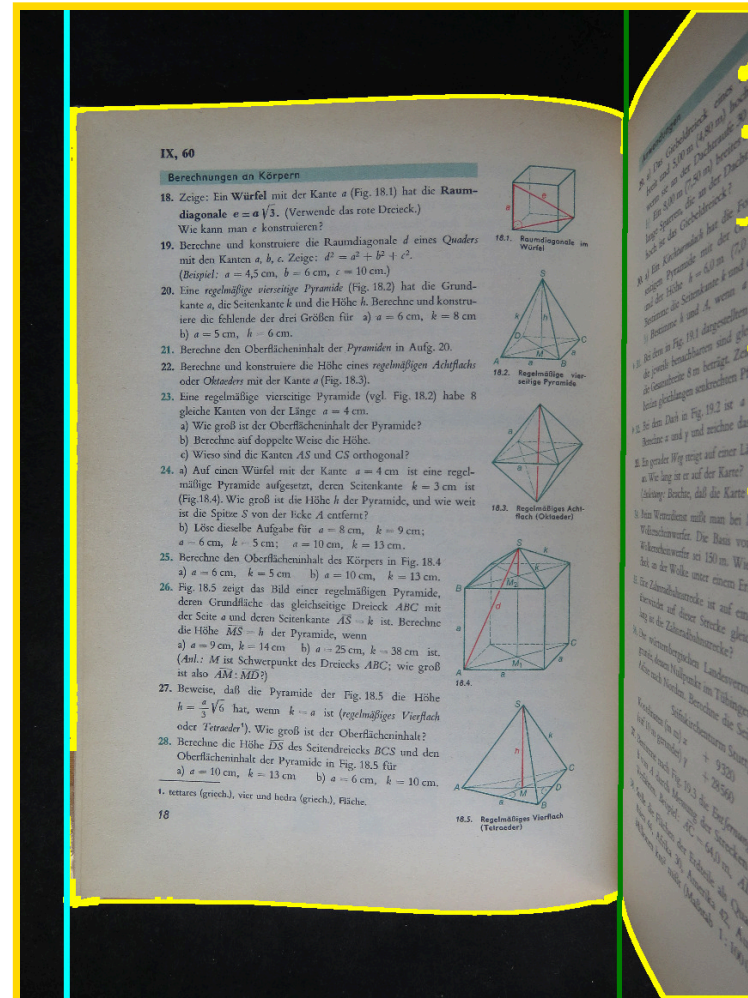
AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE REFINED



