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How to Prepare Agriculture Operations under the Impact of LLM Technology (Focusing on the Perilla Vegetable Harvest Mobile Robot and Gripper)

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Abstract: This paper deals with studying about impact of LLM and its application on the agriculture operation (smart farm 4.0). To study the influence of LLM, Firstly, this paper reviews several LLMs on how LLM gives an influence in many areas because its area is so wide such as normal editing works, speak, many advises, and code development by using huge data. Secondly, this paper studies on how we have to introduce into agriculture area, especially vegetable harvest among all agriculture's current issues. Finally, this study focuses on how to design mobile robot and gripper for the effective harvest of vegetable of perilla. Currently, in farm site (country site), there are many problems because almost farmers are old age and young generations are not coming into agriculture site. However, they have to work and farming is important not give up to survive for food. Government is trying to innovate with many ways but it is too far from farmer. Vegetable agriculture is important but no technology because of complex process. This paper study for this issue and simulate before design mobile robot and gripper for perilla harvest in Korean country site. After simulation, we will design and produce mobile robot with H/W and S/W.

Keywords: ChatGPT, LLM, Perilla, Vegetable robot, Smart farm.

I. INTRODUCTION

Currently, the mentioning of LLM (ChatGPT) covers all over the world and every area, such as industry, art, movie product, story-telling, after unveiled ChatGP 4.0 in March 2023 following ChatGPT 3.5 in Nov. Several analyzers say its impact is over the steam of the 1700s after released.

After this ChatGPT released by OpenAI is leading technology paradigm and social is changing, and giving an impact on everything and everywhere in our community and business. The basic theory of this technology is not so difficult and instead of it impact is so big. Therefore, so many companies and countries are interested in developing or how to use this related technology.

This LLM (ChatGPT: Chat Generative Pretrained Transformer AI) technology has learning system (supervised learning, unsupervised learning, and reinforcement learning to train language) as basic learning and they combine for the situation effectively learning. The ChatGPT models are also not difficult to understand technology but its impact is a very huge and is changing social as well as the paradigm of research and coding.

Generative AI has been influencing on design, movie, art design, inter design, public design, image product, and others. Right now, we cannot predict how much more these technologies will impact on human society in the future. However, at least now, we can predict its impact power. As far as unstopping developing activities, many countries and companies will attempt to develop a new large language model (LLM) or a small language model (SLLM) or others. They like to have an initiative advantage in economy and or capture knowledge property through solving customer services.

The generative AI model based LLM (Large Language Model), TIM (Text-to-Image Model), and ITM (Image-to-Text Model) are rapidly increasing for applying in everywhere because a new generation of user-friendly tool (Generative AI: Chat GPT) is useful for texts, images, and videos.

Of course, economic effect of generative AI is quite huge such as automation by generative AI, heighten labor productivity by generative AI, higher education, and higher wages occupations (McKinsey, in June 2023). A new revolutionary paradigm of generative model will mainly impact on leading economic growth with the new content, LLM based collaboration swells, lifelong learning for old ages, and several tasks because its impact is wide and more profoundly in tasks such as stroy telling writers, translators, customer servers, marketing, legal professionals, document analyzer and makers, graphic designers, architects, artists, image generators, educator, students, and visual contents.

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However, some researchers will worry about its over influence and creativity that were previously thought to be human creativity and reasoning such as writing, drawing, analysis, music, and art. However, its impact is started from movie producers.

Herein, what will generative models impact on the economic leader and social pattern in the future? The advanced country and rich person can have much chance to advance and build their properties. However, under-developing countries and poor persons cannot have a chance to advance because they do not know current technology mega trend to introduce. Basically, generative model has an ability with human-like writing and additionally Google released Bard trained DALL-E2 model, which can generate images on demand by huge amounts of data. MS also developed another model LaMDA (it has two stages for trains like pre-training and fine-tuning with 1.56 trillion word, 137 billion parameters) for their competition against Google model (https://www.searchenginejournal.com/how-google-lamda-works/442064/#close).

MS announced Bing AI powered GPT-4 and they can use it on real time service. Also, many ventures and companies are trying to build new business by using these ChatGPT technologies. That is, education, agriculture operation system as well as social and business paradigms will be changed because of this powerful generative model and related technologies. The generative model (Dinesh Katta, 2023) is a big power engine for economic growth and job changing.

As mentioned before, the generative model is not so high technology as we guess to understand.

The first aim of his paper is to provide study strategies on how generative model and related technologies will impact on agriculture operation and what we have to prepare and study through analysing, reviewing reports, papers, and our project research. It is very important to understand and decide on how and what we have to do agriculture, market analysis, farmer education, and decide milestones agriculture operations.

The second aim is to offer policy decision materials for agriculture government and official agriculture organizations or young farmer that are going to return.

II. THE IMPACT OF LLMS

A. The Status of LLMs

This AI technology has a very strong trigger role to develop new AI and has initiative in AI areas. There are several LLM (ChatGPT) and related LLM after releasing GhatGPT 3.5 and 4.0 for ChatGPT5o based technology. That is, many ChatGPT-based applications are developing it is changing for our economic growing pattern and job changing. This paper provides current patterns for ChatGPT technologies and its application.

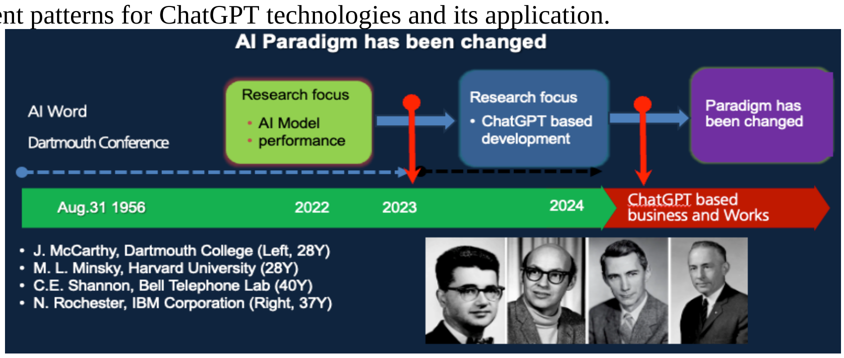

Fig. 1. Timeline of AI paradigm from 1956.

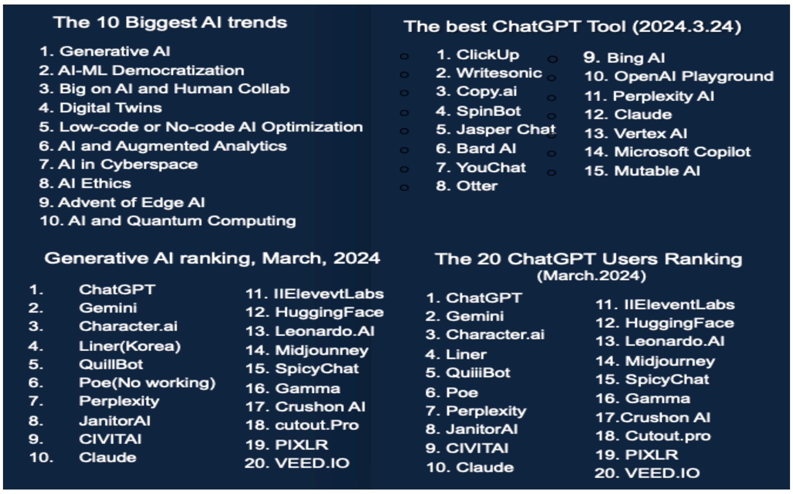

Fig. 2. LLM (ChatGPT) status [132, 133, 134].

