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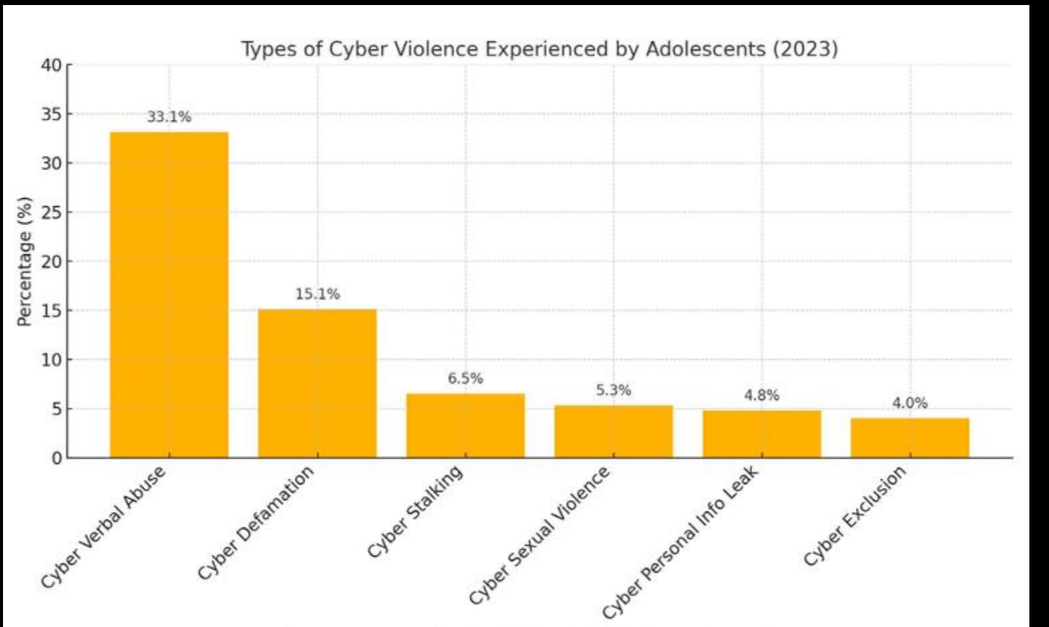
초등학생들의 희망 직업 1위는 4년째 운동선수(9.8%)가 차지하고 있다. 2위는 1년 전보다 한 계단 상승한 교사(6.5%)였다. 3위에는 크리에이터(6.1%), 4위에는 의사(6.0%), 5위에는 경찰관/수사관(4.5%)이 각각 올랐다.

Cyberbullying and Anonymity Protection

* Key Summary

33.1% of teenagers have experienced cyber verbal abuse (NIA 2023)

VTubers as a means of protecting privacy



<그림 2> 2023년 사이버폭력 실태조사 그래프

VTubers as a way to express unique personal identities

*** Key Summary**

Expansion of VTuber Culture After the Pandemic

Enables content creation without revealing one's face

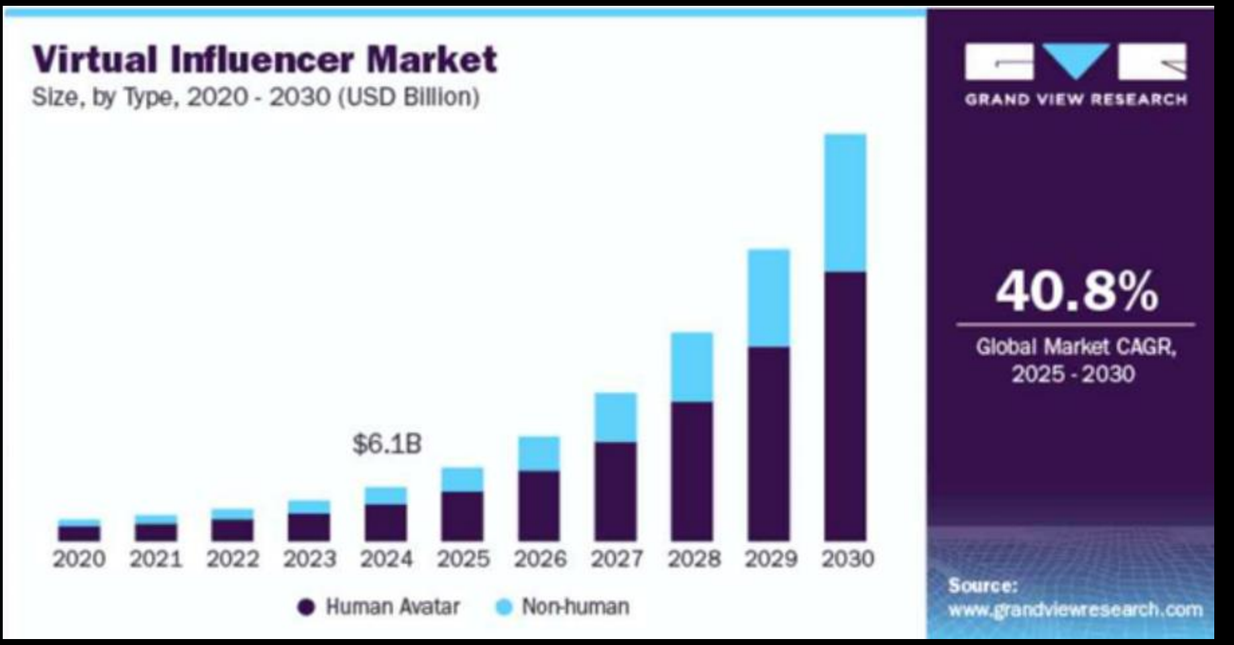
Utilized on metaverse platforms (e.g., ZEP, ifland)

Explosive Growth of the Virtual Market

*** Key Summary**

2024: $6.06 billion
→ 2030: Annual growth rate of 40.8%

SNS Insider: Expected to reach $154.6 billion by 2032



Economic Barriers to Entry for Virtual Model Creation

*** Key Summary**

LIVE2D commissions: Minimum of 100,000 KRW to over 1,000,000 KRW

Equipment + software can cost several million KRW

항목	설명	예상비용
 2D 모델 제작	Live2D돌 활용한 2D 아바타 제작	$100~$200
 3D 모델 제작	Vroid Studio 등으로 제작한 3D 아바타	$1000~ $5000
 하드웨어	PC, 웹캠 , 마이크 등, 장비	$500~$2000
 소프트웨어	Live2D ,Vtube Studio 등의 라이센스	$20~$60 /월

