CAAS (Chatbot as a Service) and IOT Devices: A review on recent approaches

[1]**Mr.Satish Bhalshankar,**   [2] **Dr. Ratnadeep R. Deshmukh,**   [3]**Dr.Yashodip R. Patil,**
[1]Research Scholar, [2]Professor & Guide,[3] Assistant Professor
[1,2]Department of Computer Science & IT,
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
[3]School of Management Studies, KBCNMU, Jalgaon.425001

Abstract: *The Internet of Things (IOT) is a comprehensive and sophisticated computer programme that may be used in the field of home automation to operate appliances like microwaves, fans, lighting, air conditioners, televisions, washing machines, refrigerators, computers, printers, etc. It has the ability to simulate real user conversations. A good example is a chat on a company's website that informs the user about the company's services. Your SBC decision will depend on how adept you are at AI and how far you have come thus far. After purchase, development boards like the NVIDIA Jetson Xavier and Google Coral Dev Board are available for AI deployment. However, due to the complexity of IoT-based platforms and the variety of methods required to transport data across embedded devices, there are now issues and hurdles that must be overcome. The chat interfaces used in instant messaging (IM) services (including Facebook Messenger, Slack, Kik, and Telegram) are already highly well-liked and are continuing to develop steadily, the survey claims. On a related note, improvements in artificial intelligence, particularly in the area of natural language processing, have improved chatbots' effectiveness and quality in terms of conversational simplicity, adaptability, and usability, as well as their capacity to enable users to submit complex requests using straightforward natural language.*

Key Words: *NLP, IOT, Internet of Things, Jetson Nano, Nvidia, Raspberry Pi, Chatbot.*

1. INTRODUCTION:

The use of IoT and chatbots has exploded across industries. The virus outbreak has spurred the development and deployment of these technologies in enterprises. The physical markets have undergone drastic changes in their operations. And it gives business owners a new look at how technology benefits businesses. Whether it is IoT development services or implementing chatbots, more and more companies are looking for suitable options. [1] [3] Previously restricted to supercomputers, artificial intelligence (AI) programmes may now be modified by producers at home. DIYers may create AI apps in the comfort of their own homes with the use of construction kits like the Google AIY Voice and Vision kits. Similar to how sophisticated single-board computers (SBCs) have evolved, many developing boards now include artificial intelligence (AI), including machine learning and natural language processing. Find the best single-computer artificial intelligence platforms [4].

SBCs, or single-use computers, are gradually taking over as everyone's favourite electronic toy. Because an SBC achieves powerful functionality while maintaining a small form factor, the main components of an SBC are the IO ports, RAM, CPU, and GPU. These characteristics can be found in nature or in a small circuit. The SBC is not as compact but rather extremely thick due to these physical qualities. ([2] ([5] The SBC user can extend the functionality of this powerful circuit integration with IOT devices through the provided input and output ports. The Arduino and Raspberry Pi SBC devices are the most well-known SBCs you may connect to, depending on the specification above. The only viable options in the present world history of DL (deep learning) and AI (artificial intelligence) SBCs are not Arduino and Raspberry Pi. Most SBCs already meet industry AI and DL requirements for standard edge computing. [2]

What is IOT?

The Internet of Things (IOT) [2][6][8] can be applied to the field of home automation to control microwave ovens, fans, lamps, air conditioners, televisions, washing machines, refrigerators, computers, printers, and others It is a modern computer, not a traditional one. It refers to the quantity of electronic devices that are linked to the Internet in order to send or receive data or both.

Both parties need an Internet connection to receive and transmit data. We can provide a web interface for input and an IOT device like the Raspberry PI to operate fans, lights, etc. These gadgets interact with the outside world over the Internet using incorporated technology [2 and 4].

