বাংলাদেশ ইউনিভার্সিটি অব প্রফেশনালস্

সেকশন/গ্রুপ B (Section-B)

ইনভিজিলেটরের স্বাক্ষর

মোট পৃষ্ঠা সংখ্যা 13 টি

BSc. in CSE-17 Final Exam (Fall), Dec-2020 পরীক্ষা(Examination), 20 20

বিষয় (Subj): Computer Graphics পত্র/কোর্স নং (Paper/Course No): CSE-413

পত্র/কোর্সের নাম (Paper/Course Name): CSE-17 কেন্দ্র (Center): MIST

রেজিঃ নম্বর (Regn No): 1314011170018 শিক্ষাবর্ষ (Session): 2019-2020

রোল নম্বর (Roll No): 201714018 তারিখ (Date): 20-12-2020

INSTRUCTIONS FOR EXAMINEE

1. Examinees are forbidden to write their names either on outer cover page or anywhere of the answer scripts. In case of violation, the answer script will not be evaluated.
2. Examinees must mention their roll and registration number along with session on the outer cover page of the answer scripts clearly. Otherwise, answer scripts may not be evaluated.
3. Students will write his examination roll number on the top left corner and section-A/B on the top right corner of each page. All pages must be numbered chronologically at the bottom center in x of y format. (for example: 1 of 21)
4. All rough works should be done in the same paper used as answer scripts. Answer scripts should be submitted intact. Papers used for rough work should be pen through by the examinees.
5. In no case, an examinee will be allowed to start the examination half an hour after the commencement of examination.
6. Examinees must abide by the instructions of chief invigilator if there are no definite instructions on any subject/matter.
7. No examinee will be allowed to leave the examination session until an hour has elapsed from the commencement of examination.
8. Legal action will be taken against the examinees those are caught for copying and found guilty for any breach of discipline as per rule.

পরীক্ষক কর্তৃক পূরণীয়

প্রশ্ন নম্বর	প্রদত্ত নম্বর
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পরীক্ষকের স্বাক্ষর

নিরীক্ষকের স্বাক্ষর

Continued......

INSTRUCTIONS FOR EXAMINEE

9. Smoking is strictly prohibited during examination.

10. The Camera of the examinee MUST always be ON during the examination and answer script submission. If Camera is OFF then that online examination will be treated as CANCELLED.

11. The answer scripts submitted beyond specified time will be treated as CANCELLED.

12. The examinee has to share his/her computer screen to the invigilator throughout the examination time.

13. The focus of the camera should be such that the invigilator(s) can see the script and examinee with his/her surroundings.

14. The examinee will send his/her scanned examination script in PDF format to the following e-mail addresses:

    (a) e-mail address of subject invigilator/examiner.

    (b) Central Database Scheme (coursecode@mist.ac.bd)
    Example: EECE433@mist.ac.bd

15. The examinee has to preserve the original answer script of every examination and be ready to submit whenever asked for.

16. Answer script should be the A4 size papers with a cover page provided by Department. Examinee has to fill up his/her necessary details on the cover page. Section A and section B must be clearly marked on the cover page like. **Section A** or **Section B**

17. Examination duration for each subject will be two hours (section-A for one hour + section B for One hour). In between students will get 20 minutes time to submit the answer script of section A and 10 minutes time to issue the question for section B . After completion of 01 hour examination time for section B, students will get 20 minutes to submit the answer script of section B.

18. After completion of written examination (online/physical), viva will be conducted by the respective faculty of that subject.

Section-B

Ans. to the ques. no.-05(a)

First we determine the Projection matrix for camera at Origin (0,0,0) then we translate:

Consider the figure on the right side. we get:

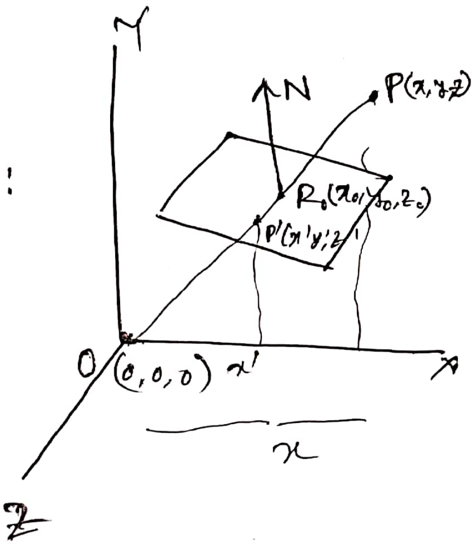


Fig-1: Projection matrix.

From:
P and P' are; P' is the projection of P on the plane (R_0, N) which is defined by (R_0, N) (we can get R_0, N from plane equation).