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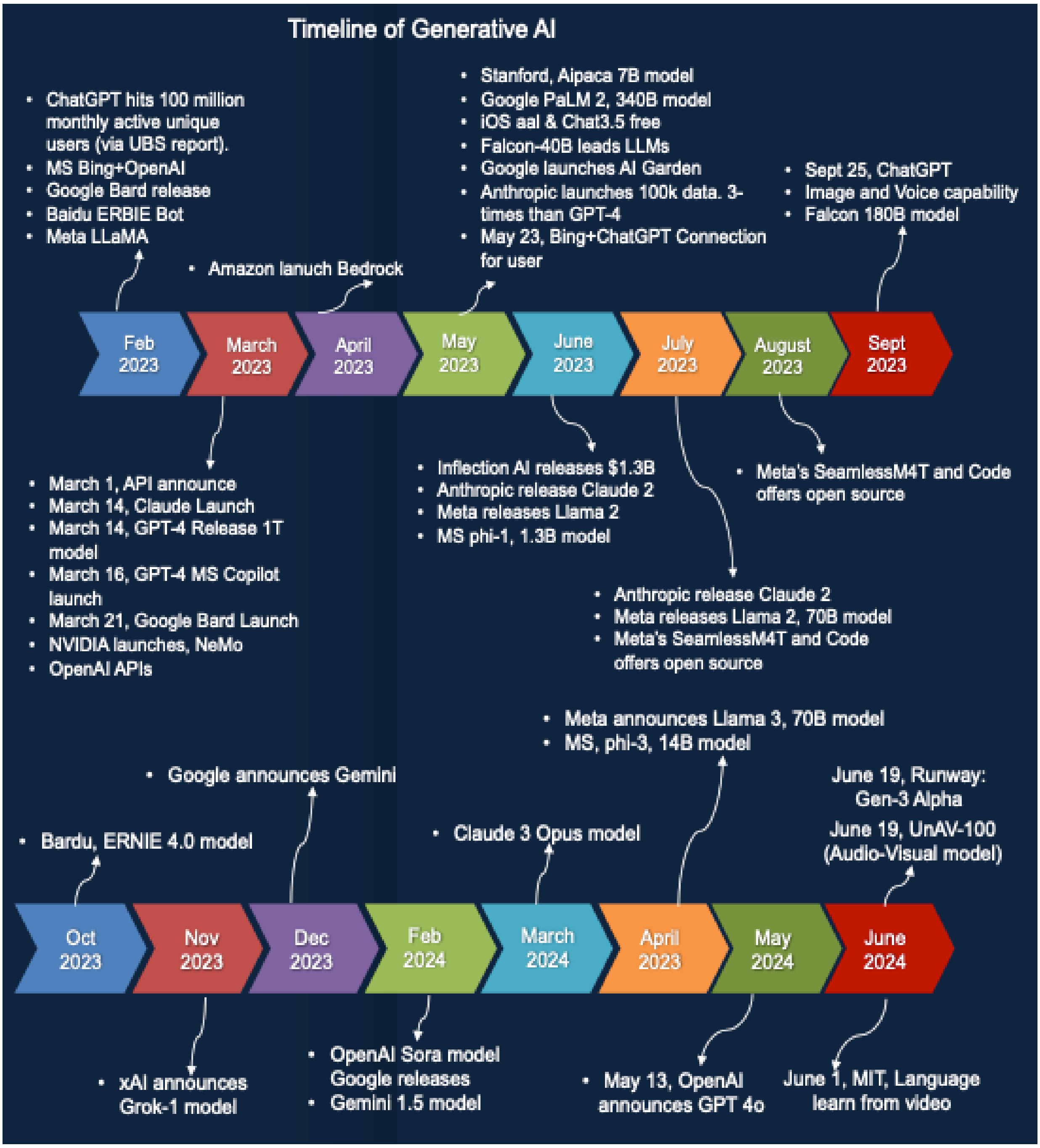

Fig. 3. Current development history of ChatGPT

Social Patterns Leading of LLMs basedTechniques: Many companies are developing generative AI for application models (Appl) as well as basic models, related technologies, and coding methods after releasing of OpenAI. The results impact on social areas as shown in Fig. 4. Its applications influence the marketing, art, industries, medical, and biotech as well as prediction and simple application, translation using GAN, transformer functions, and variational auto-encoders. The LLM combines with robots and its results have much more impact on education patterns.

Fig. 4 shows how generative AI can give an impact on everywhere. First impact is closer technology and engineering and second influence will education, health, smart city, and others as shown in Fig. 6.

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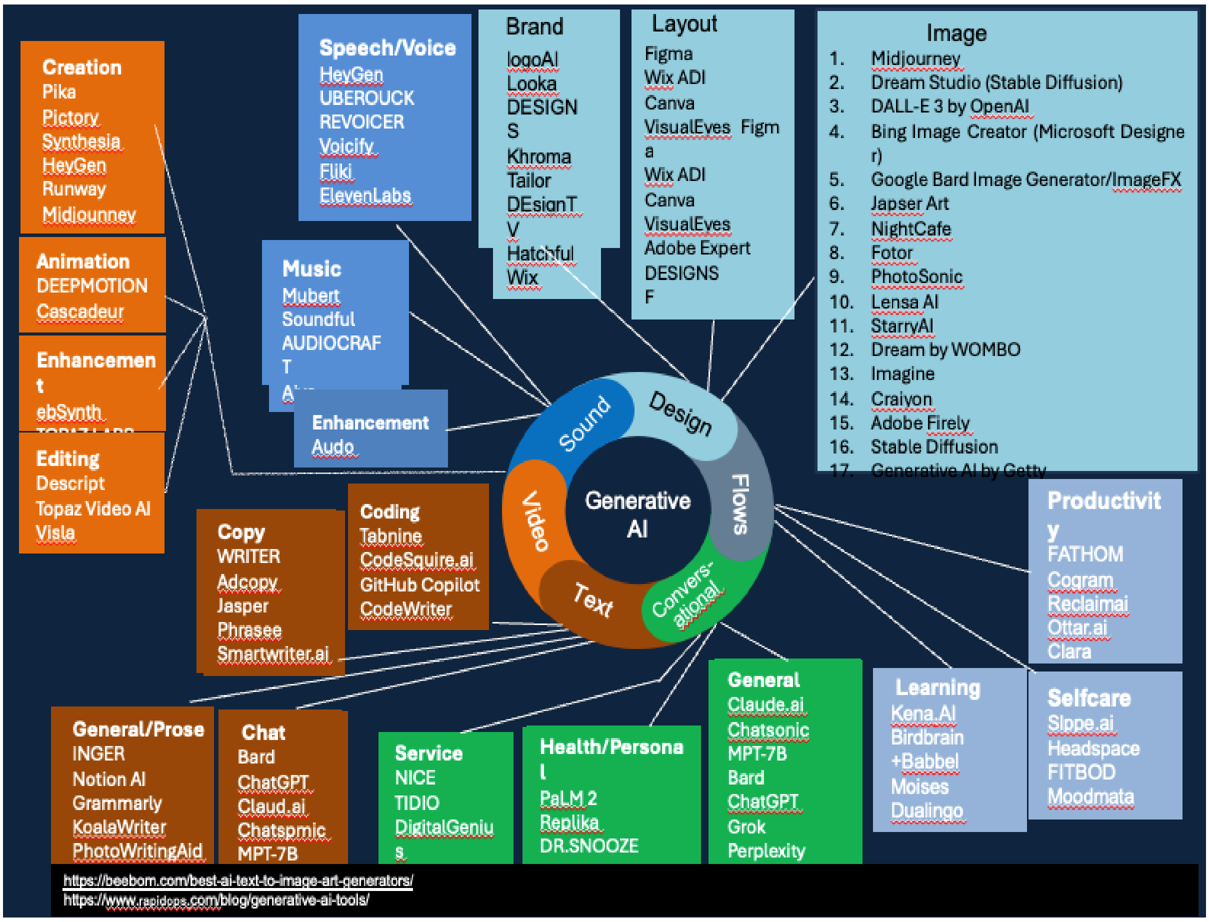

Fig. 4. Comparison MS, Google, and Meta of ChatGPT.

Major investments by Top 5 companies: Ref. [131] shows the market size of LLMs. Apple’s stock price increased by 36% in 2023. The company’s growth was largely driven by solid earnings for a consumer slowdown. Microsoft’s stock price rose by 37% in 2023. The company’s growth was supercharged by the excitement over generative AI, a technology to which Microsoft has close ties. Alphabet, the parent company of Google, saw its stock price increase by 39% in 2023. Like Microsoft, Alphabet’s growth was fueled by the hype around generative AI. Amazon’s stock price grew by 44% in 2023. The company’s growth was largely driven by remarkably solid earnings that de32ed earlier expectations for a consumer slowdown. Nvidia, a leader in AI and graphics processing units, saw a massive surge in its stock price by 159% in 2023. The company’s growth was driven by the excitement over AI-related advancements.

Job Patterns: The potential benefits of the generative AI are to transform technology by using confusion and speed up to developing terms. Generative AI also can easily estimate productivity growth using wide and huge data. It will give an impact on widespread adoption and add trillions of dollars a year to global economic output (WJS).

Fig. 5 shows on how impact will give areas by generative AI by summarized author based on [135]. LLM-based economic patters is changing so fast and millions of employees at labor jobs including higher jobs have been decreasing by LLM based robots. It means so-called knowledge workers and white-collar professionals such as designer, art producer, movie producer, story teller writer, project manager, and so on. will be impacted more pain because of these fusion technologies based on generative AI.