An IoT system has three main layers, including

- Awareness layer
- System Layer
- Applying layer

Real-time devices such as cameras, U disks, and sensors are part of the awareness layer. The awareness layer transmits data to the following layer. The system layer is the middle level that connects the physical and virtual worlds. The application created for smart cities, smart agriculture, and e-health is called an application layer. This layer, known as the client layer, is where the user receives information and controls the device (Figure 1).
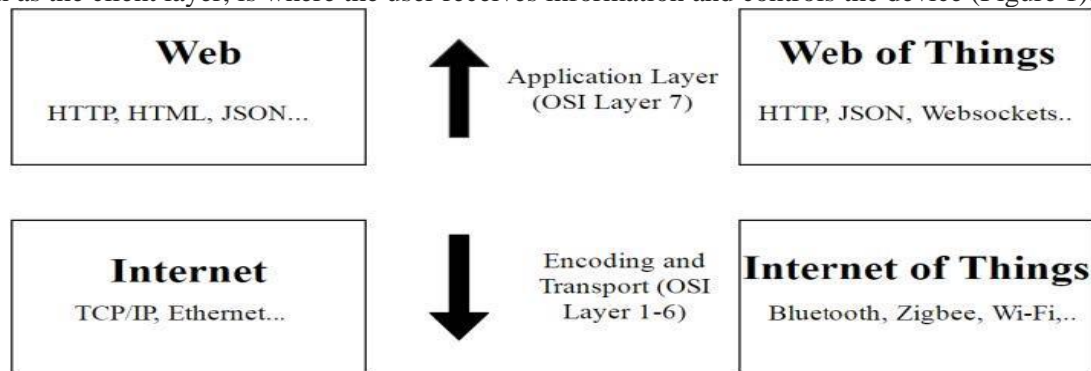

Figure 1. IOT Structure
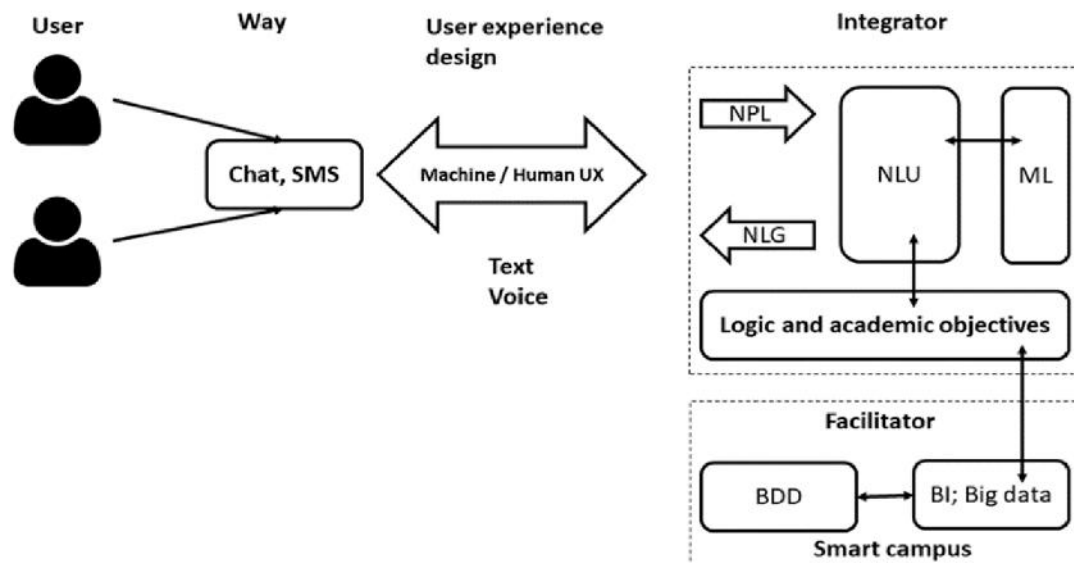
What is IoT Chatbot?