P and P' are on the same line so we can write:

$$\alpha OP = OP'$$

$$\Rightarrow \alpha x = x' \qquad [OP = x, OP' = x']$$

$$\Rightarrow x' = \alpha x$$

Similarly we can write,

$$y' = \alpha y \text{ and}$$

$$z' = \alpha z.$$

P.T.O.

Again, we can write, since $\overrightarrow{P'R_0}$ and $\vec{N}$ are perpendicular,

$$\overrightarrow{P'R_0} \cdot \vec{N} = 0$$

$$\Rightarrow (P' - R_0)\vec{N} = 0$$

$$\Rightarrow P' \cdot \vec{N} = R_0 \cdot \vec{N}$$

$$\Rightarrow x'n_1 + y'n_2 + z'n_3 = x_0 n_1 + y_0 n_2 + z_0 n_3$$

Here, $\vec{N} = n_1 \hat{i} + n_2 \hat{j} + n_3 \hat{k}$

and, $x_0 n_1 + y_0 n_2 + z_0 n_3 = d_0$ [since const]

$$\Rightarrow x'n_1 + y'n_2 + z'n_3 = d_0$$

$$\Rightarrow \alpha x n_1 + \alpha y n_2 + \alpha z n_3 = d_0 \quad \left[\begin{array}{l} x' = \alpha x \\ y' = \alpha y \\ z' = \alpha z \end{array} \right]$$

$$\Rightarrow \alpha = \frac{d_0}{x n_1 + y n_2 + z n_3}$$

So, the projection matrix:

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} \alpha x \\ \alpha y \\ \alpha z \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{d_0 x}{x n_1 + y n_2 + z n_3} \\ \frac{d_0 y}{x n_1 + y n_2 + z n_3} \\ \frac{d_0 z}{x n_1 + y n_2 + z n_3} \\ 1 \end{bmatrix} = \begin{bmatrix} d_0 x \\ d_0 y \\ d_0 z \\ x n_1 + y n_2 + z n_3 \end{bmatrix}$$

$$= \begin{bmatrix} d_0 & 0 & 0 & 0 \\ 0 & d_0 & 0 & 0 \\ 0 & 0 & d_0 & 0 \\ n_1 & n_2 & n_3 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

P.T.O

which is the projection matrix for when camera at origin.

Now our, camera is at (2, 7, 3)

So we need to:

① Translate camera to origin (0,0,0)

② Project p'

③ Translate back camera to (2,7,3) from origin (0,0,0).

So, the Final Projection matrix:

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 7 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} d_0 & 0 & 0 & 0 \\ 0 & d_0 & 0 & 0 \\ 0 & 0 & d_0 & 0 \\ n_1 & n_2 & n_3 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -2 \\ 0 & 1 & 0 & -7 \\ 0 & 0 & 1 & -3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \quad \text{--- ①}$$

Here, plane equation:

$$2x + 3y + 4z = 10$$

So, the normal to this plane, $\vec{N} = (2, 3, 4)$

So, $n_1 = 2$, $n_2 = 3$, $n_3 = 4$ $[\vec{N} = n_1\hat{i} + n_2\hat{j} + n_3\hat{k}]$

d_0 = perpendicular distance to the plane from Camera(2,7,3) $= \left| \dfrac{2\cdot2 + 3\cdot7 + 4\cdot3 - 10}{\sqrt{2^2+3^2+4^2}} \right|$

$= \cancel{20}\ 5.014$

So the Projection matrix':

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 7 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5.014 & 0 & 0 & 0 \\ 0 & 5.014 & 0 & 0 \\ 0 & 0 & 5.014 & 0 \\ 2 & 3 & 4 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -2 \\ 0 & 1 & 0 & -7 \\ 0 & 0 & 1 & -3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

This is the final Projection matrix which can be multiplied with matrix multiplication (which is not done here).

- This projection matrix is for $P'(x', y', z')$ for the point $P(x, y, z)$ on the plane $2x + 3y + 4z = 10$ where camera is at $(2, 7, 3)$.

201714018 Section- B

Ans. to the ques. no.-05(b)

Given,

Camera position at (1, 1, 1)

Looking direction :

$l = -Y$

$u = -Z$

$r = X$

But we want,

camera at (0, 0, 0)

and Looking direction:

$l = Y$

$u = Z$

$r = X$

So the, translation of camera matrix is:

$$T = \begin{bmatrix} 1 & 0 & 0 & -1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Now,

For, r: $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = V \cdot \begin{bmatrix} r.x \\ r.y \\ r.z \end{bmatrix}$

For, l: $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \cancel{V \begin{bmatrix} -l.x \\ -l.y \\ -l.z \end{bmatrix}} \quad V \begin{bmatrix} -l.x \\ -l.y \\ -l.z \end{bmatrix}$

For, u: $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = V \begin{bmatrix} -u.x \\ -u.y \\ -u.z \end{bmatrix}$

P.T.O.