Applications of generative AI ready to penetrate into business and many startups of generative AI based business is developing business system as well as generators for text, computer code, images, video, design, voice and music. Illustrators, healthcare workers, actors, educators, legal researchers, office workers and drug-company technicians could be the first occupations threatened with this new form of this AI.

As Fig. 5 is results reported by Mckinsey, the impact of generative AI by business functions do vary but the report notes very compelling specific examples: Generative AI could increase sales productivity by 3-5% of current global sales expenditures. Across 63 use cases, generative AI has the potential to generate $2.6 trillion to $4.4 trillion in value across industries.

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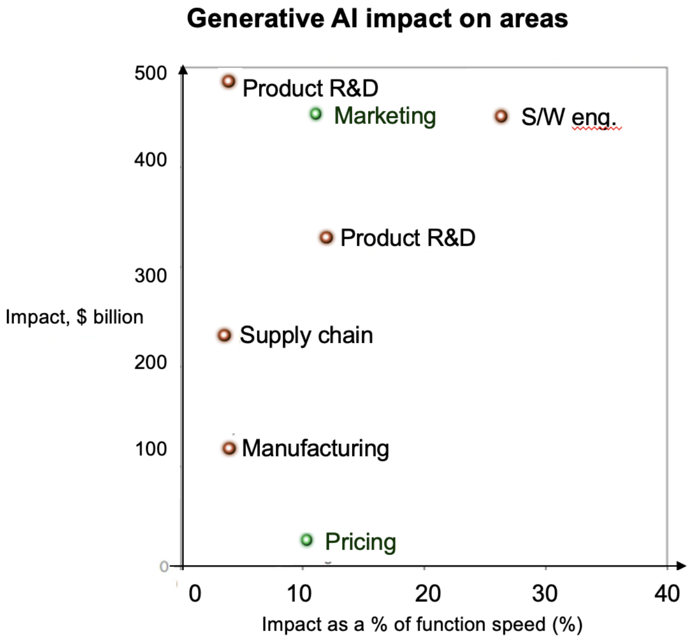

Fig. 5. Generative AI impact on each area [135].

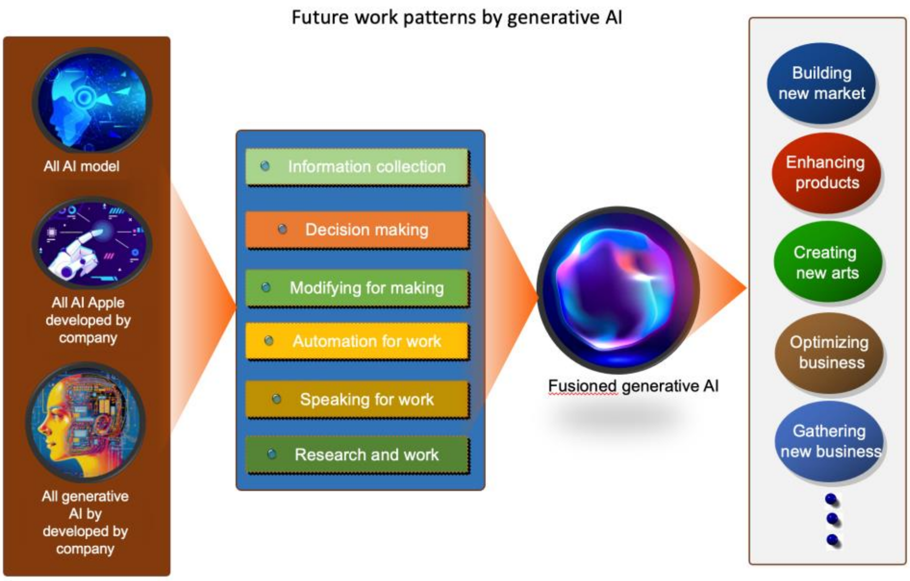

Fig. 6. Future impact by LLM.

B. Model Characteristics of LLM

LLM-technology has a very strong motivation to develop a new AI and research paradigm. As shown in in Fig. 1-4, We can see on how competition is struggle from this figure. It means the event of LLM is quite big impact on economic area and job changing. OpenAI do open their parameter to train with 175 billion parameters (they guess ChatGPT-3). In case of ChatGPT-4, it has a different parameter such as, positional parameter (it is function is to understand the order of words in sentence), learned parameter (which is making an accuracy of learning through weights and bias tuning), hyperparameters (Definition of the overall model structure and model behavior), and model configuration parameters (definition of the number of layer and nodes in each layer) (Sanuj Bhatia, March 2023).

The number of parameters LLM means a measure of model capacity for learning and complex understanding. So, LLM with more parameters learn more detailed and nuanced illustrates of language. That is, it allows model to generate more accurate and human-like sentence.

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TABLE 1. Comparison of each LLM.

LLM	Developer	Popular apps that use it	# of parameters	Access
GPT	OpenAI	Microsoft, Duolingo, Stripe, Zapier, Dropbox, ChatGPT	175 billion+	API
Gemini	Google	Some queries on Bard	Nano: 1.8 & 3.25 billion; others unknown	API
PaLM 2	Google	Google Bard, Docs, Gmail, and other Google apps	340 billion	API
Llama 2	Meta	Undisclosed	7, 13, and 70 billion	Open source
Vicuna	LMSYS Org	Chatbot Arena	7, 13, and 33 billion	Open source
Claude 2	Anthropic	Slack, Notion, Zoom	Unknown	API
Stable Beluga	Stability AI	Undisclosed	7, 13, and 70 billion	Open source
StableLM	Stability AI	Undisclosed	7, 13, and 70 billion	Open source
Coral	Cohere	HyperWrite, Jasper, Notion, LongShot	Unknown	API
Falcon	Technology Innovation Institute	Undisclosed	1.3, 7.5, 40, and 180 billion	Open source
MPT	Mosaic	Undisclosed	7 and 30 billion	Open source
Mixtral 8x7B	Mistral AI	Undisclosed	46.7 billion	Open source
XGen-7B	Salesforce	Undisclosed	7 billion	Open source
Grok	xAI	Grok Chatbot	Unknown	Chatbot

Fig. 7. Language speaking based control structure of MS based on LLM.

Microsoft 365 Copilot and Bing: MS 365 Copilot offers as LLM for tasks and activities. MS released ChatBing Feb. 2023 and it likes OpenAI in the search engine Bing. MS is studying robot control using ChatGPT as shown in Fig.7.

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Google Bard the chatbot, which was released under AI just like ChatGPT on March 21, 2023 for conversation with human. ChatGPT can be used only on the web browsers but Google bard can help in doing tasks like planning a vacation, meal planning, finding some reservation, and etc.

Meta: Meta opened its LLaMa2 as open source, which was pre-trained using 7 trillion, 130 trillion, 70 trillion parameters on July 18, 2023. LLAMA Model (Version 1) was developed from Dec 2022 to Feb. 2023, which is an auto-regressive language model based on the transformer and it can be trained easier because it is a smaller parameter than another model.

C. an Important Characteristics of LLM

Why are there so many LLMs? Until a year or two back before ChatGPT of OpenAI, LLMs were not interested in research and technology demonstrations at conferences or research topic. Now, these models powering countless useful tools, and there are hundreds of different models available that we can apply for ourself.

The biggest advantage of some ones is that it could be used to build practical tools for user friendly. So, lots of companies started doing the same with GPT-3 and ChatGPT that OpenAI had demonstrated AI research because of impact.

LLMs must take a lot of computing power to train. However, it can be done in a matter of weeks or months. There are also lots of open sources models that can be retrained or adapted into new models without additional needs to develop a whole new model.

Many startup companies as well as almost major tech companies, such as Amazon, IBM, Meta, OpenAI, MS, and NVIDIA release a new version or a new service under development of all LLMs for customers to use. They are going to improve a lot more efficient LLMs to run on smartphones and other lightweight devices for their initiative in business. Another big thing that will be going is large multimodal models or LLMs. These combine text generation with other modalities, like images and audio or voice covers all tasks what's going on in an image or responds with audio.

LLMs are powerful because they're able to be generalized to so many different situations and uses using mega data and several learning methods. The more useful core LLM will be developed and can be used to do dozens of different tasks. Because everything we want to do generates from text and image to another tasks, the specific ways we are going to tried to do it changes what features we want to appear.