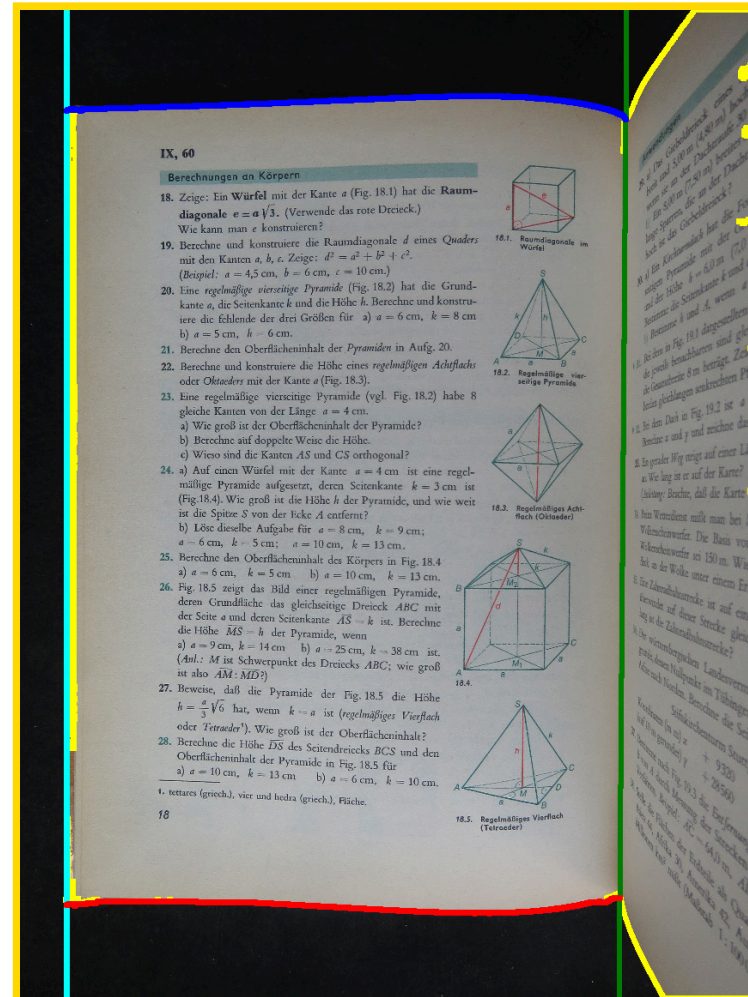
AK TCL IMAGE VECTOR EXTENSION

REFINED LEFT/RIGHT BORDERS



AK TCL IMAGE VECTOR EXTENSION

LEFT/RIGHT/TOP/BOTTOM BORDERS



AK TCL IMAGE VECTOR EXTENSION

DO-COLLECT-TANGENTS

```
param rtxt geo
param rtxt profile

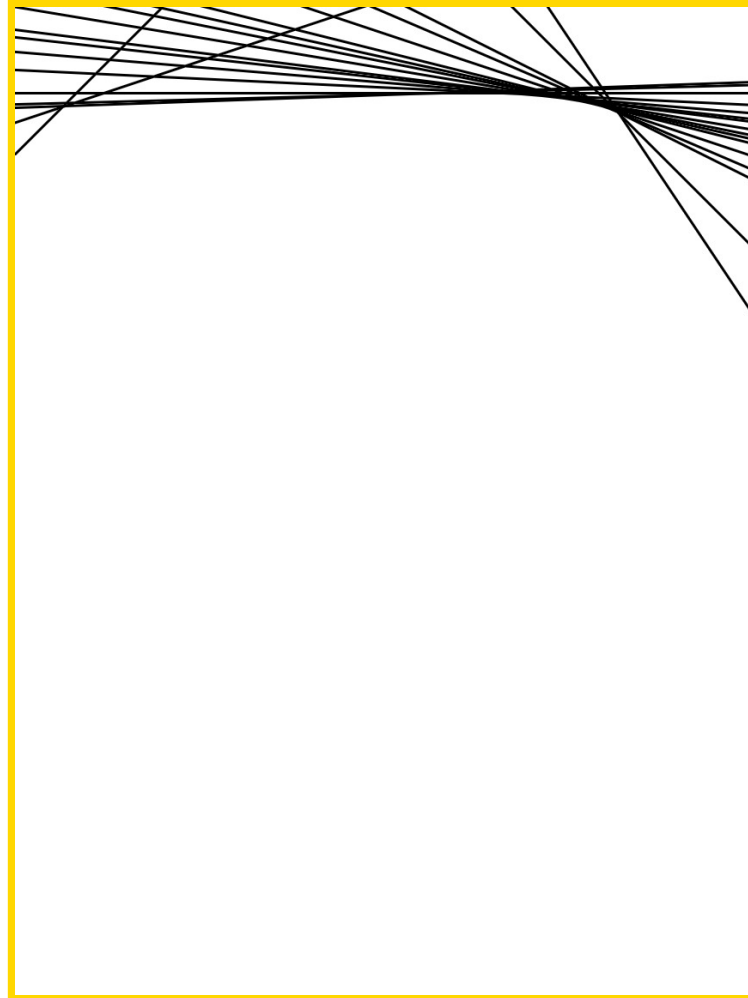
if {[llength $profile] > 100 } {
    set hullspec [join [list 2 [llength $profile] {*}]$profile] \n]
    set result    [exec qconvex Fx << $hullspec]
    set indices   [lassign [split [string trim $result] \n] n]
    set profile   [lmap i [lreverse $indices] { lindex $profile $i }]
}

set pairs       [pairs $profile]
set tangents    [filter $pairs $where $profile]
set tangents    [unique-tangents $tangents]

result         wtxt dstdata $tangents
placeholder    dstshow
debugs {
    lassign $geo w h
    result pgm dstshow [draw-lines $w $h [t-lines $w $tangents]]
}
```