So, Resultant Rotation Matrix = V.R

$$\Rightarrow \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = V \begin{bmatrix} r.x & -l.x & -u.x \\ r.y & -l.y & -u.y \\ r.z & -l.z & -u.z \end{bmatrix}$$

$$\Rightarrow I = V.R$$

$$\Rightarrow V = R^{-1} = R^{T}$$

$$\text{So } V = \begin{bmatrix} r.x & r.y & r.z \\ -l.x & -l.y & -l.z \\ -u.x & -u.y & -u.z \end{bmatrix}$$

So, the transformation matrix are T and V. <u>Ans</u>

Ans. to the ques. no.- 05(c)

Yes it is possible to derive the equation of the plane using the projection of that plan to the other planes.

the plane equation can be used liked this: $Ax + By + Cz + D = 0$ --(1)

Now, if we project this plane on to of YZ plane then that area on the YZ will be A. similarly

∴ Area on XZ plane = B

∴ Area on XY plane = C.

And we can found an area on the XY, YZ, XZ plane using the trapezium formula of:

$$C = \frac{1}{2}(y_i + y_{i \oplus n})(x_{i \oplus n} - x_i)$$

$\oplus$ is for if $i = n$, $i = 1$

So, we can find the A, B.

P.T.O.

with these Areas we can determine A, B, C and can determine D so, the plane equation can be derived using its projection on XY, YZ, XZ planes and ~~found~~ calculating their Areas.

Ans. to the ques. no. - 06 (a)

(i) Ans: x- extent , y- extent , z- extents can be calculated if we know the X_{min} , X_{max} , Y_{min} , Y_{max} , Z_{min} , Z_{max} of the lines/curves. then,

$$x\text{-extent} = X_{max} - X_{min}$$

$$y\text{-extent} = Y_{max} - Y_{min}$$

$$z\text{-extent} = Z_{max} - Z_{min}.$$

In this way we can calculate the x- extent, y- extent, z- extent of a polygon.

P.T.O.

[6(a)]
(ii) Ans: To sequence the overlapping of polygons I can use the painters algorithm to dept sort the polygons and ~~pa~~ render the polygon which is at the farthest. The process:

1. Finding the z-extent of two polygons if they overlap then proceed else can be rendered any order.

2. 3 questions, in sequence, is asked. If Yes of any then P can be rendered before:
   a. are X-extent disjoint.
   b. Is P entirely on the opposite side of Q.
   c. Is Q entirely on the same side as P.

3. If No to all (in sequence) then we enter change P and Q and redo 2.(b) and 2.(c) question. if any Yes then Q can be rendered before P.

4. If all No then split.

Ans. to the ques.no.-06 (b)

Generating the BSP Tree from the given polygon: (3 as starting point)

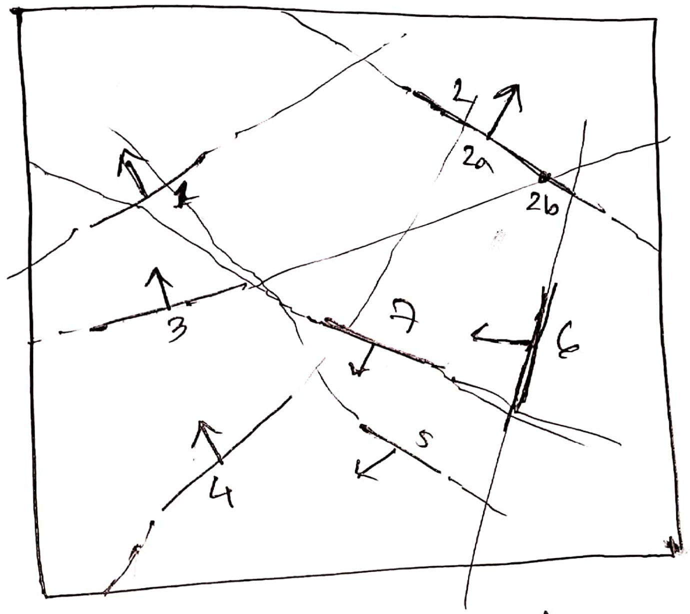
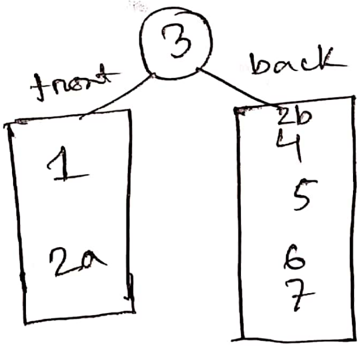
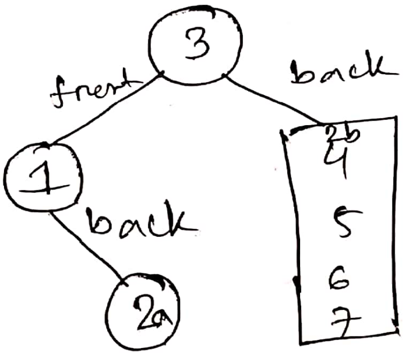