Here are some of the tasks LLMs are commonly used for: General-purpose chatbots (like ChatGPT) with cheaper and user friendly; More cheaper customer service that are trained on user business's focus; Translating text from one language to another; Converting text into computer code; Generating social media like a movie; Research report writing and analysis; Correcting and editing writing; Data analysis and generating; Generating images for customer purpose; Convert files to different formats; Perform mathematic equation and other logical products.

D. Behavior Characteristics of LLM

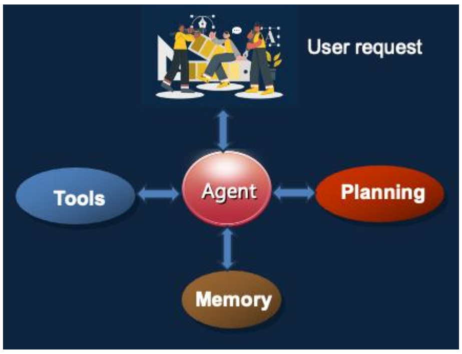

Fig. 8. Easy operation principle of LLM.

The Action Process of ChatGPT: To write proper prompt, users have to know the working process of ChatGPT to know well prompt process. Fig. 8 shows action process of ChatGPT. User request: the question or request of users; Agent: Coordination of workface as main brain of LLM; Planning: Assister of agent for the future action to break the necessary that the agent solves. Usually, CoT (Chain of Thought) and ToT (Tree of Thoughts) can be used; Memory: Manager of the agent's past behavior. Short term memory (Information of the agent's current situation), the information of the agent's past and thoughts as needed.

Structure of LLM Tools: LLM, as revolutionized Natural Language Processing (NLP), enables the sentences of human-like text and the understanding of complex language structures. To develop LLM applications effectively, developers work on a suite of tools and frameworks for building LLMs such as covering data sources, common tools, and cloud platforms. Retrieval-augmented generation (RAG) is a powerful tools LLM development for combining information retrieval with text generation to produce contextually relevant and coherent outputs. RAG integrates with popular data sources and pipelines, including cloud platforms.

RRHF and PPO of LLM: As shown in Fig. 9, Reinforcement Learning based on Human Feedback (RLHF) in LLM enables alignment of complicated language outputs with human preferences. The structure of RLHF has three main categories; Supervised Fine-Tuning (SFT), Reward Model Training, and Proximal Policy Optimization (PPO). Firstly,

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they apply supervised fine-tuning (SFT) on the initial models to learn by following human instructs. Secondly, a reward model learns from the ranking of human preferences. Finally, scores generated by the reward model apply gradient policy in PPO to align human preferences. So, PPO is an important and strong reinforcement learning (RL) process and has the key role in RLHF to align human preferences. This PPO training stage is powerful process. However, it is complex. It requires tuning a large number of hyperparameters for conservative parameter updating, reward design, advantage estimation, etc.

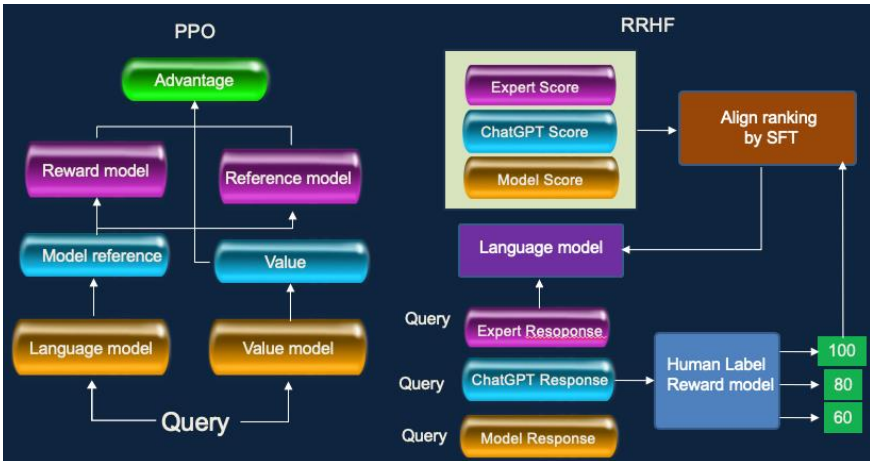

Fig. 9. Function of RRHF in LLM.

Reinforcement Learning of LLM: Fig. 10 shows the learning process.

Step-1 (Pretraining Stage): The pretraining is statistical information getting stage about language as encoding stage pf a language model. Statistical information provides how words or characters will appear in a given context. Speakers of a language have statistical knowledge of that language. A large language model (LLM), often known as the pretrained model include GPT-x (OpenAI), Gopher (DeepMind), LLaMa (Meta), StableLM (Stability AI).

Step-2 (Supervised Fine Tuning (SFT): The goal of SFT is to optimize the pretrained model to generate the responses that users are looking for.

Step-3 (RLHF): RLHF improves performance significantly compared to SFT alone. n this phase, LLMs further train the SFT model to generate output responses by the RM. This Proximal Policy Optimization (PPO) was released by OpenAI for a reinforcement learning algorithm in 2017. OpenAI provides this great diagram that explains the SFT and RLHF for InstructGPT (Fig. 6).

Retrieval Augmented Generation (RAG) in LLM

Retrieval-augmented generation (RAG) is one of learning for improving the accuracy and reliability of LLMs with facts offered from external sources. LLMs are the deigned model based on neural networks. The LLM parameters represent the general patterns by how many parameters they contain about how humans use words.

The RAG (Retrieval Augmented Generation of LLM can offer to enhance the accuracy, controllability, and relevancy of the LLM's response. This is why RAG (LLM) reduce issues of hallucination.

LangSmith

This is a platform for making it as easy as possible to develop LLM-powered applications. It was started at the same time of LLM (2022). LangSmith is developed by LangChain. The key configure: Pricing, learn about the pricing model for LangSmith; Self-Hosting, Learn about self- hosting options for LangSmith; Proxy, Learn about the proxy capabilities of LangSmith; Tracing, Learn about the tracing capabilities of LangSmith; Evaluation, Learn about the evaluation capabilities of LangSmith; Prompt Hub Learn about the Prompt Hub, a prompt management tool built into LangSmith.

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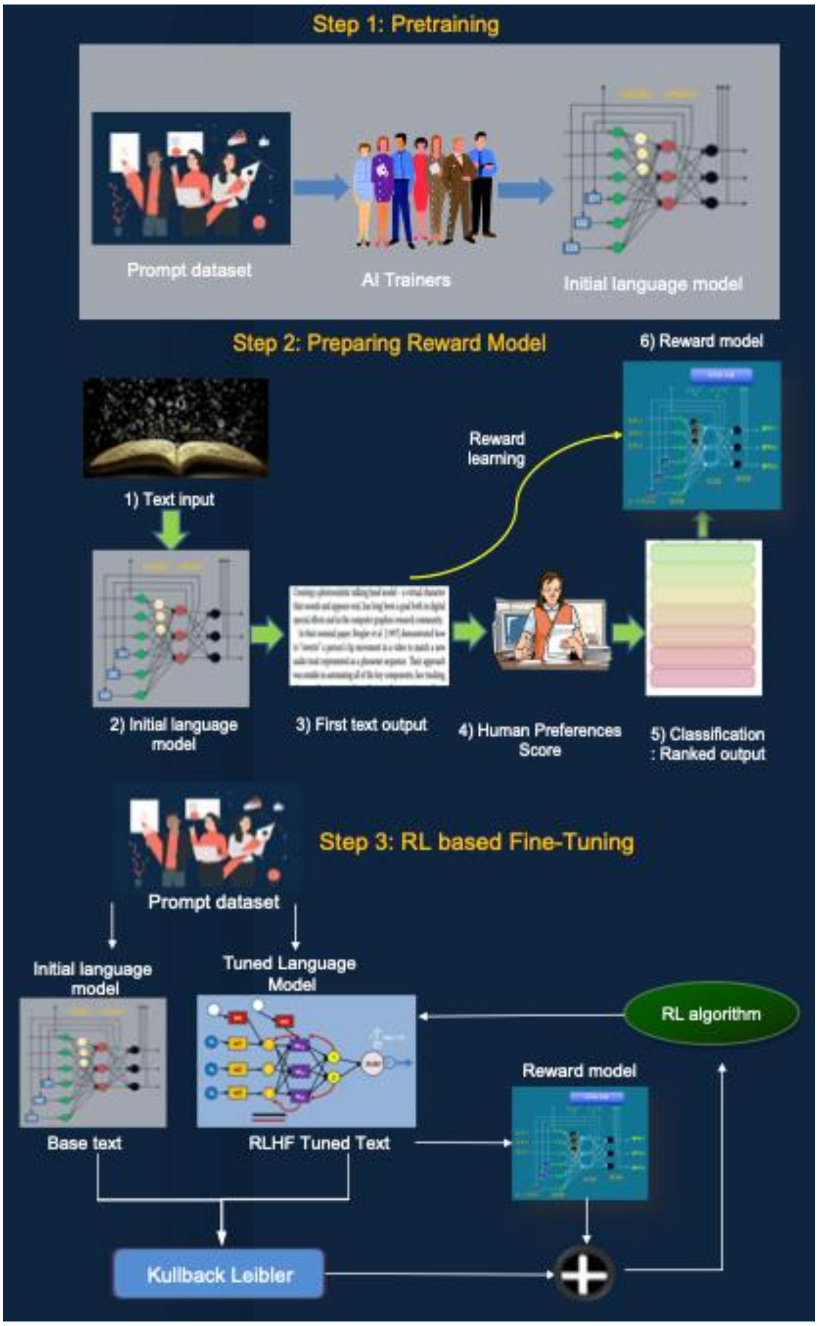


Fig. 10. Learning process of ChatGPT for sentence.