AK TCL IMAGE VECTOR EXTENSION

TOP PROFILE TANGENTS



AK TCL IMAGE VECTOR EXTENSION

DO-CHOOSE-TANGENT

```
param rtxt geo
param rtxt profile
param rtxt tangents

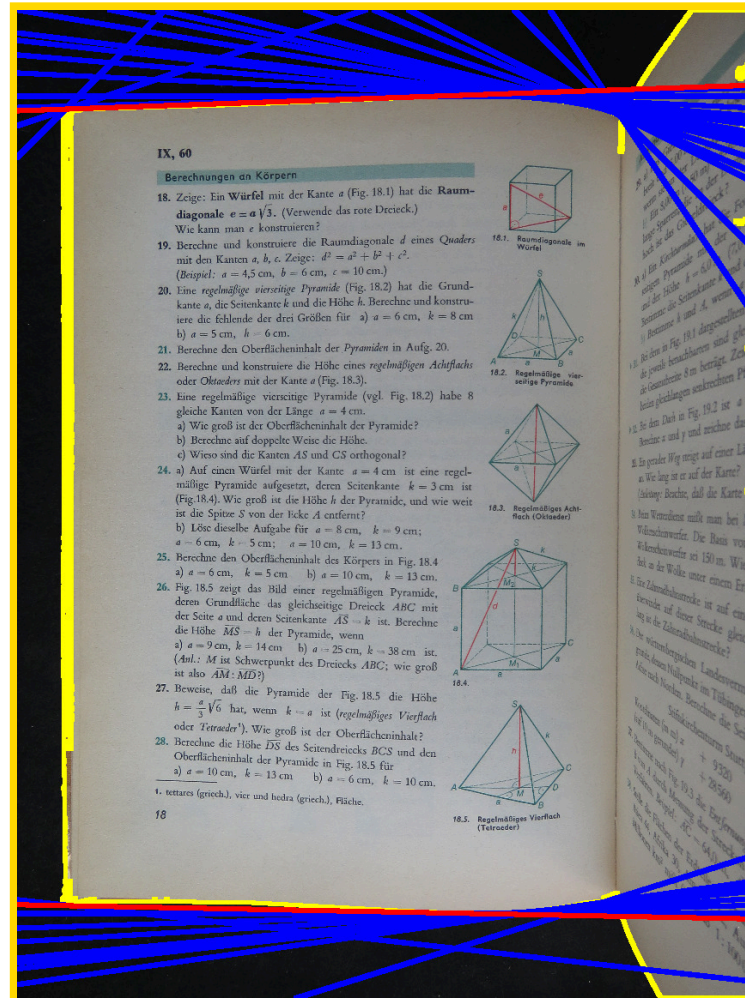
if {[llength $tangents]} return

set tareas [map $tangents line-area-delta $profile]
set best    [fold {} {} {} {} Inf} $tareas min-area]
lassign $geo w h
lassign [h-expand $w $best] a b

result      wtxt dstdata [list $a $b]
placeholder      dstshow
debugs {result pgm dstshow [draw-line $w $h $a $b]}
```