Fig: 6 (b) polygon.

on front of 3
1, 2 and
back is 4,5,6,7
extending 3 we
can get this:
2a is on front of 3
2b is on Back

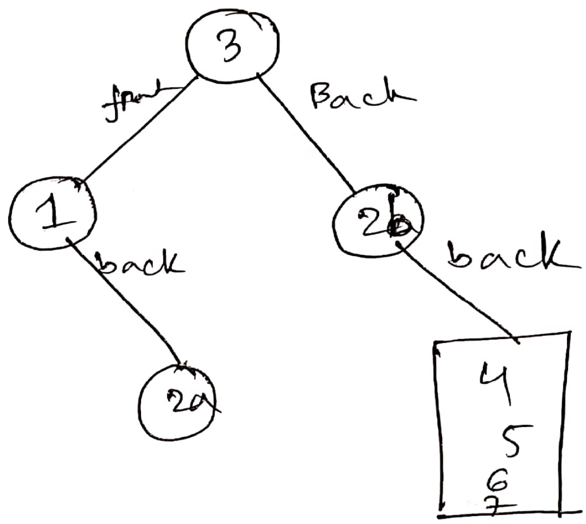


For 1
~~arden~~
2a is on backside
of 1

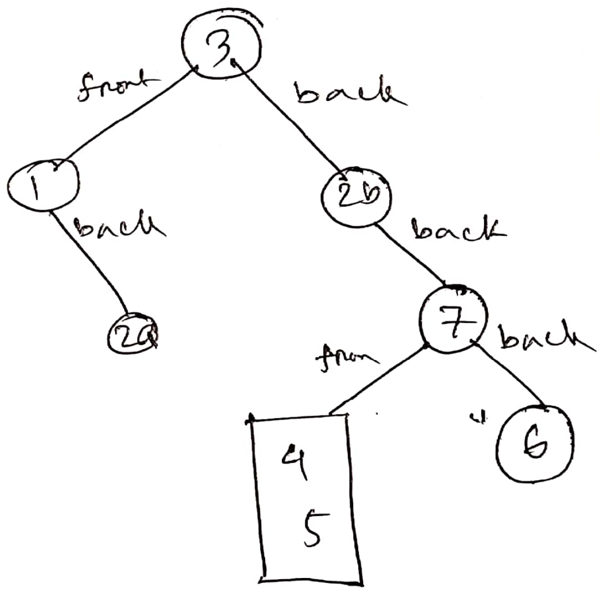


P.T.O.

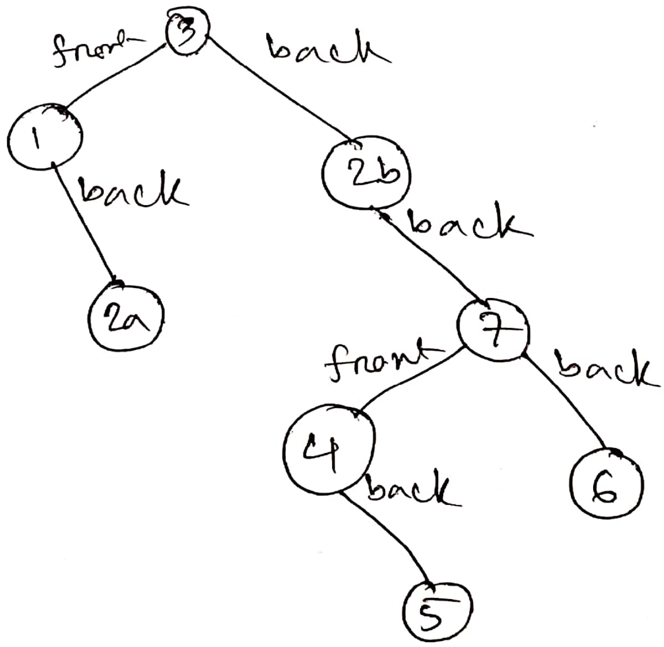
all are at back of 2b:



For 7.
(since its easier).



Final
BSP Tree:



Ans. to the ques. no. - 06(c)

Image Precision ~~Z-buffer~~ algorithm exmamines all n objects for each pixel and finds the closest one to dro.

Advantages of ~~Z-buffer~~ Image-precision:

① quickly find z-extends of objects.

② ~~sort~~ render the furthest fast.

③ quick,

④ easy Algorithm.

Disadvantages:

① O(np) which is expensive.

② considers all n objects, calculation is hard.