E. Translation Korean Sentence Comparison of LLMs

This paper tests the quality of LLM in translation. Of course, this paper experiments all LLM tools to see nuance translation. However, we suggest only two examples because of limited pager.

Original sentence: This novel is a very famous in USA written in 2017. They produce dram after novel and obtain many awards. Page 7 of this novel

Original: "What I wouldn't give to have a grandson of my own one day," the matchmaker said, making her closing gambit while peering hard at the boardinghouse keeper's creased, brown face.

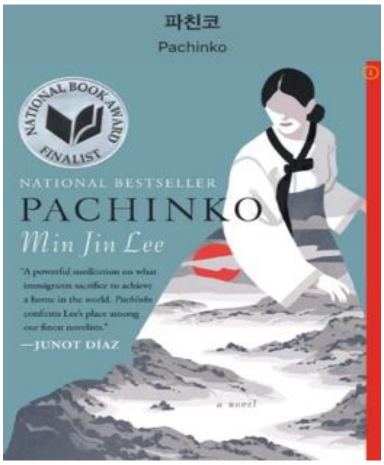
"지도 손자를 볼 수만 있다면야 뭐든지 줄 수 있다 아입니꺼"중매쟁이가 훈이 엄마의 주름진 구릿빛 얼굴을 뚫어지게 들여다보면서 승부수를 던졌다.

WRTN (The best Korean Translation LLM): "내가 언젠가 내 손자를 갖게 되었으면 하는데," 라고 중매쟁이가 말했습니다. 그녀는 주름진 갈색 얼굴의 여관 주인을 빤히 쳐다보며 마지막 제안을 했습니다.

ChatGPT: "나는 언젠가 내 손자를 가질 수 있다면 무엇이든 주겠어요,"라고 중매쟁이가 말하며 마무리 수를 두고 하숙집 주인의 주름진 갈색 얼굴을 뚫어지게 쳐다보았다.

Liner.AI: "내가 언젠가 나만의 손자를 가질 수 있다면 얼마나 좋을까요," 중매인이 말했습니다. 그녀는 보딩하우스 주인의 주름지고 갈색 얼굴을 주의 깊게 바라보며 최종 제안을 했습니다.

Gemini: "언젠가 손자가 생기면 좋을텐데..." 중매쟁이는 하숙집 주인의 주름지고 검게 탄 얼굴을 じっと (じっと - ji っと - intently) 들여다보며 마지막 제안을 꺼냈다.



Genre	Long novel (Pachinko)
Author	Lee Min Jin
Translator	Mi Jung Lee
Publisher	Grand central publishing
Date	Nov. 14, 2017
Page	512
ISBN	9781455563920

Fig. 11. A Novel to compare the quality of LLM.

Here's a breakdown of the translation:

- **"What I wouldn't give to..."**: This is a common English idiom that translates to a strong desire for something. Here, it's translated to >"언젠가 손자가 생기면 좋을텐데..." (eoneunga sonsaganeun saenggimyeon johaltende...) which literally means "It would be nice if I had a grandson someday..."
- **"closing gambit"**: This refers to the final attempt to persuade someone in a negotiation. Here, it's translated to >"마지막 제안을 꺼냈다" (majimak jeaneul-eul kkeonaedda) which means "she took out her final proposal."
- **"peering hard"**: This means looking intently or closely. Here, it's translated to >"じっと (じっと - ji っと)" (jitto) which is a Japanese adverb meaning "intently" and is commonly used in Korean as well.
- **"creased, brown face"**: This descriptive phrase is directly translated to >"주름지고 검게 탄 얼굴" (jujeumjigoseo geomge taneun eolgul) which means "wrinkled and tanned face".

I hope this translation is helpful! (www.readinggroupguides.com/reviews/pachinko/excerpt)

F. Auto GPT for Metaverse Design

Whenever we put into prompt in different LLM to compare, it is too boring. So, AUTO GPT was released on March 30, 2023 by Toran Bruce Richards, the founder and lead developer at video game company Significant Gravitas Ltd. Auto-GPT is an open-source autonomous AI agent based on OpenAI's API for GPT-4 the LLM released on March 14, 2023. Auto-GPT is among the first examples of an application using GPT-4 to perform autonomous tasks. This auto-GPT is useful for prompt engineering. However, to operate, the users have to another skill.

G. ChatGPT and Metaverse

The recent popularity of ChatGPT has insert into the knowledge creation. and the computer age. ChatGPT increase popularity and apply to the metaverse. By utilizing LLM, we believe that this LLM will combine with AR/VR and data, and will give a significant contribution to the paradigm shift of the new era. Therefore, we must prepare and education will also be impacted from this related technology.

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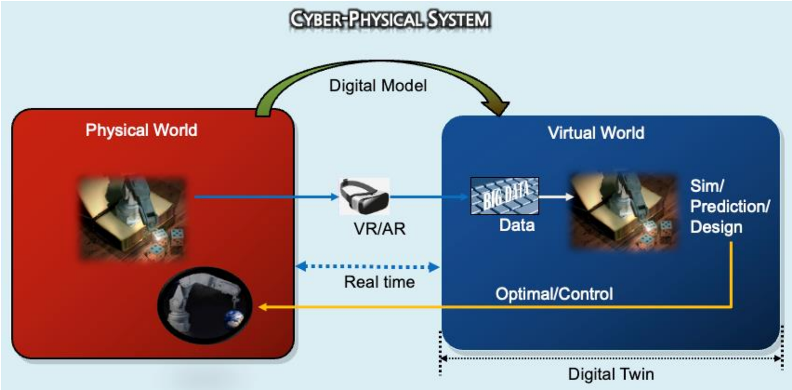

Fig. 12. LLM and metaverse.

III. THE AGRICULTURE IMPACT OF GENERATIVE AI

LLM Application in Agriculture Operations: Fig. 13 shows well why we have to introduce into agriculture. Right now, they are sleeping or dawn in ChatGPT because of a long traditional work patterns with heavy labor. The fast growth of the global population will be reached 10 billion by 2050 and food issues will give a significant pressure on the agricultural technologies to increase crop production and maximize yields. To recover this food shortage, we can consider two potential approaches have emerged. That is, agriculture issues are two kinds: expanding land use (adopting large-scale farming) and innovative technologies to enhance productivity on existing farmland.

However, expending use land is limited because of environment problems and cost. We are already facing environment around world.

That is, developing technologies for agriculture are only solution. Many obstacles such as limited labor (in advanced countries), drought, limited agriculture technologies (chemicals, seeds, seed cultivation, and etc.) and limited land holdings, labor shortages, climate change, environmental issues, and diminishing soil fertility, and so on reduce to achieve desired farming productivity. Therefore, many the modern agricultural landscape is evolving, branching out in various innovative directions. Farming has certainly come a long way since hand plows and horse-drawn machinery. Modern brings a new agriculture method to improve efficiency and capitalize on the harvest. However, both current by individual farmers and limited technology often miss out on the opportunities that AI (artificial intelligence) for agriculture can offer to their farming methods because of difficult to apply.

Benefits of LLM in agriculture: After all, agriculture is the backbone of human civilization for millennia, providing sustenance as well as contributing to economic development and to survive, while even the most primitive AI only focused on industrial areas since several decades ago. Agriculture is also no exception. Currently, many star up and the global companies have been seeing rapid advancements in agricultural technology, revolutionizing farming practices. These AI based innovations are becoming to get over a lot of global challenges such as climate change, population growth, limited operation technology.