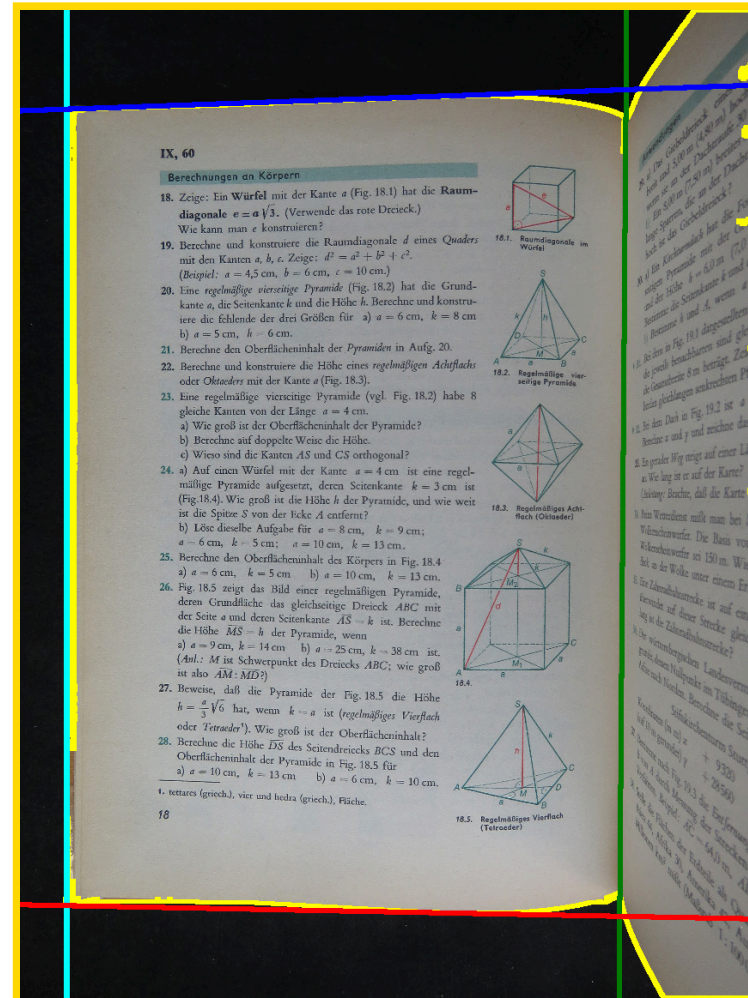
AK TCL IMAGE VECTOR EXTENSION

BORDER + TANGENTS + BEST



AK TCL IMAGE VECTOR EXTENSION

LEFT/RIGHT TOP/BOTTOM BOX



AK TCL IMAGE VECTOR EXTENSION

DO-FIT-QUADRILATERAL

```
param rtxt geo
param rtxt left
param rtxt right
param rtxt top
param rtxt bottom

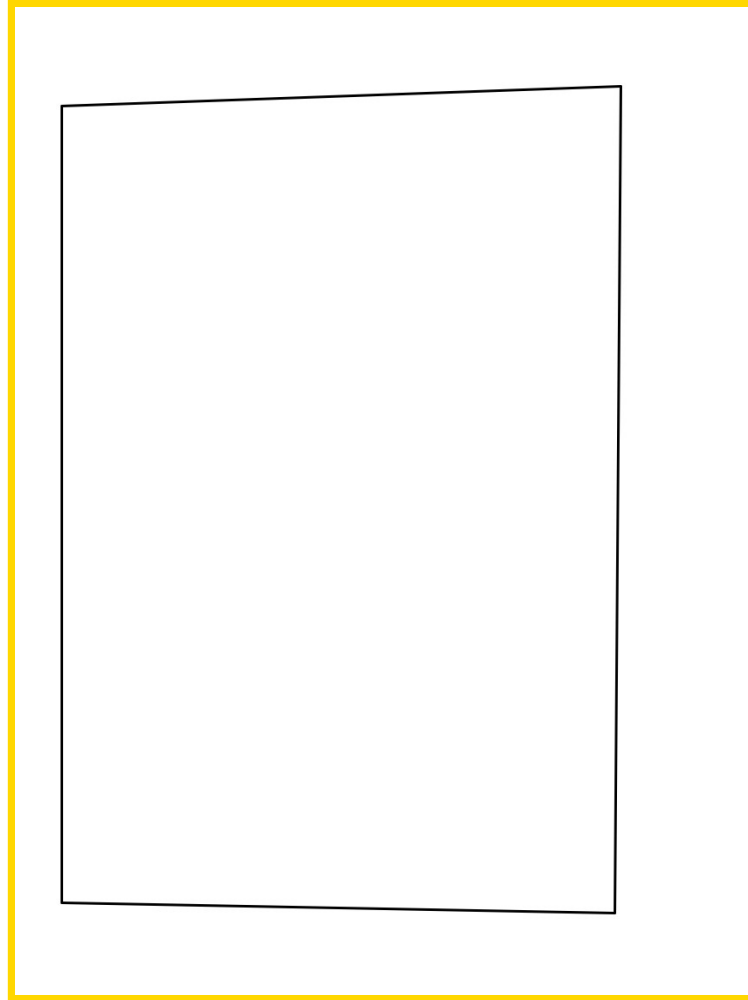
if {[catch {
    set i [intersect $a $d $e $f]
    set j [intersect $b $c $e $f]
    set k [intersect $b $c $g $h]
    set l [intersect $a $d $g $h]

    set poly      [list $i $j $k $l]
    set polyclose $poly ; lappend polyclose $i

    result          wtxt dstdata $poly
    placeholder      dstshow
    debugs {result pgm dstshow [draw-poly {*}$geo $polyclose]}
```