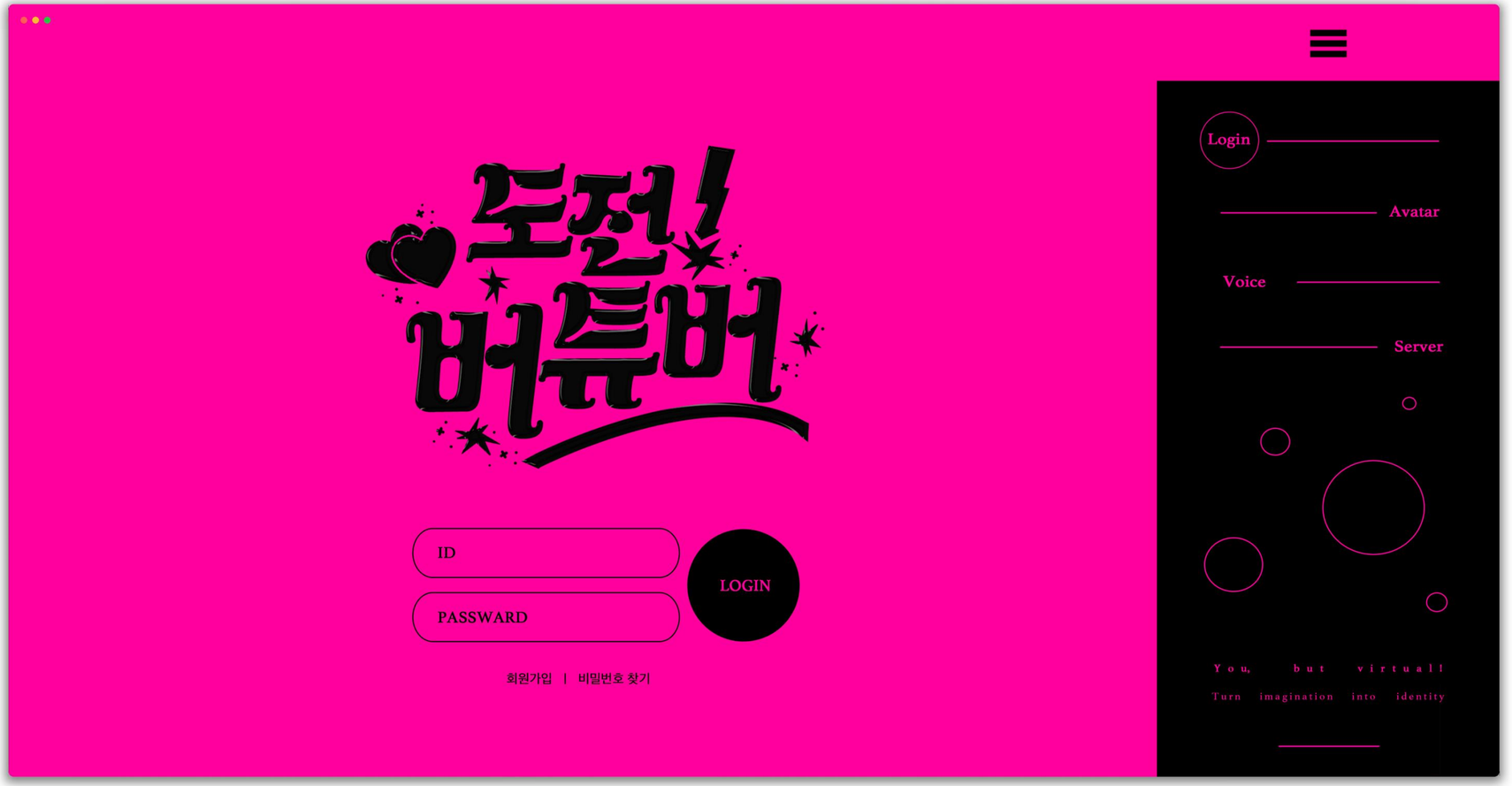
Virtual Model Creation

버추얼 아바타 캐릭터를 만들어줘. 걍 보편적인 예쁘고 특이한 느낌으로

2D to 2.5D Conversion

There is a change!

Final program UI example



Final program UI example

Expected Transmission Screen

2D to 2.5D Conversion

There is a change!

Voice Modulation

03. Novelties of the design

Category	Virtual Model Creation	Expression-Based Model Conversion	Text Input-Based Model Creation	Voice Modification	Voice Blending	UX/UI Convenience	Expandability	Cost & Accessibility	System Integration
System (e.g., VSeeFace, FaceRig	Only pre-made, rigged characters can be used	Only basic expressions supported, no auto changes	X	Requires external voice changer	Requires external system	Complex setup, needs additional software	Supports adding characters and modifying poses	Some software requires payment	Supports facial tracking and character export (voice modification needs external program)
iPhone Memoji/ ARKit Emoji	Fixed models only, no creation capability	Expression tracking available, but model conversion not possible	X	X	X	Simple setup, lacks expandability	Limited to Apple devices, lacks external expansion	Device-dependent, limited functionality	Supports tracking only, no export function
Auto rig pro	X	Available, semi-automated	X	X	X	Complex setup, Blender usage is complicated	Can rig other characters	Paid	Only semi-automated rigging supported
Meshy ai	Available (image to 3D model)	Available Not face rigging	Available	X	X	Easy prompt input and UI configuration	Expandable with various formats	Paid	Only generates 3D models from images

Category	Virtual Model Creation	Expression-Based Model Conversion	Text Input-Based Model Creation	Voice Modification	Voice Blending	UX/UI Convenience	Expandability	Cost & Accessibility	System Integration
Applio	X	X	X	Supported, but no real-time output	Voice blending supported	Limited convenience	Real-time output not supported	Free, but only offers blending feature	Voice only, no video
*Voice Changer (e.g., w-okada, used standalone)	X	X	X	Voice modification only	Voice blending supported	Limited convenience	No AR support	Free, but only offers voice modification	Voice only, no video
Live2D	2D virtual model creation specialized	Expression-based animation supported	X	No built-in voice features	No voice features	Professional UI with dedicated software	Extensive plugin support, OBS integration	Paid software (Cubism PRO required)	2D animation + streaming Integration
제안 시스템 (도전 버튜버!)	**Based on LLM (ChatGPT/DALL·E), auto image generation with AR**	**Real-time BlendShapes → Emoji conversion**	**Text input → LLM → Auto image generation**	**Real-time AI-based voice transformation**	**Voice blending supported**	**Intuitive UI for settings**	**Custom prompts, supports various virtual model formats, 2D masking available**	**Free open-source model use, API planned**	**Face tracking + image generation + voice modulation + export**