Fig. 13. Agriculture operation by AI.

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Data-based optimal decisions for agriculture: The modern industrial works is going to improve their all business by data. Operation of the agricultural sector has to do by data-based decision to obtain optimal decision in every detail of the farming process, such as marketing, customer information, weather condition as shown in Fig. 14**.**

AI-based predictive analysis is already introduced into many ways and agriculture will not except. So far, farmers gathered vegetable and fruit by hard labor. Therefore, there is no an importance of data in agriculture. However, AI analyze market demand, forecast prices as well as determine optimal times for sowing and harvesting shown in Fig. 13.

AI based agriculture explore a new idea and cost saving, additionally the soil health condition, monitoring of weather conditions (through link weather forecast system), the application of fertilizer and pesticides can be and recommended. AI based agriculture can boosts production together with profitability, enabling farmers to make better decisions at every stage of the crop cultivation process.

Fig. 14. AI based smart farm strategy.

Cost savings of agriculture operation: Improvement of farm operation by AI and data yields statistics and constant goal for farmers. Many materials combined with AI help to operate farmers grow more crops with fewer resources. AI based material predicts soil management practices provides information with real-time crop insights. Therefore, it helps them to identify which areas need irrigation, fertilization, or pesticide treatment. Innovative farming practices can also increase food production while minimizing resource usage. Resulting in reduced use of herbicides, better harvest quality, higher profits alongside significant cost savings.

Self-operation and Automation by LLMs: Agricultural work is so hard because of labor works and productivity is shortage as well as working patterns is slow. However, AI based self-automation provides a solution without the need to hire more people.

AI based automated farm machinery like driverless tractors, fertilization systems, IoT-powered agricultural drones, smart spraying, S/W and LLM-based greenhouse robots for harvesting are absolutely necessary.

The traditional agriculture is worked by various manual processes. LLM-based farming have many advantages against the conventional works. Of course, LLM based system collects through data, while determining and initiating the best solution of action.

Optimization of automated irrigation systems by LLMs: LLM-based self-farming enable autonomous crop management using IoT (Internet of Things) and sensors to monitor soil moisture levels and weather conditions and provides decision in real-time how much water to provide to crops and situation. An AI based autonomous crop irrigation system is designed to conserve water. LLM-based smart greenhouses optimizes plant growth by automatically adjusting temperature, humidity, and light levels by real-time data.

Crop and soil monitoring: The wrong combination of nutrients in soil can seriously affect the health and growth of crops. AI based operation recognize problems of these nutrients and enable to determine their effects on crop.

While human observation is limited in its accuracy, computer vision models can monitor soil conditions to gather accurate data necessary for combatting crop diseases. This plant science data is then used to determine crop health, predict yields while flagging any particular issues. Plants start AI systems through sensors that detect their growth conditions, triggering automated adjustments to the environment.

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Detecting disease and pests by computer vision: Current technologies enable agriculture and farming to accurately track for problems in agriculture system. Computer vision of LLM can detect the presence of pests or diseases as well as soil quality and crop growth status. This works by using LLM in agriculture provide to scan images and to find mold, rot, insects, or other threats, and to crop health. LLM technology in agriculture has been used to detect apple black rot with an accuracy of over 90%. It can also identify insects like flies, bees, moths, etc., with the same degree of accuracy. However, researchers we need to collect images of these data for their training.

Monitoring agriculture environment: LLM solutions determine the impact of environmental conditions. By now, farmers are well aware of their working patterns. However, unfortunately, the traditional approaches might be slow and difficult work. LLM-based spraying is quicker and less labor-intensive accuracy, leading to environment contamination.

predictive analytics: LLM algorithms can predict through analyze large datasets in real time. This helps farmers understand the patterns and characteristics of their crops, allowing for better planning. By combining techniques like 3D mapping, data from sensors and drones, farmers can predict soil yields for specific crops.

Automatic weeding and harvesting: LLM can provide no how computer vision can detect pests and diseases and also be used to detect weeds and invasive plant species. It analyzes the size, shape, and color of leaves to distinguish weeds from crops. When it combined with robots, it carries out tasks, such as automatic weeding and harvesting. Computer vision of LLM detects current issues as well as disease in harvested crops.

III. **Simulation of Vegetable Mobile Robot by LLM**

This paper reviews many materials about the market position of generative AI and situation as well as basic technology, impacting factors. The issue is to obtain how we have to and what we have to have a solution for economic growth. To obtain this question, this paper suggests research schedule as shown in Fig. 14. At this point, this paper will not show all research results because of generative AI model is so many and something is not correct. However, its technology has a big power for impacting economy and this paper open how it has strategy.

Mobile Robot Application of LLM

Creating a mobile robot moving simulation using LLM (ChatGPT) involves designing a simple environment where we simulate basic robot movements based on text commands. While this paper uses full-fledged robotics platforms like ROS or Gazebo directly in this environment, we can create a simple Python-based simulation using basic graphics and command parsing Fig. 15 shows moving position for point to point.

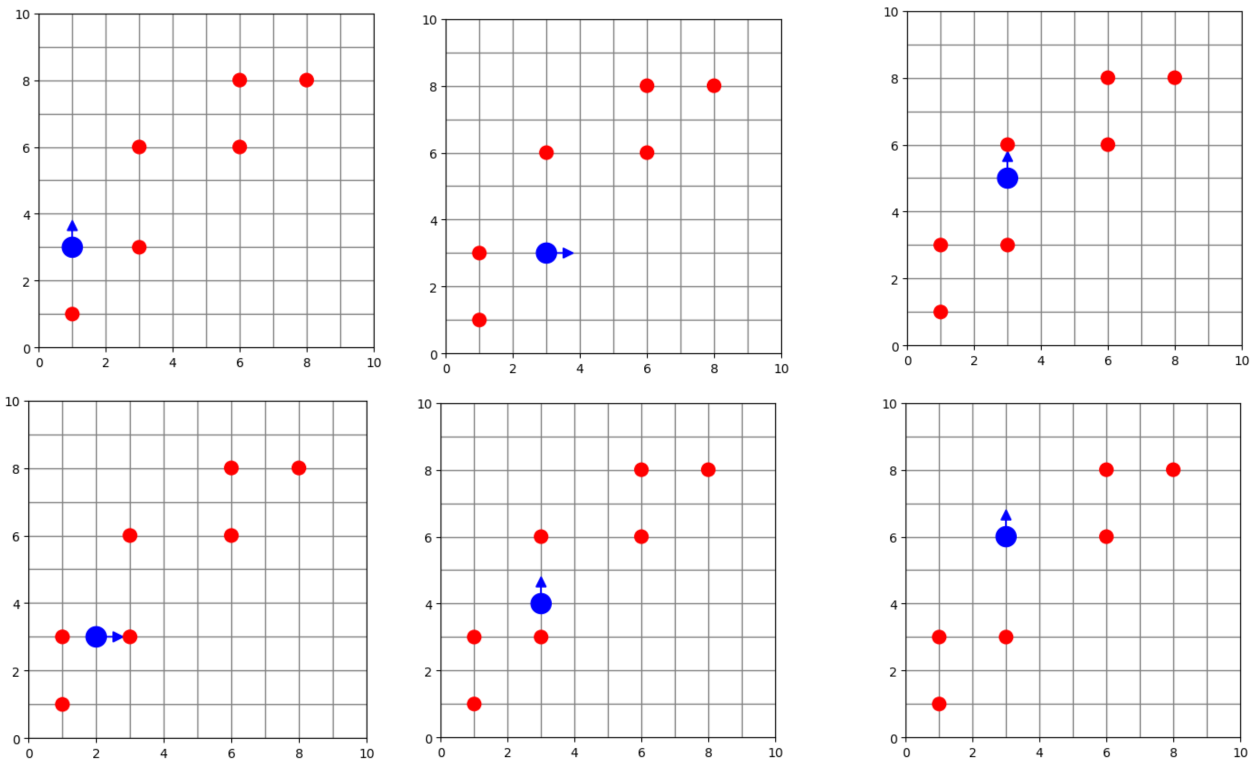

Fig. 15. Simulation results of moving position (point-to-point) of smart vegetable mobile robot.

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To simulate a mobile robot following a smooth curve, this paper defines a continuous path, such as a circular or sinusoidal path, and have the robot follow this path in Fig. 16. The results update the robot's position smoothly along the curve, creating a more realistic simulation of continuous movement. Simulation results of moving position (circle tracking) of smart vegetable mobile robot.