Figure 2. IOT Chatbot Schematic Diagram

IoT is a network of devices connected to the internet and each other. A perfect example would be a smart home with a thermostat, camera, virtual assistant, etc. Everything is connected to the internet [4]. On the other hand, chat is a comprehensive and complex computer program. It has the ability to simulate real user conversations. A good example is a chat room on a company's website that informs the user about the company's services, shown in Figure 2. The combination of these two concepts is considered under IoTchatbot. An IoT chatbot that monitors your IoT network to provide alerts and improve its health is called an IoT chatbot. [4] An example would be a chat room used in WhatsApp or Facebook Messenger. It can inform the user about the status of the thermostat in the house. Based on a measured parameter, such as temperature, the user can ask the chat to lower it. A chat connected to a home automation system can adjust the temperature. IoT chatbots are not a new concept; they have been developed on a smaller scale by various tech giants. Because they have the best technology, they believe that conventional chatbots

are only the tip of the iceberg. [5] The level of technology used in IoT chatbots is high. Here are some key technologies that make up the essence of a chatbot:

NLP (Natural Language Processing):

NLP, together with AI, forms the heart of the chatbot. The idea behind the old chatbots was to search for a keyword in what you (only) write and give an answer based on that. However, the IoT needs more. [9] Major tech companies like Google believe the true power of chatbots has yet to be revealed. NLP helps chatbots understand what someone is saying and develop ideas based on that. Unlike traditional chatbots, modern assistants like Google Assistant and Siri use NLP to understand user input.

Complex algorithms are used by NLP to process data. To comprehend voice and text written in natural language, it employs natural language production and natural language understanding. They can easily interpret what the user has said and determine a series of actions based on that. The NLP process includes:**Lexical analysis**: I break down a text into sentences and words.

- **Syntactic analysis (parsing)**: grammatical analysis and arrangement of words.
- **Semantic analysis**: An analysis of the meaning of the text
- **Integrating discourse and pragmatic analysis**: the general meaning of what is said in the context.

Based on the shared meaning, NLG generates a meaningful response. This is done through text planning and text implementation.

3. COMPARATIVE STUDY OF TYPES OF BEST SINGLE BOARD IOT DEVICES FOR CHATBOT SYSTEMS
Raspbian Pi 4:

We think it's best to start this SBC review of this article with a well-known face. The Raspbian Pi 4 was launched with one goal: IoT and artificial intelligence. Any mention of artificial intelligence automatically includes deep learning, because the latter cannot exist without the former. With an estimated cost of $35, this electrical board is the most frequently used veneer due to its low cost. The user community is quite supportive of the Raspbian Pi 4. It includes a comprehensive and well-researched user manual that will help any user understand how to begin using Raspbian Pi. It is conceptualised as an altered SOC. The Raspbian Pi 4's hardware specs provide consumers the option of 2GB, 4GB, or 8GB of DDR4 RAM. This board is perfect for AI-based applications because of its wide variety of specifications and hardware. [11]

Figure 3: Raspbian Pi 4Architecture

You may evaluate the Raspbian Pi 4's performance using open source machine learning frameworks like TensorFlow and contrast it against the Raspbian Pi 3 to determine how well it performs. Compared to its predecessor, the Raspbian Pi 4 will have a lot more computer capability. Performance is greatly enhanced with USB 3.0 port support. In Raspbian Pi 4, AI-enabled third-party accessories are added. For instance, you may use a USB connection to link your Raspbian Pi 4 to the Intel Neural Compute Stick 2. This third-party add-on is ideal for simplifying AI infrastructure configuration. The Coral Edge TPU USB Accelerator is yet another extra third-party attachment. It's the ideal tool for connecting to your Raspbian Pi board. Another excellent tool for interacting with your Raspbian Pi board for AI and DL applications is the Google AIY Vision and Voicekits.

The Raspbian Pi 4 is the most well-known SBC on the globe and is a low-cost construction board with a starting price of $35. He has an outstanding track record and backing. The Pi 4 is a fantastic AI device thanks to its many third-party attachments. With the help of a USB connection, the Intel Neural Compute Stick 2 connects to a Raspbian Pi 4 and offers an AI framework. A nice alternative for the Pi is the Coral Edge TPU USB Accelerator. Google provides its AIY vision and speech suite, enabling DIY creators to experiment with artificial intelligence and create cool projects, like object and self-driving car recognition systems. The Raspbian Pi 4 is the greatest single-board AI computer from most manufacturers because of its exceptionally low price and a variety of AI add-ons like the Intel Neural Compute Stick and the GoogleAIY Kit.