VTuber System Performance Analysis

01. Key Performance Indicators (Realistic)

COST REDUCTION

30-50%

$2,000 → $1,200

Compared to mid-tier solutions

SETUP TO DEPLOYMENT

82.5%

40hrs → 7hrs

Complete workflow

SOFTWARE REQUIRED

67%

3 → 1

Integrated solution

LEARNING CURVE

70%

20hrs → 6hrs

To basic proficiency

RESOURCE EFFICIENCY

CPU 50%

vs 60-80%

Lower usage vs standard

COST SAVINGS ROI

400%

4x investment

Hardware ownership assumed

02. Cost Comparison by Quality Tier

Quality Tier	Traditional Market Price	Our System Cost	Realistic Savings
Basic Entry Level Simple model, basic features	$500-800 (Commission $300 + Tools $200)	**$0** **(Only PC + iPhone required)**	**100%** **(If you have hardware)**
Mid-Tier Professional Custom design, good rigging	$1,500-2,500 (Commission $1,000 + Rigging $500 + Tools)	**$0** **(Only PC + iPhone required)**	**100%** **(If you have hardware)**
High-End Premium Professional quality, complex rigging	$3,000-5,000 (High-end commission + expert rigging)	**$0** **(Only PC + iPhone required)**	**100%** **(If you have hardware)**

💡 **Single Configuration:** Our system offers one unified setup that works for all quality tiers. No need for expensive upgrades or additional software. If you already own a PC (mid-spec) and iPhone (Face ID enabled), you can start immediately at zero additional cost.

03. Real-World Streaming Performance Analysis

📊 **Based on Actual User Reports (2025):** Analysis of VTube Studio, VSeeFace, and other popular solutions with 100+ hours of community feedback and testing data.

Platform	Real Performance	Common Issues	Our System Comparison
VTube Studio (Most Popular)	• 30-45fps typical • CPU: 35-50% • RAM: 3-4GB • Easy setup	• Frame drops during gaming • Lag with high-spec games • Expression tracking limited • CPU bottleneck common	**Similar:** 30fps, CPU 50% **Better:** More stable **Advantage:** Zero cost if have hardware
VSeeFace (Advanced Users)	• 45-60fps capable • CPU: 40-60% • RAM: 4-5GB • VRM compatible	• Complex setup • Audio-video sync issues • Driver instability • High hardware demand	**Better:** Simpler setup **Better:** Zero cost **Worse:** Lower FPS currently
Live2D + nizima (Professional)	• 60fps smooth • CPU: 30-45% • High quality • Expensive	• $1,500-3,000 initial cost • Steep learning curve • Time-consuming setup • Multiple software needed	**Better:** 100% cost savings **Better:** Faster setup (7hrs) **Trade-off:** Lower FPS for now
AI Motion Capture **(Viggle LIVE, etc.)**	• 30-45fps • AI-powered • Quick start • Limited customization	• Precision limitations • High system requirements • Less customization • Subscription costs	**Better:** More customization **Better:** No subscription **Similar:** AI approach

04. Real User Scenarios & Solutions

Streaming Scenario	Common Problems (Industry)	Our System Performance	Optimization Tips
Gaming + VTubing (AAA titles)	• Frame drops to 15-25fps • CPU: 80-95% usage • Frequent stuttering • Requires high-end PC	• **Maintains 25-30fps** • **CPU: 70-85% total** • **Smoother experience** • **Mid-tier PC sufficient**	• Lower game graphics to High • Use 720p streaming • Close background apps
Chatting Stream (Low CPU games)	• Generally stable • CPU: 35-50% • No major issues • All solutions work well	• **Very stable** • **CPU: 30-40%** • **Excellent multitasking** • **Can run Discord, browser, etc.**	• Ideal use case • Plenty of headroom • Add overlays freely
Singing/Music (Audio quality critical)	• Audio-video sync issues • Buffer adjustments needed • Latency problems • Complex audio routing	• **140-180ms latency** • **Acceptable for singing** • **Requires audio interface** • **Manual calibration needed**	• Use ASIO drivers • Adjust OBS audio delay • Test before stream • Monitor audio closely
Drawing/Art (Screen sharing)	• High CPU load • Canvas capture issues • Delay in movements • 45-65% CPU typical	• **Lower CPU overhead** • **Smoother canvas capture** • **40-55% CPU usage** • **Better responsiveness**	• Use window capture • Reduce canvas size • Lower streaming bitrate
IRL/Outdoor (Mobile setup)	• Limited to iPhone/iPad • Battery drain severe • Network instability • Quality compromises	• **iPhone Face ID works** • **Battery: 2-3 hours max** • **4G/5G streaming possible** • **Lower quality but functional**	• Bring power bank (20,000mAh+) • Test network beforehand • Use 720p 30fps • Have backup plan

20장 부연설명

Common Streaming Issues & Solutions

⚠ **Issue:** Face tracking freezes during high CPU spikes → **Solution:** Set VTuber software to "High Priority" in Task Manager

⚠ **Issue:** Audio out of sync after 30+ minutes → **Solution:** Restart stream or adjust OBS audio delay (+50-100ms typically needed)

⚠ **Issue:** Expression recognition poor in dim lighting → **Solution:** Add ring light or desk lamp, ensure face is well-lit

⚠ **Issue:** Frame drops when switching scenes in OBS → **Solution:** Pre-load scenes, reduce transition effects, use Studio Mode

⚠ **Issue:** Memory leak after 3+ hours streaming → **Solution:** Schedule 5-min break every 2 hours, restart software

⚠ **Issue:** Overheating laptop/PC during summer → **Solution:** Laptop cooling pad, room AC, reduce CPU load (lower game settings)

05. Feature Comparison (Honest Assessment)

Feature	Traditional Solution	Our System	Assessment
Character Generation	2-7 days Artist commission	**5 minutes** **AI-generated**	**99% faster** **Instant creation**
Rigging Process	8-40 hours Manual work	**6 hours** **Semi-automated**	**80-85% faster** **Good quality**
Face Tracking FPS	45-60fps Industry standard	**30fps** **iPhone-based**	**Below standard** **Roadmap: 45fps+ by Q3 2025**
CPU Usage	60-80% During gaming streams	**50%** **More headroom**	**Better multitasking** **Gaming-friendly**
Setup Complexity	High Multiple software	**Medium** **Integrated solution**	**Easier but still requires** **6-hour learning**
Customization Level	High Full artistic control	**Medium** **AI-assisted**	AI limits some artistic nuances