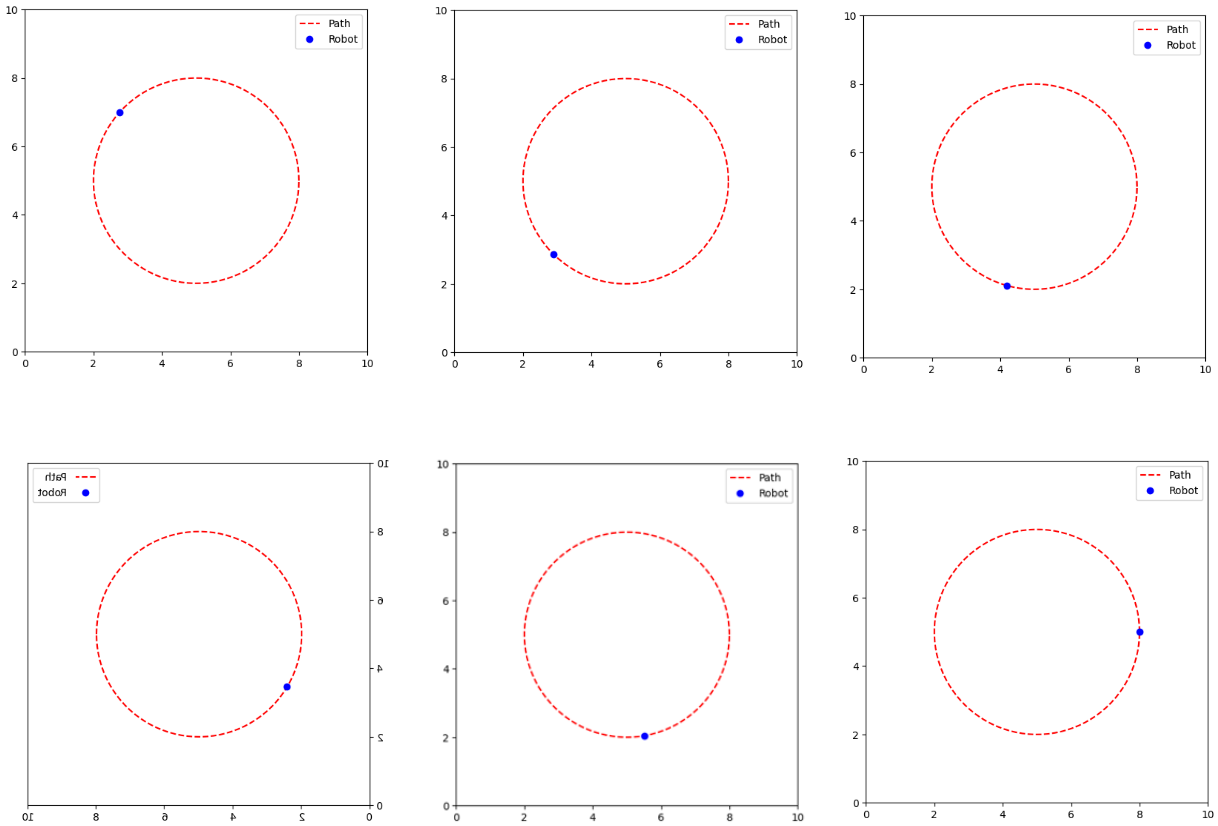

Fig. 16. Simulation results of moving position (circle tracking) of smart vegetable mobile robot.

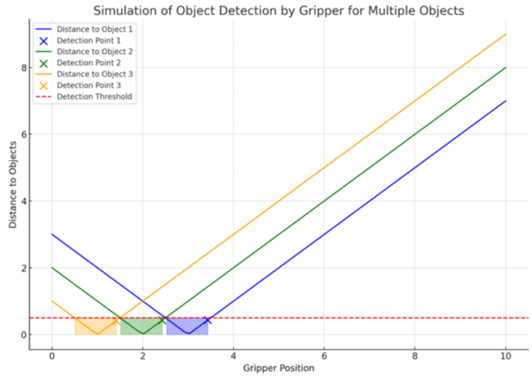

Fig. 17. Simulation result of designed gripper to detect multiple objects

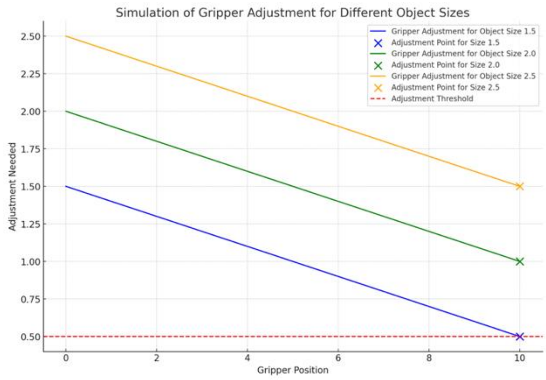

Fig. 18. Simulation result of gripper adjustment for different object sizes.

Fig. 17 shows simulation result of designed gripper to detect multiple objects and Fig. 18 is simulation result of gripper adjustment for different object sizes.

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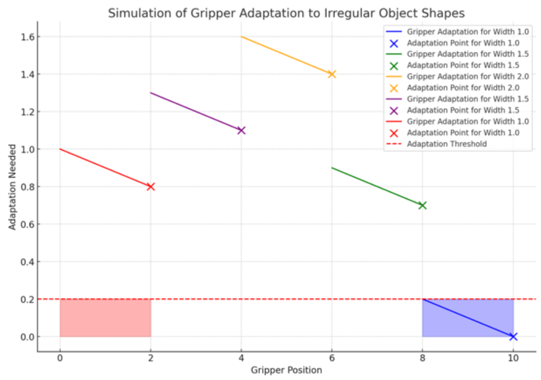

Fig. 19. Simulation result of gripper adaptation to irregular object shapes

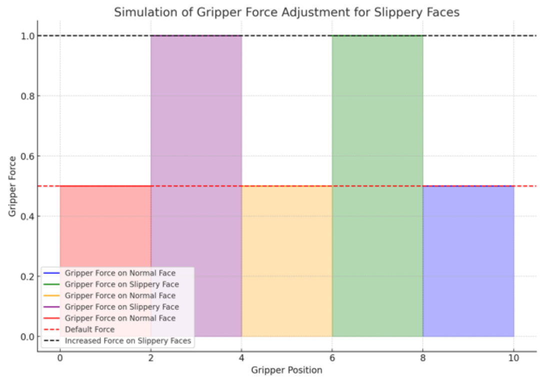

Fig. 20. Simulation result of gripper force adjustment for slipper faces.

Gripper Behavior of LLM: This paper simulates to design gripper for vegetable. It appears that the execution environment was reset, which means that the simulation code I attempted to run could not complete in Fig. 19, Fig. 20.

Simulation of a Gripper Handling Multiple Objects: To demonstrate how a gripper might handle multiple objects, this paper simulates a scenario where the gripper detects and picks up multiple objects in its workspace. This could involve using multiple proximity sensors or a vision system to detect the objects' positions and then planning a grasp that allows the gripper to pick up all objects simultaneously or in sequence. This graph demonstrates how the gripper detects multiple objects sequentially as it moves towards them. Each object's detection occurs when the gripper's distance to the object falls below the detection threshold. This kind of visualization is useful for understanding how a robotic gripper could manage to detect and interact with multiple objects in its workspace.

Simulation of Gripper Adaptation to Irregular Object Shapes: Here is the simulation result showing how a gripper adapts to irregular object shapes. The graph illustrates the following in Fig. 20 and Fig. 21.

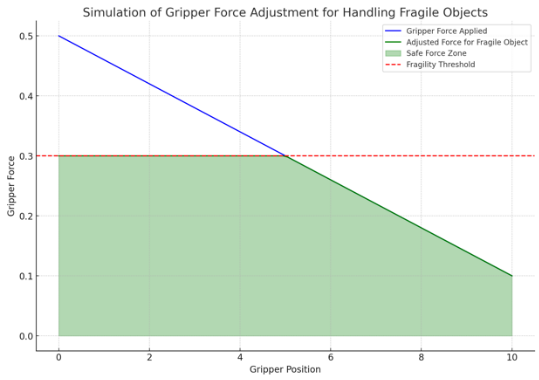

Fig. 20. Simulation result of gripper force adjustment for handling fragile objects.