Advantage:
- Versatile
- Affordable
- Several different RAM options
- easy to use
- Excellent value
- Small footprint
- Low energy consumption
- Huge OS compatibility, Android, Chrome OS , including non-Linux OS and Linux
- Provide more powerful SBC

Raspberry Pi 4 Specifications:
- 1.5 GHz Cortex-A72 (ARM v8) quad-core SoC from Broadcom
- LPDDR4-2400 SDRAM of 1 GB, 2 GB, 4 GB, or 8 GB
- IEEE 802.11ac wireless technology, Bluetooth 5.0, and BLE
- Ethernet in Gigabit
- Dual USB 3.0 and USB 2.0 ports.
- two micro-HDMI ports (allows for upto to 4kp60)
- Port for a 2-channel MIPI DSI display
- Port for a 2-way MIPI CSI camera
- ports for composite video and 4 pole stereo audio
- H264 (1080p60 decode, 1080p30 encode) and H.265 (4kp60 decode)

Jetson Xavier NX from NVIDIA:

The #1 candidate on this list, without a doubt, is Jetson XavierNX. Despite being the world's smallest AI and DL supercomputer, this SBC has theoretically infinite capability. With a 15W power supply, it has a processing speed of 21 trillion operations per second (TOPS). The Nvidia Jetson Xavier NX will still be about 14 TOPS if we cut this power supply to about 10W. The Nvidia Jetson Xavier NX is marketed as a robust single-board computer with minimal power consumption. It is really small, with a length of 70-45 mm. Its technical sheet is compact, yet it has a striking side. Its 6-core 64-bit NVIDIA Carmel ARM v8.2 CPU has 48 tensor cores and a 384-core NVIDIA Volta GPU. [11] [12]. In performance comparison tests, the all-in-one's youthful relations, Jetson Nano, and Jetson TX2 couldn't match the power and performance. Despite the single board computer's performance impressions, it is not very expensive; you would need just $400 to get this potent SBC. The Jetson Nano and its SBC brothers are on sale for a reasonable $59 each. Based on such differences in the cost range, SBC is neither underqualified for AI assignments nor overqualified for them. You must be specific about the goals of your AI project.

Figure 4: Jetson Xavier NX from NVIDIA

As previously stated, this SBC is the Nvidia Jetson Xavier NX's younger brother. Its request cost is lower than that of the Nvidia Jetson Xavier NX on the open market. We can buy this hardware SBC with an estimated budget of $59. At this price, the price/performance ratio is quite good. Numerous neural-related AI procedures may be carried out on this hardware with great success. These AI application procedures include, for instance, image representation, voice processing, object localisation and segmentation. Boost the performance of your computer by no less than 21 TOPS (tera operations per second) with only 15 W of power. With under 10 W of electricity usage, the Xavier NX runs on approximately 14 TOPS, which is incredibly powerful yet energy efficient. The Jetson Xavier NX from NVIDIA outscored its smaller siblings, the Jetson Nano and Jetson TX2, in benchmark tests. The Xavier NX is beaten by the Jetson AGX Xavier, although it isn't far behind. Unfortunately, it's not inexpensive. The Jetson Nano is $100, whereas the Nvidia Jetson Xavier NX is anticipated to cost roughly $400. The Jetson Nano ought to function just fine for less demanding AI applications. The NVIDIA Jetson Xavier NX, however, is the solution if you require supercomputing power.