06. AI Automation Performance (Conservative Estimates)

Process Stage	Traditional Time	Our System Time	Automation Level	Quality Note
Character Design	24-72 hours	**5 minutes**	**99.4% faster**	Instant generation
Initial Rigging	8-20 hours	**Instant (automated)**	**100% automated**	Auto-generated
Expression Setup	4-10 hours	**Instant (automated)**	**100% automated**	Good default quality
Voice Training	2-4 hours	**3 hours**	Requires training time	Quality depends on input
Testing & Integration	8-16 hours	**6 hours**	**50-62% faster**	Testing required
Total End-to-End	**46-122 hours**	**~7 hours**	**85-94% faster**	**Production-ready**

07. Technical Performance (Measured Results)

Metric	Target	Current	Industry Standard	Status
Face Tracking FPS	60fps	**30fps**	45-60fps	**Needs Improvement** **Roadmap: Q3 2025**
CPU Usage	<50%	**50%**	60-80%	**Better efficiency**
Memory Usage	<3.5GB	**2.5-3.5GB**	4-6GB	**30-40% Better**
GPU Usage	<40%	**28-38%**	45-65%	**25-35% Better**
Pipeline Latency	<120ms	**140-180ms**	150-200ms	Acceptable Room for improvement

💡 **Key Strength:** Our system excels at resource efficiency and automation speed. Character generation takes 5 minutes instead of days, and the entire setup process is completed in ~7 hours instead of weeks.

08. Cost Savings Analysis (Not Revenue)

Scenario	Traditional Cost	Our System Cost	Savings	Notes
With Hardware (PC + iPhone owned)	$1,500-2,500	**$0**	**100% ($1,500-2,500)**	Most realistic scenario Zero additional cost
Need iPhone	$2,200-3,200	**$700**	**68-78% ($1,500-2,500)**	iPhone Face ID required
Complete Fresh Start	$3,200-4,200	**$1,700**	**47-60% ($1,500-2,500)**	PC + iPhone purchase needed

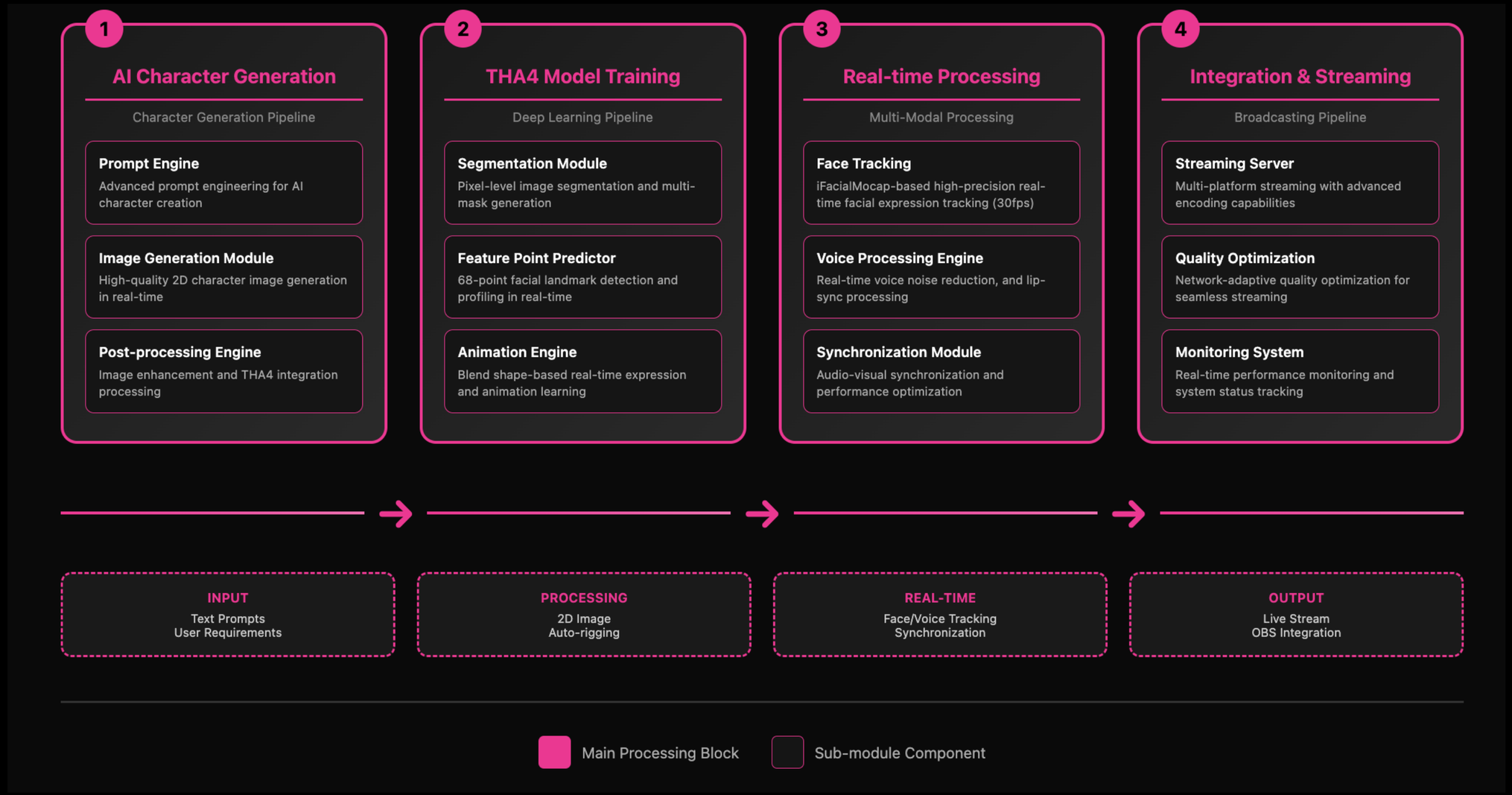
⚠ **Important Clarification:** The percentages above represent **cost savings ONLY**, not revenue generation. VTuber monetization is challenging:

- YouTube Partner Program requires 500 subscribers + 3,000 watch hours
- Average ad revenue: $0.05-0.70 per 1,000 views (extremely low)
- Super Chat income highly variable and audience-dependent
- Most VTubers take 6-18 months to achieve basic monetization

This system reduces initial investment costs but does NOT guarantee income.