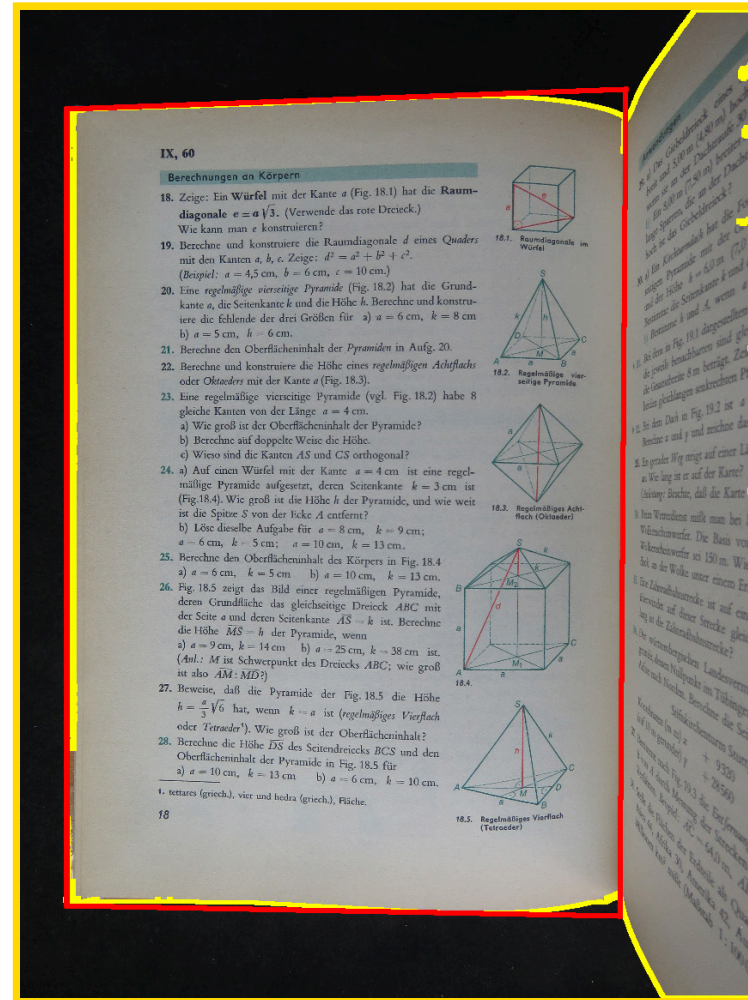
AK TCL IMAGE VECTOR EXTENSION

ENCLOSING QUADRILATERAL



AK TCL IMAGE VECTOR EXTENSION

BORDER + BOX



AK TCL IMAGE VECTOR EXTENSION

DO-RECTIFY

```
param pnm src
param rtxt quad
param rtxt top ; set top [sup $top]
param rtxt bottom ; set bottom [sup $bottom]

lassign [active query domain $src] _ _ w h
lassign $quad i j k l

set quad [active transform quad unit2 a $i b $j c $k d $l]
set iquad [active transform invert $quad]
set scale [active transform scale x $w y $h]
set transform [active transform compose $scale $iquad]
set rect [active op transform by $transform $src]
set top [active transform points $transform series {*} $top]
set bottom [active transform points $transform series {*} $bottom]

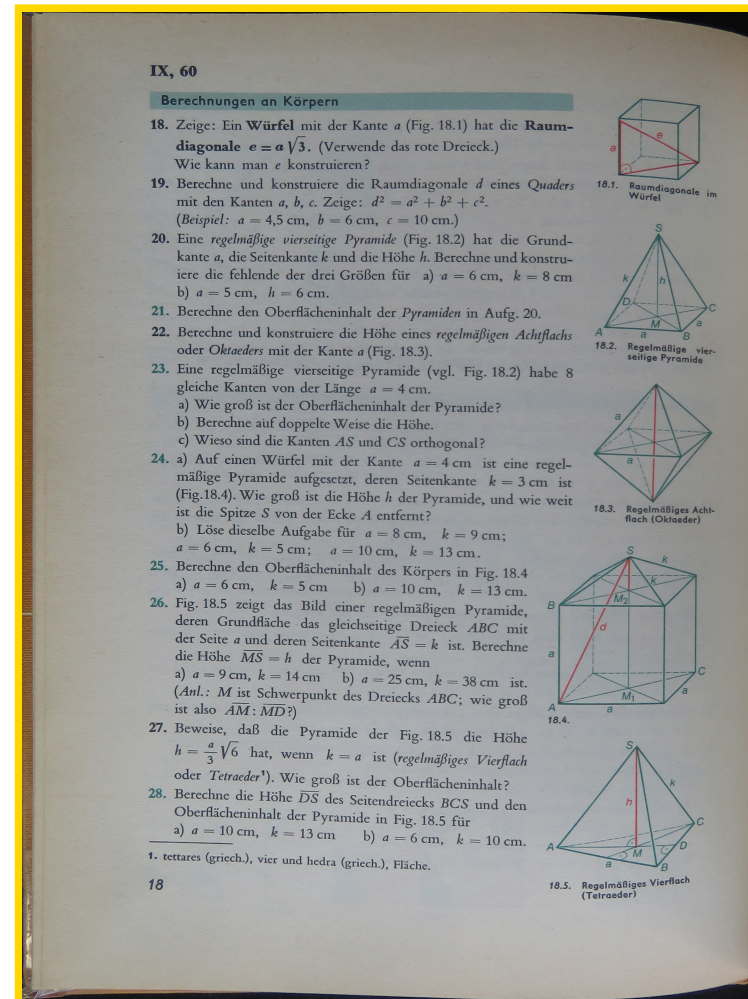
result ppm dst [active op view $rect port [list 0 0 $w $h]]
result wtxt tresidue $top
result wtxt bresidue $bottom
debugs {result pgm tshow [draw-poly $w $h $top]}
```