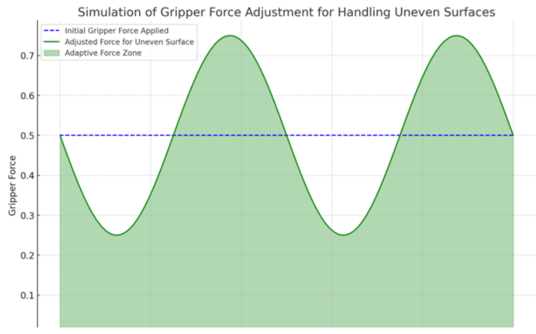

Fig. 21. Simulation result of gripper force adjustment for handling uneven surfaces.

Gripper Movement: The gripper moves from an initial position toward an object with an irregular shape, where the object's width varies at different heights.

Irregular Object Shape: The object is simulated with different widths (1.0, 1.5, 2.0, 1.5, and 1.0 units) at different heights. Each width represents a different part of the object that the gripper encounters as it moves closer.

Adaptation Process: As the gripper approaches each part of the object, it adjusts the spacing between its fingers to match the object's varying width.

Adaptation Threshold: The red dashed line indicates the threshold distance at which the gripper starts adjusting its fingers to accommodate the changing width of the object.

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Adaptation Points: The points where the gripper first detects the need to adapt its grip for each part of the object are marked with dots. The shaded regions represent the areas where the gripper is actively adapting to the irregular shape.

This simulation demonstrates how the gripper uses sensor feedback to continuously adapt to the varying widths of an irregularly shaped object, ensuring a secure grip that conforms to the object's shape. This ability is essential for handling objects that do not have uniform or predictable shapes, such as natural products or complex industrial parts.

Simulation of Gripper Force Adjustment for Slippery Faces

Here is the simulation result showing how a gripper manages slippery faces on an object. The graph illustrates the following (Fig. 20)

Gripper Movement: The gripper moves from an initial position toward an object with both slippery and non-slippery faces.

Slippery Faces: The object is simulated with alternating slippery and non-slippery faces. These are indicated by the changes in the applied force in the graph.

Force Adjustment:

- The gripper applies a default force of 0.5 units on non-slippery faces (indicated by the red dashed line).
- When the gripper encounters a slippery face, it increases the applied force to 1.0 units (indicated by the black dashed line) to ensure a secure grip.

Adaptation to Slippery Faces: The graph shows how the gripper adjusts its force as it moves across different segments of the object. The shaded regions represent the force applied on each segment, with increased force on slippery faces to prevent the object from slipping.

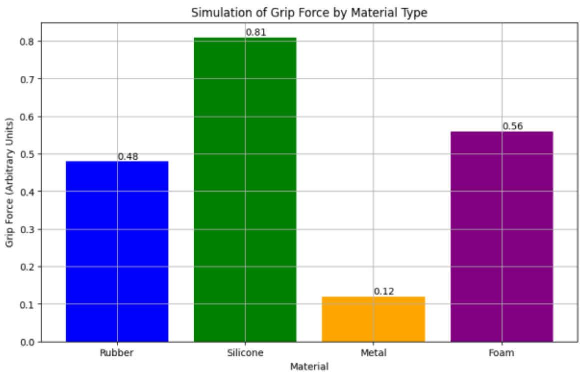

Fig. 22. Simulation result of gripper force by material type.

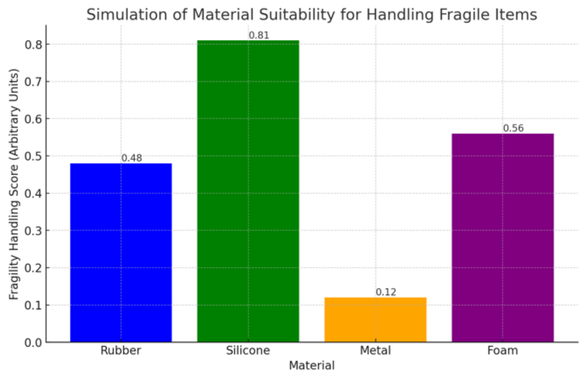

Fig. 23. Simulation of gripper for handling fragile items.

This simulation demonstrates how a gripper can detect slippery surfaces and adapt by applying more force to maintain a secure grip, ensuring that the object does not slip out of the gripper's grasp. This capability is crucial for handling objects with varying surface properties, such as wet or oily materials, where the risk of slipping is higher.

The simulation results with graph about how the gripper handle fragile objects.

Here is the simulation result showing how a gripper handles fragile objects. The graph illustrates the following (Fig. 22 and Fig 23):

Gripper Movement: The gripper moves closer to the fragile object, applying an increasing amount of force as it prepares to grip the object.

Fragility Threshold: The fragile object can only withstand a certain amount of force before it breaks. This threshold is indicated by the red dashed line at 0.3 units.

Force Adjustment:

- The blue line represents the force that the gripper initially applies as it moves closer to the object.
- The green line shows the adjusted force that the gripper applies after detecting the object's fragility. The gripper ensures that the force does not exceed the fragility threshold to prevent breaking the object.

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Safe Force Zone: The shaded green area represents the zone where the applied force is within the safe range for the fragile object. The gripper adapts its force to stay within this zone, ensuring a secure yet gentle grip.

This simulation demonstrates how a gripper can detect the fragility of an object and adjust the applied force accordingly. By limiting the force, the gripper ensures that the object is handled carefully without causing damage. This capability is particularly important in applications where delicate items, such as glassware, electronics, or medical instruments, need to be handled safely.

The simulation results with graph about how the gripper handle uneven surfaces: Here is the simulation result showing how a gripper handles uneven surfaces. The graph illustrates the following (Fig. 21):

Gripper Movement: The gripper moves closer to an object with an uneven surface profile, which is represented by a sinusoidal wave. This wave simulates the varying height or texture of the object's surface.

Initial Force: The blue dashed line represents the initial, uniform force that the gripper would apply if the surface were even.

Force Adjustment:

- The green line shows how the gripper adjusts the applied force based on the surface profile. As the gripper encounters higher or lower sections of the surface, it modifies its force accordingly.
- The force increases where the surface protrudes and decreases where the surface recedes, ensuring consistent contact and grip across the uneven surface.

Adaptive Force Zone: The shaded green area represents the zone where the gripper is actively adapting its force to conform to the uneven surface. This adaptation ensures that the gripper maintains a secure grip on the object despite the irregularities in the surface.

This simulation demonstrates the importance of adaptive force control when handling objects with uneven surfaces. By adjusting the applied force in response to surface variations, the gripper can maintain a stable and secure grip, reducing the risk of slipping or losing the object. This capability is particularly useful in industrial applications, where objects may have irregular textures or surfaces.

T**he simulation results about graph materials:** To simulate and analyze which materials might be better for a gripper, we can consider factors such as grip force, surface friction, and material compliance (flexibility). Different materials used in grippers—such as rubber, silicone, metal, and foam—can have different characteristics that affect their performance in handling objects. Let's simulate how these materials might behave in terms of grip force and friction.

Assumptions for the Simulation:

Material Types:

- **Rubber**: High friction, moderate flexibility.
- **Silicone**: High friction, high flexibility.
- **Metal**: Low friction, low flexibility.
- **Foam**: Moderate friction, high flexibility.

Grip Force:

- Different materials apply different forces due to their compliance and friction properties.

Friction Coefficient:

- A measure of how much grip the material has on the object. Higher friction coefficients mean better grip.

This simulation suggests that **silicone** and **rubber** are generally better materials for a gripper due to their higher grip forces. **Foam** is also a good option, particularly for delicate or irregular objects. **Metal**, while offering lower grip, might still be useful in applications requiring high precision and rigidity. The choice of material ultimately depends on the specific requirements of the application, including the types of objects being handled, the environment, and the desired durability of the gripper.

CONCLUSION

This paper studies about agriculture operation (smart farm 4.0) and simulation of mobile robot and gripper for perilla vegetable. There are some research results for fruit such as tomato, apple, and strawberry. However, there is no research paper about the mobile robot for vegetable such perilla. This research provides smart farm strategy through reviewing many reports and papers on how much generative LLM impact on agriculture.

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All materials shown in this reviewing should mention that LLM impact is so high and should prepare for the future. At this point, we do not figure out what factors will give an impact on agriculture leading factor because of short data and limited simulation in vegetable and fruit.

The simulation suggests that silicone is the best material for handling fragile items due to its combination of high flexibility and grip. Foam is also a strong contender, especially for objects with irregular shapes or those requiring a softer touch. Rubber is suitable but might be more appropriate for items that are less fragile. Metal is not recommended for fragile items due to its rigidity and lower compliance.

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