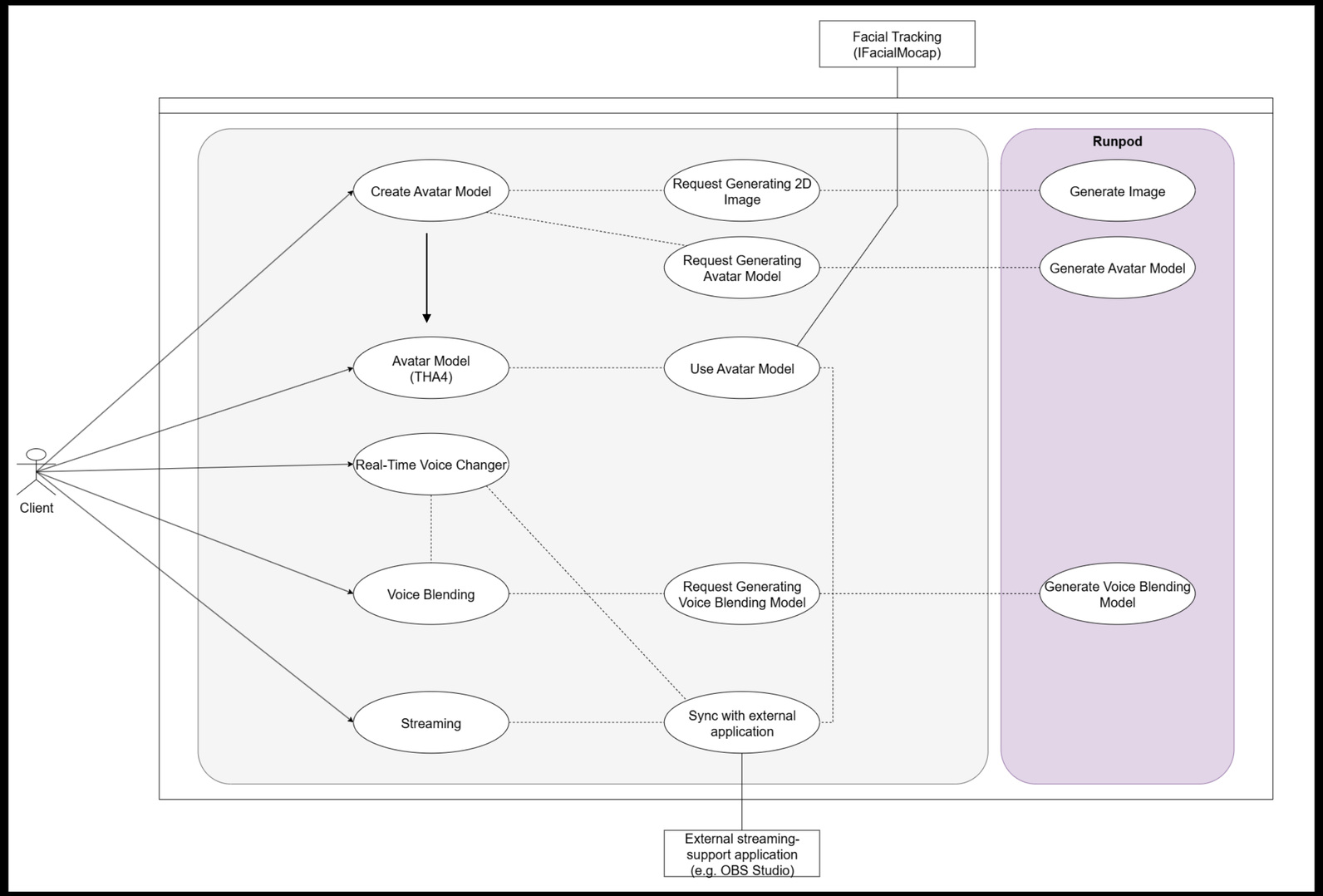
System Block Diagram

There is a change!



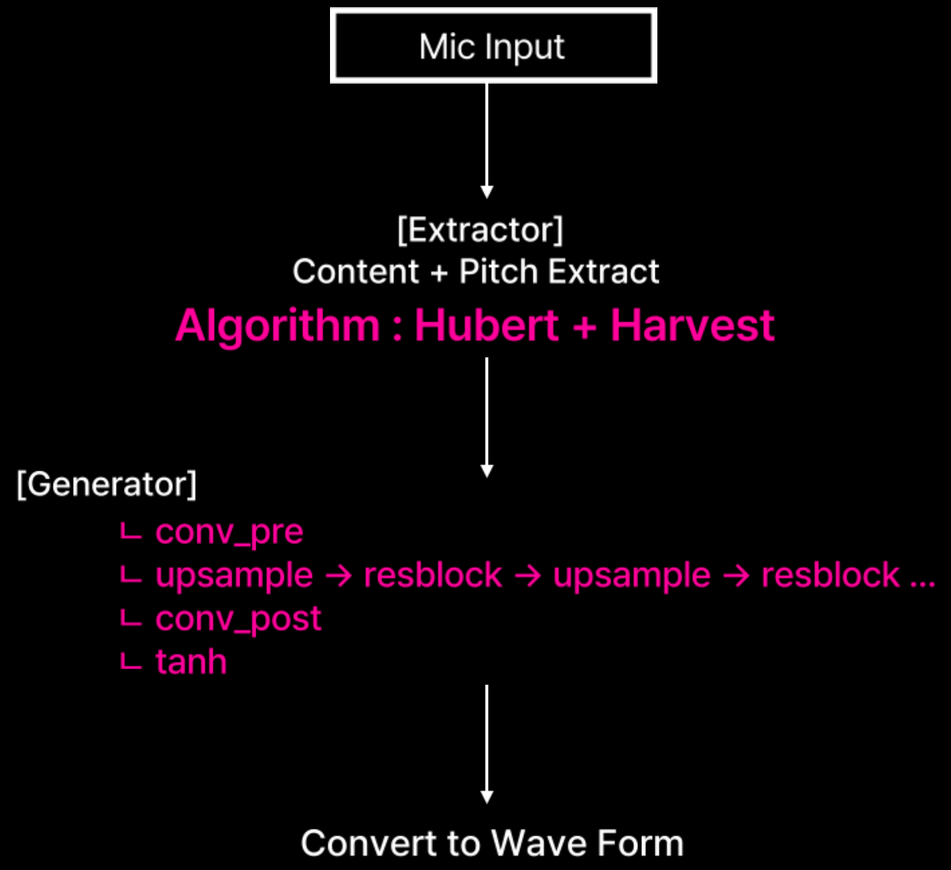
System Block Diagram

There is a change!