AK TCL IMAGE VECTOR EXTENSION

AKTIVE documentation; quadrilateral warping

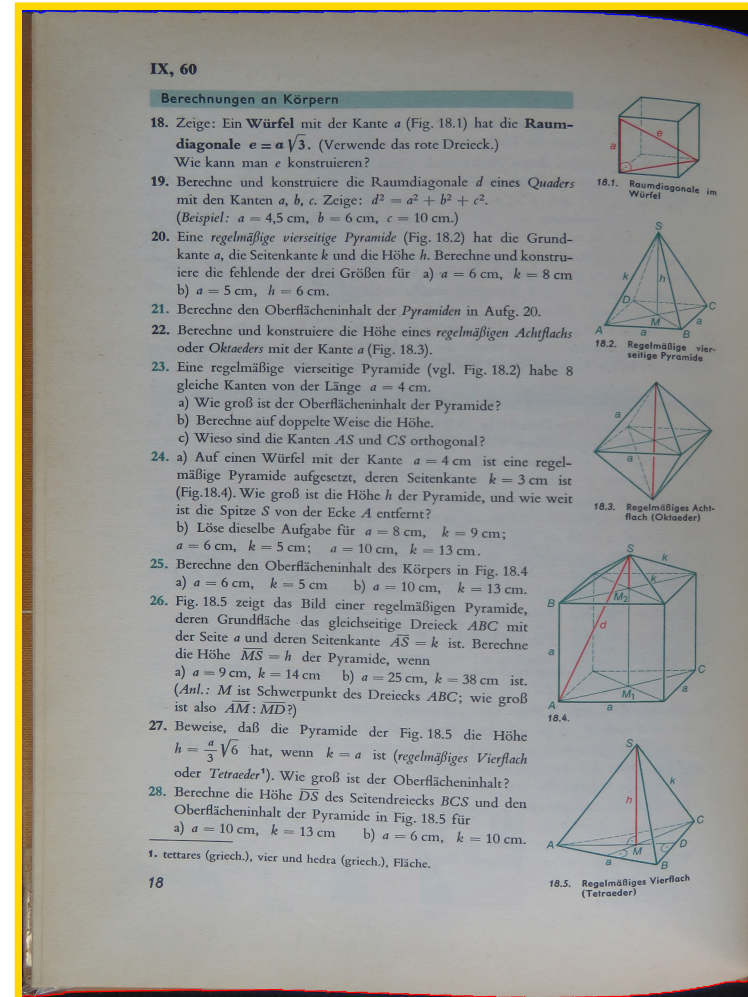
AK TCL IMAGE VECTOR EXTENSION

RECTIFIED PAGE 3456 X 4608



AK TCL IMAGE VECTOR EXTENSION

RECTIFIED + RESIDUALS



AK TCL IMAGE VECTOR EXTENSION

Book Geometry-2--1970--Lambacher-Schweizer--Ernst-Klett-Verlag-Stuttgart

Exit

Help Catalog Sheets Issues Jobs Export

1970 | hardcover | Geometry 2

All Ignored Book Unnumbered Worksheet --Worksheet Load Save 184 Shotorder

Id Kind Page Pic Text Flags Bad

20240921-130122-5515.jpg	page	104		general	-0---RCWT	
20240921-130125-5516.jpg	page	102		general	-0---RCWT	
20240921-130129-5517.jpg	page	100		general	-0---RCWT	
20240921-130135-5518.jpg	page	98		general	-0---RCWT	
20240921-130139-5519.jpg	page	96		general	-0---RCWT	
20240921-130143-5520.jpg	page	94		general	-0---RCWT	
20240921-130147-5521.jpg	page	92		general	-0---RCWT	
20240921-130153-5522.jpg	page	90		general	-0---RCWT	
20240921-130156-5523.jpg	page	88		general	-0---RCWT	
20240921-130200-5524.jpg	page	86		general	-0---RCWT	
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Berechnungen an Körpern.

18. Zeige: Ein Würfel mit der Kante a (Fig. 18.1) hat die Raumdiagonale $e = a\sqrt{3}$. (Verwende das rote Dreieck.) Wie kann man e konstruieren?

19. Berechne und konstruiere die Raumdiagonale d eines Quaders mit den Kanten a, b, c . Zeige: $d^2 = a^2 + b^2 + c^2$. (Beispiel: $a = 4.5$ cm, $b = 6$ cm, $c = 10$ cm.)

20. Eine regelmäßige vierseitige Pyramide (Fig. 18.2) hat die Grundkante a , die Seitenkante k und die Höhe h . Berechne und konstruiere die fehlende der drei Größen für a) $a = 6$ cm, $k = 8$ cm b) $a = 5$ cm, $h = 6$ cm.

21. Berechne den Oberflächeninhalt der Pyramide in Aufg. 20.

22. Berechne und konstruiere die Höhe eines regelmäßigen Achsecks oder Oktaeders mit der Kante a (Fig. 18.3).

23. Eine regelmäßige vierseitige Pyramide (vgl. Fig. 18.2) habe 8 gleiche Kanten von der Länge $a = 4$ cm.

a) Wie groß ist der Oberflächeninhalt der Pyramide?

b) Berechne auf doppelte Weise die Höhe.

c) Wisse und die Kanten AS und CS orthogonal?

24. a) Auf einen Würfel mit der Kante $a = 4$ cm ist eine regelmäßige Pyramide aufgesetzt, deren Seitenkante $k = 3$ cm ist (Fig. 18.4). Wie groß ist die Höhe h der Pyramide, und wie weit ist die Spitze S von der Ecke A entfernt?

b) Löse dieselbe Aufgabe für $a = 8$ cm, $k = 9$ cm; $a = 6$ cm, $k = 5$ cm; $a = 10$ cm, $k = 13$ cm.