Advantages:
- Supports artificial intelligence - handles natural language processing and machine learning, etc.
- The best among robots - Ideal for computer use
- Perfect for sophisticated vintage game emulation
- Wi-Fi, Bluetooth, USB 3.1, GPIO and HDMI/DisplayPort provide excellent I/O.
- 21 TOPS of computational power or more

Disadvantages:
- Larger than the Raspberry Pi and comparable devices
- Specifications for the Nvidia Jetson Xavier NX
- Processor: 6MB L2 + 4MB L3 NVIDIA Carmel 6-Core ARMv8.2 64-bit @ 1400MHz*
- GPU: 48 tensor cores and 384 NVIDIA Volta cores operating at 1100 MHz
- There are two NVDLA (NVIDIA Deep Learning Accelerator) engines.
- 51.2 GB/s | 8GB 128-bit LPDDR4x @ 1600 MHz

NVIDIA Jetson-Nano:

Both 2GB and 4GB variants of the NVIDIA Jetson Nano are available. Both are suitable options for AI work. The Jetson Nano is a compact, powerful, and power-efficient single-board computer equipped with a quad-core ARM A57 CPU and a 28-core NVIDIA Maxwell-based GPU. The Jetson Nano is a compact, powerful, and power-efficient single-board computer equipped with a quad-core ARM A57 CPU and a 28-core NVIDIA Maxwell-based GPU. [11][13]. The M.2 connection is absent from the DisplayPort connector, but the cost is reduced from $100 to $59. The NVIDIA Jetson Nano 2GB's capabilities amazed me throughout testing. Beginners, students, and anybody on a tight budget should consider it.

Figure 5: NVIDIA Jetson-Nano

Advantages:
- Runs Linux out of the box and is simple to use.
- Affordable
- Flexible - Excellent for robots and artificial intelligence

Specifications of the device:
- Few operating systems available
- NVIDIA Jetson Nano 2 GB specifications:

- GPU: GPU based on NVIDIA Maxwell™ architecture with 128 cores
- Processor: ARM® Quad-Core A57
- Video: encoding and decoding for 4K at 30 frames per second and 4K at 60 frames per second (H.264/H.265)
- 12x (module) and 1x MIPI CSI-2 DPHY lanes camera
- 2GB 64bit LPDDR4; 25.6 GB/s memory

Jetson AGX Xavier from NVIDIA:

It is the most costly SBC product available from NVIDIA. Our best estimate for the market price is $694.91. Although some people would consider the price to be too costly given their features and effort, this is a useful marketing element. This SBC board's functional goal is to introduce or incorporate mechanical AI technologies into business applications in the commercial or industrial environment. With regard to gardening, hospitality, the automotive industry, retail, and manufacturing, this SBC board is adaptable enough to fit into any commercial or industrial setting. You require Nvidia Jetson AGX Xavier SBC's substantial assistance in several additional business and industrial circumstances. [12], [14].

Figure 6: Jetson AGX Xavier from NVIDIA

The Nvidia Jetson AGX Xavier is not for novices or map explorers because of this and the astounding pricing of this SBC. Engineers aiming for the highest quality of design outcomes and numerical performance will find the SBC to be the right tool due to its design and operating capabilities. If they choose to work with Nvidia Jetson AGX Xavier, organizations, corporations, or firms seeking a broad variety of software and hardware won't ever be dissatisfied. The HDMI 2.0 display, 32GB of eMMC 5.1 storage with an optional UFS/usD storage expansion card, VLIW Vision processor accelerator, 2xNVDLA Engine DL accelerator, Tensor cores with 512 cores, and Volta GPUs are just a few of this SBC's standout features. 8-core, 64-bit ARM v8.2 CPU.

Tip for developers: Google Coral:

This SBC is excellent for deep learning with AI because of its practical design and implementation. You need the convenient Google Coral Dev Board SBC if your AI project calls for quick, simple, and sophisticated computer prototyping. The replaceable system module is one of this single-board computer's distinguishing features. The optimal TOPS number (Tera Operations Per Second), which is 9 TOPS, is another aspect of this SBC. For this SBC, TOPS is calculated per watt.