Virtual Voice

Real Time Voice Changer



Voice Blending

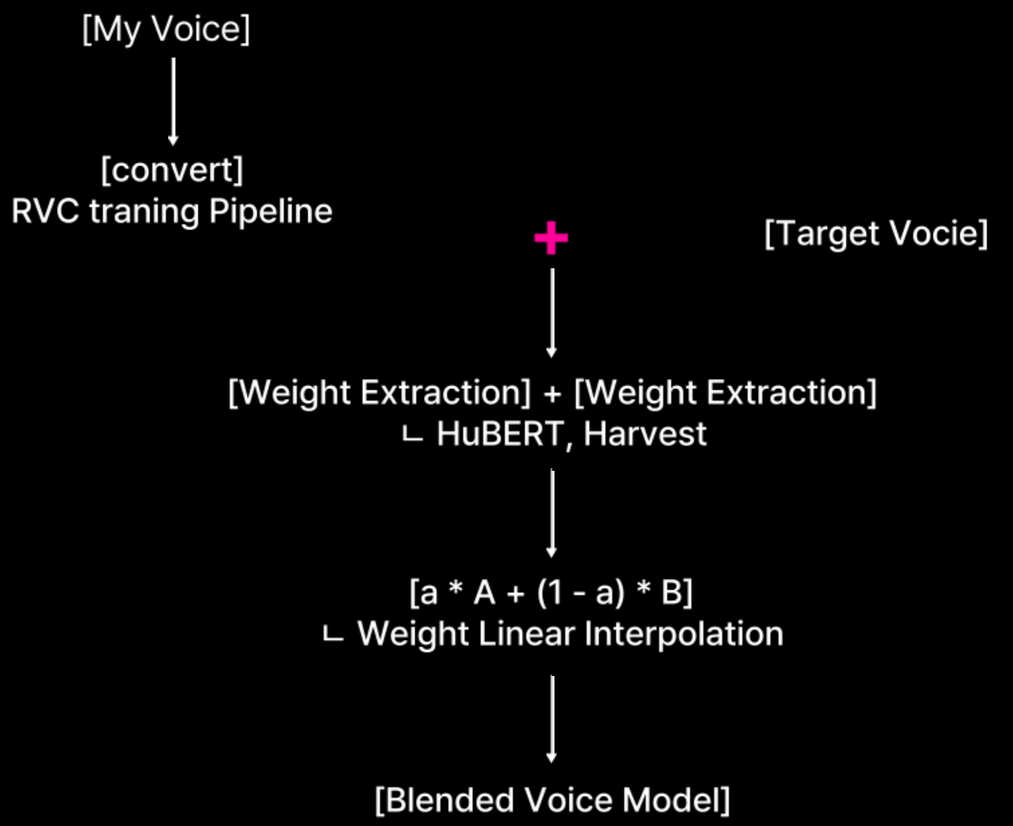


Image Generation

Prompts

1girl, hatsune miku, worst quality, ms paint (medium).

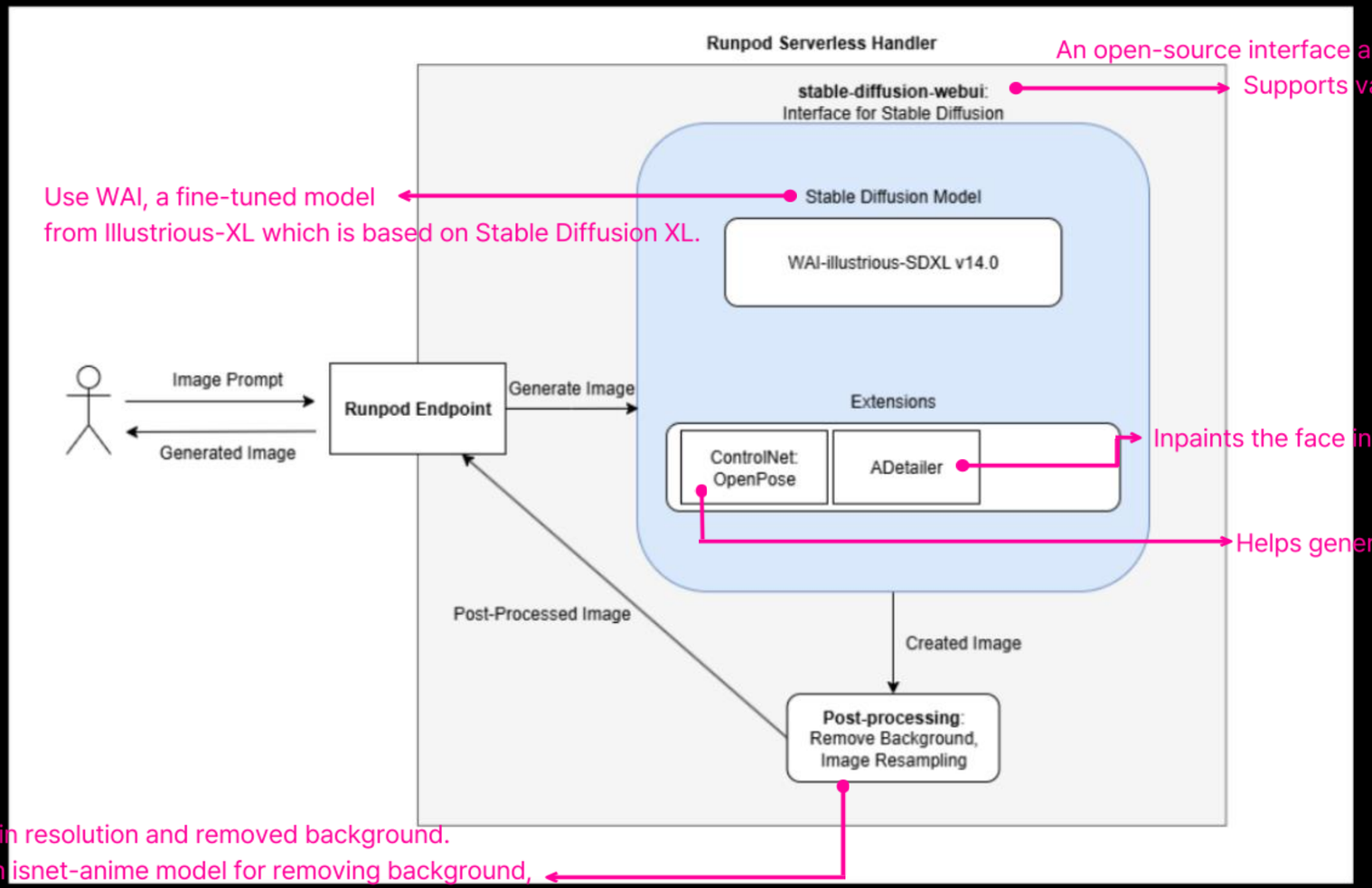
ILLUSTRIOUS

1girl, happy, smile, crying, 2koma.