25. Berechne den Oberflächeninhalt der Körper in Fig. 18.4 a) $a = 6$ cm, $k = 5$ cm b) $a = 10$ cm, $k = 13$ cm.

26. Fig. 18.5 zeigt das Bild einer regelmäßigen Pyramide, deren Grundfläche das gleichseitige Dreieck ABC mit der Seite a und deren Seitenkante $AS = k$ ist. Berechne die Höhe $AS = h$ der Pyramide, wenn a) $a = 9$ cm, $k = 14$ cm b) $a = 25$ cm, $k = 38$ cm ist. (Hinl.: M ist Schwerpunkt des Dreiecks ABC ; wie groß ist also AM , MD ?)

27. Beweise, daß die Pyramide der Fig. 18.5 die Höhe $h = \frac{\sqrt{3}}{6} a$ hat, wenn $k = a$ ist (regelmäßiges Vierfläch oder Tetraeder). Wie groß ist der Oberflächeninhalt?

28. Berechne die Höhe DS des Sechsecks BCS und den Oberflächeninhalt der Pyramide in Fig. 18.5 für a) $a = 10$ cm, $k = 13$ cm b) $a = 5$ cm, $k = 10$ cm.

18.1. Regelmäßige vierseitige Pyramide (Tetraeder).

18.2. Regelmäßige vierseitige Pyramide.

18.3. Regelmäßiges Achteck (Oktaeder).

18.4. Regelmäßige vierseitige Pyramide auf einem Würfel.

18.5. Regelmäßiges Vierfläch (Tetraeder).

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Berechnungen an Körpern

18. Zeige: Ein Würfel mit der Kante a (Fig. 18.1) hat die Raumdiagonale $\sigma = a\sqrt{3}$. (Verwende das rote Dreieck.) Wie kann man σ konstruieren?

19. Berechne und konstruiere die Raumdiagonale d eines Quaders mit den Kanten a, b, c . Zeige: $d^2 = a^2 + b^2 + c^2$. (Beispiel: $a = 4,5 \text{ cm}$, $b = 6 \text{ cm}$, $c = 10 \text{ cm}$.)

20. Eine regelmäßige vierseitige Pyramide (Fig. 18.2) hat die Grundkante a , die Seitenkante k und die Höhe h . Berechne und konstruiere die fehlende der drei Größen für a) $a = 6 \text{ cm}$, $k = 8 \text{ cm}$ b) $a = 5 \text{ cm}$, $h = 6 \text{ cm}$.

21. Berechne den Oberflächeninhalt der Pyramiden in Aufg. 20.

22. Berechne und konstruiere die Höhe eines regelmäßigen Achtfachs oder Oktaeders mit der Kante a (Fig. 18.3).

23. Eine regelmäßige vierseitige Pyramide (vgl. Fig. 18.2) habe 8 gleiche Kanten von der Länge $a = 4 \text{ cm}$. a) Wie groß ist der Oberflächeninhalt der Pyramide? b) Berechne auf doppelte Weise die Höhe. c) Wieso sind die Kanten AS und CS orthogonal?

24. a) Auf einen Würfel mit der Kante $a = 4 \text{ cm}$ ist eine regelmäßige Pyramide aufgesetzt, deren Seitenkante $k = 3 \text{ cm}$ ist (Fig. 18.4). Wie groß ist die Höhe h der Pyramide, und wie weit ist die Spitze S von der Ecke A entfernt? b) Löse dieselbe Aufgabe für $a = 8 \text{ cm}$, $k = 9 \text{ cm}$; $a = 6 \text{ cm}$, $k = 5 \text{ cm}$; $a = 10 \text{ cm}$, $k = 13 \text{ cm}$.

25. Berechne den Oberflächeninhalt des Körpers in Fig. 18.4 a) $a = 6 \text{ cm}$, $k = 5 \text{ cm}$ b) $a = 10 \text{ cm}$, $k = 13 \text{ cm}$.

26. Fig. 18.5 zeigt das Bild einer regelmäßigen Pyramide, deren Grundfläche das gleichschenkelige Dreieck ABC mit der Seite a und deren Seitenkante $AS = k$ ist. Berechne die Höhe $MS = h$ der Pyramide, wenn a) $a = 9 \text{ cm}$, $k = 14 \text{ cm}$ b) $a = 25 \text{ cm}$, $k = 38 \text{ cm}$ ist. (Anl.: M ist Schwerpunkt des Dreiecks ABC ; wie groß ist also $AM:MD$?)

27. Beweise, daß die Pyramide der Fig. 18.5 die Höhe $h = \frac{\sqrt{3}}{2}a$ hat, wenn $k = a$ ist (regelmäßiges Vierfläch oder Tetraeder). Wie groß ist der Oberflächeninhalt?

28. Berechne die Höhe DS des Seitendreiecks BDS und den Oberflächeninhalt der Pyramide in Fig. 18.5 für a) $a = 10 \text{ cm}$, $k = 13 \text{ cm}$ b) $a = 6 \text{ cm}$, $k = 10 \text{ cm}$.

1. tetrares (griech.), vier und hedra (griech.), Fläche.