Fine Tuning (LoRA)

Image Generation

There is a change!

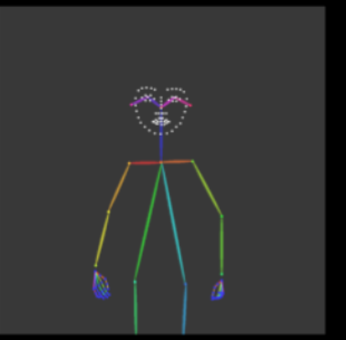


An open-source interface application for Stable Diffusion.
Supports various models and extensions.

Use WAI, a fine-tuned model
from Illustrious-XL which is based on Stable Diffusion XL.

Inpaints the face in the generated image for better quality.

Helps generate images of desired poses.

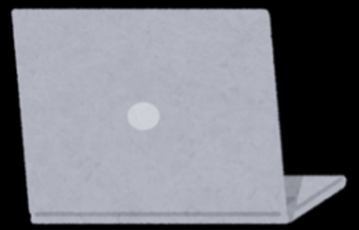


To generate a model with THA4,
an input image should have certain resolution and removed background.
We use rembg Python library with isnet-anime model for removing background,
and Pillow for image resampling.

Image Generation

There is a change!

Write and send image prompt



User

Request

Response (202)

Retrieve image (later)

Firebase-based Backend
Validate and forward request

Firebase

Request

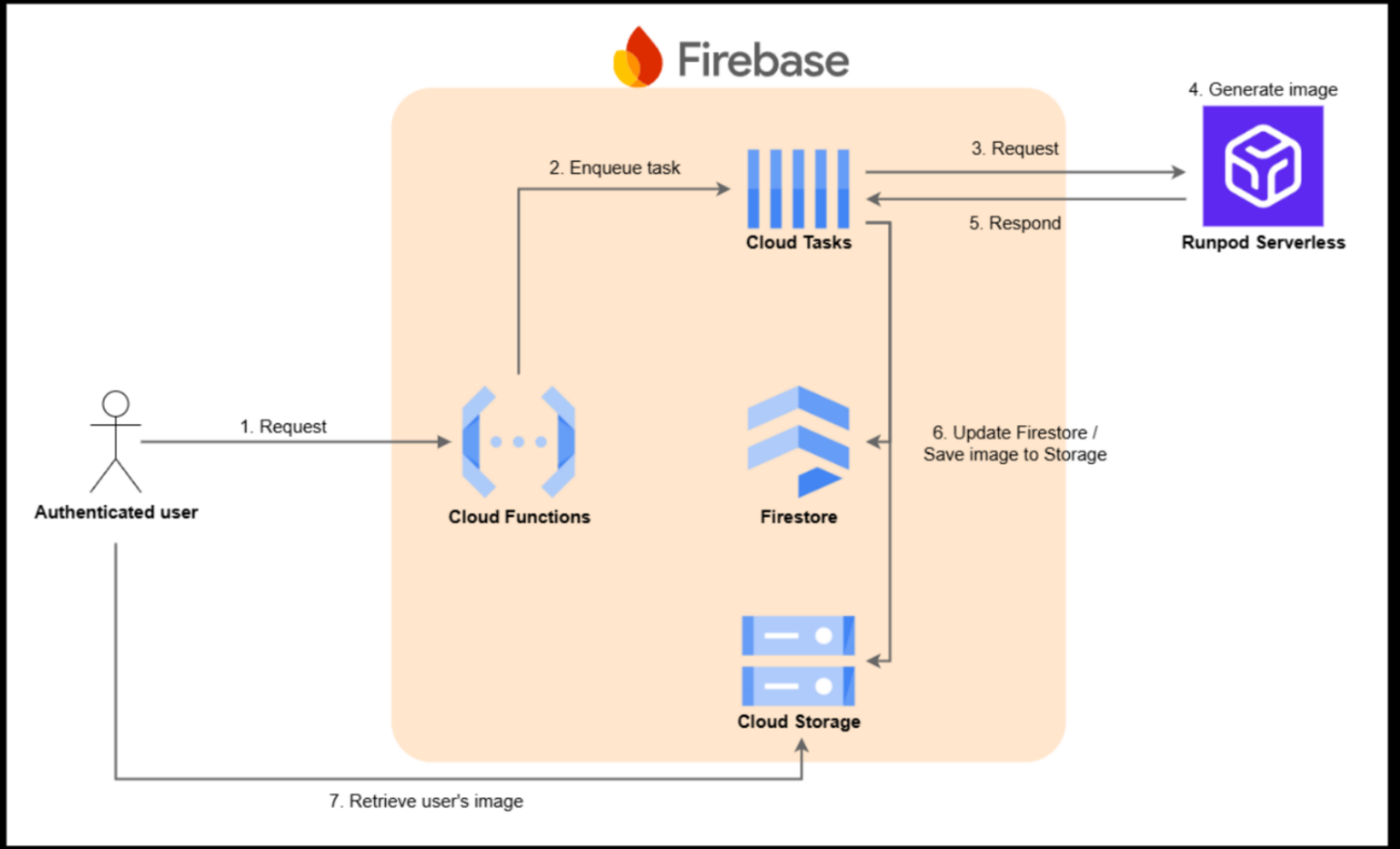
Response

Deploy AI image generator to Runpod
Generate requested image

Runpod

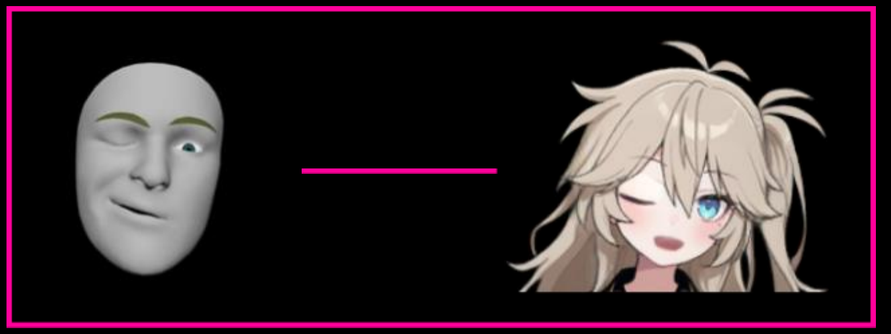
Image Generation

There is a change!



Modeling

There is a change!



IFACIALMOCAP

Face motion

pixiv

Your creative journey awaits

Taking head motion

OBS studio

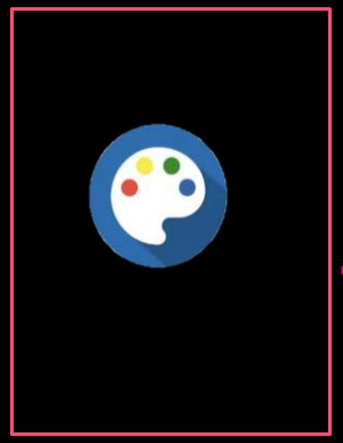
Image

Capture

Virtual Avatar

There is a change!

Image generator



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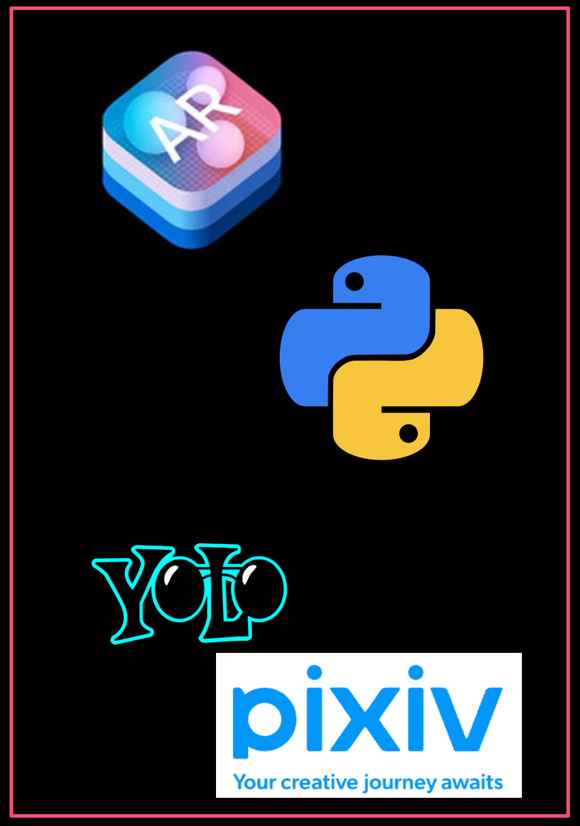
Virtual Avatar



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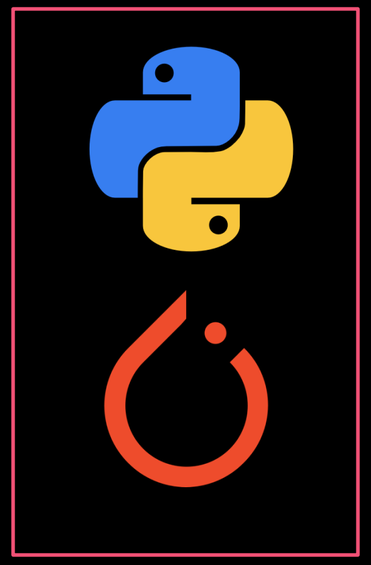
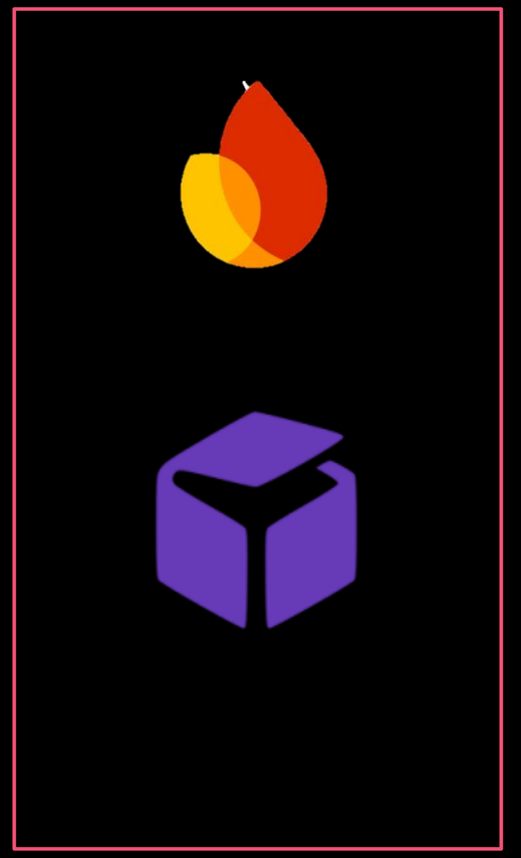
Virtual Voice



→

Server



Task Allocation for each team member

01 방문혁

AR integration, automated image rigging,
iPhone compatibility

02 한승호

Image rigging model tuning,
Server implementation

03 조현석

Voice modulation,
Server implementation

04 김리현

UI development,
LLM model training

Work Schedule

Task Description	May	Jun	Jul	Aug	Sep	Oct	Nov
Image and model generation based on user request							
Real-time voice changer and voice blending implementation							
Development of auto-rigging system							
Backend system construction							
Development of user application							

Target Performance Metrics

Functions	Detailed Items
User APP	- Animates model based on face tracking and displays the result in the screen
Real-Time Voice Changer	- Performs real-time voice modification using voice feature mapping, with noise filtering
Voice Blending	- Blends the user's voice with a target voice based on tone, without altering pitch
Creating VTuber Model	- Generates a character image from LLM-processed text prompts, and creates a model from the generated image
Auto-Rigging System	- Automatically performs facial rigging by segmenting facial features and attaching rigging points to each feature
Server	- Loads AI models and the database, then runs inference on the models based on user's inputs

Performance Evaluation Method

Functions	Detailed Items
Real-Time Voice Changer	- Latency: Voice delay from input to output. Should be under 100ms for smooth real-time use. - PESQ: Checks how natural the voice sounds after conversion. Over 3.5 means good quality. - STOI: Measures how clearly the voice can be understood. Over 0.75 is considered clear.
Voice Blending	- Output Stability: We check if voice quality stays stable with different input voices. If scores don’t change much, the model is considered stable.
VTuber Image Generation	- CLIP Score: Measures how well the generated image matches the user’s text prompt (like eye color, hair style). Over 0.30 is a good match.
Auto Rigging	- We compare our face landmark model with other public models to see which works better for animation.