18

18.1. Raumdiagonale im Würfel

18.2. Regelmäßige vierseitige Pyramide

18.3. Regelmäßiges Achtfach (Oktaeder)

18.4.

18.5. Regelmäßiges Vierfläch (Tetraeder)

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22. Berechne und konstruiere die Höhe eines regelmäßigen Achtfaches oder Oktaeders mit der Kante a (Fig. 18.3).

23. Eine regelmäßige vierseitige Pyramide (vgl. Fig. 18.2) habe 8 gleiche Kanten von der Länge $a = 4 \text{ cm}$. a) Wie groß ist der Oberflächeninhalt der Pyramide? b) Berechne auf doppelte Weise die Höhe. c) Wieso sind die Kanten AS und CS orthogonal?

24. a) Auf einen Würfel mit der Kante $a = 4 \text{ cm}$ ist eine regelmäßige Pyramide aufgesetzt, deren Seitenkante $k = 3 \text{ cm}$ ist (Fig. 18.4). Wie groß ist die Höhe h der Pyramide, und wie weit ist die Spitze S von der Ecke A entfernt? b) Löse dieselbe Aufgabe für $a = 8 \text{ cm}$, $k = 9 \text{ cm}$; $a = 6 \text{ cm}$, $k = 5 \text{ cm}$; $a = 10 \text{ cm}$, $k = 13 \text{ cm}$.

25. Berechne den Oberflächeninhalt des Körpers in Fig. 18.4 a) $a = 6 \text{ cm}$, $k = 5 \text{ cm}$ b) $a = 10 \text{ cm}$, $k = 13 \text{ cm}$.

26. Fig. 18.5 zeigt das Bild einer regelmäßigen Pyramide, deren Grundfläche das gleichseitige Dreieck ABC mit der Seite a und deren Seitenkante $AS = k$ ist. Berechne die Höhe $MS = h$ der Pyramide, wenn a) $a = 9 \text{ cm}$, $k = 14 \text{ cm}$ b) $a = 25 \text{ cm}$, $k = 38 \text{ cm}$ ist. (Anl.: M ist Schwerpunkt des Dreiecks ABC ; wie groß ist also $AM:MD$?)

27. Beweise, daß die Pyramide der Fig. 18.5 die Höhe $h = \frac{a}{\sqrt{6}}$ hat, wenn $k = a$ ist (regelmäßiges Vierfläch oder Tetraeder). Wie groß ist der Oberflächeninhalt?

28. Berechne die Höhe DS des Sechsecks BCS und den Oberflächeninhalt der Pyramide in Fig. 18.5 für a) $a = 10 \text{ cm}$, $k = 13 \text{ cm}$ b) $a = 6 \text{ cm}$, $k = 10 \text{ cm}$.

1. tetrares (griech.), vier und hedra (griech.), Fläche.

18

18.1. Regelmäßige Pyramide in Würfel

18.2. Regelmäßige vierseitige Pyramide

18.3. Regelmäßiges Achtfach (Oktaeder)

18.4.

18.5. Regelmäßiges Vierfläch (Tetraeder)

AK TCL IMAGE VECTOR EXTENSION

Exit

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Comments

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- Future Work



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- Future Work
 - Generally



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- Future Work
 - Generally
 - Benchmarking
 - FFT
 - Hough Transform
 - Hit/Miss Transform
 - More file formats
 - Matrix ops
 - Image Smoothing via L_0 Gradient Minimization
 - ...



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- Future Work
 - Generally
 - Demo Task



AK TCL IMAGE VECTOR EXTENSION

- Future Work
 - Generally
 - Demo Task
 - Color edges for better borders?
 - Remove residual curvature
 - Blank page detection
 - Text/Image Segmentation
 - OCR



AK TCL IMAGE VECTOR EXTENSION

- Future Work
 - Generally
 - Demo Task
 - Color edges for better borders?
 - Remove residual curvature
 - Forward transform profiles
 - Profile approximations (spline, cubic, ...)
 - Unwarp along the approximation
 - Blank page detection
 - Text/Image Segmentation
 - OCR



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- Questions ? ...



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Warp Core

op warp bicubic

op warp bilinear

op warp lanczos

op warp near-neighbour



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Warp Origins

warp matrix

warp 2cartesian

warp 2polar

warp noise gauss

warp noise uniform

warp swirl

warp wobble



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Warp Origins	Warpers
warp matrix	op transform by
warp 2cartesian	effect 2cartesian
warp 2polar	effect 2polar
warp noise gauss	effect jitter gauss
warp noise uniform	effect jitter uniform
warp swirl	effect swirl
warp wobble	effect wobble



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transform ...

... projective

... identity

... reflect x

... affine

... translate

... reflect y

... scale

... reflect line

... compose

... rotate

... quad 2quad

... invert

... shear

... quad unit2

... point

... points

... domain