Figure 7: Google Coral Developer Tip

The Google Coral DevBoard is excellent for low-cost AI and deep learning applications because of the two qualities described above. The NXP i.MX 8M SoC serves as the brains of this SBC. The SoC has a GPU called the GC7000 Lite. A Google Edge TPU CPU, Wi-Fi and Bluetooth hardware, 1GB of LBDDR4 RAM, and 8GB of eMMC flash memory were also discovered in another review of this SBC board. The Google Coral USB TPU Accelerator and the Raspberry Pi 4 Plus are excellent places to start if you're seeking practical experience with AI and deep learning. The Edge TPU machine learning on the Google Coral development board, 1GB of DDR4 memory, and a quad-core Cortex A-53 SoC as the main power source are notable advantages. One significant disadvantage is the $129.99 cost. Additionally, using it as a desktop computer is not recommended.

Advantages:
- Edge TPU-based on-device machine learning
- A powerful Cortex A-53 SoC with four cores
- 1GB DDR4

Disadvantages:

- Inappropriate for desktop use
- **Features of Google Coral Dev Board:**
- Processor: NXP i.MX 8M SOC (quad-core Cortex-A53, Cortex-M4F)
- GPU: GC7000 Lite Integrated Graphics
- Built-in Google Edge TPU
- 1GB LPDDR4

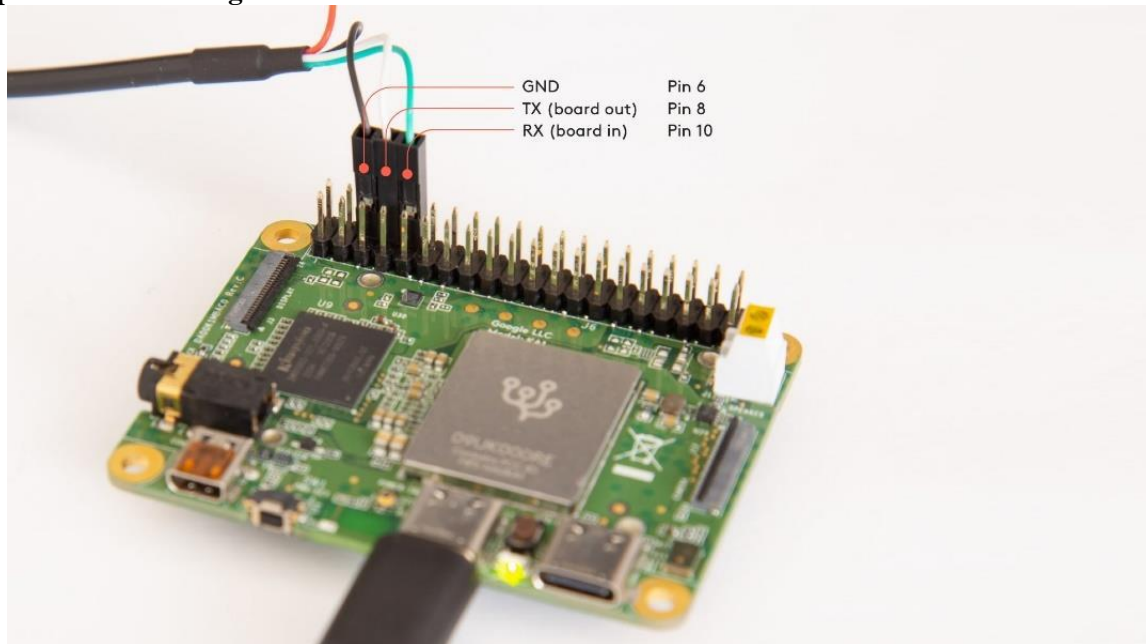**Coral Developer Board for Google Mini:**

Figure 8: Coral Developer Board for Google Mini

This SBC was created as a successor to the Google Coral Dev Board. Its low price of $99.99 is an undeniable draw for users who have been saving up to get their predecessor. This is due to the smaller form factor and higher processing power [12 and 14].

The Google Coral Dev Board Mini's primary components are an Arm Cortex-A35 quad-core processor, 8 GB of eMMC storage, 2 GB of LPDDR3 storage, RAM, IMGPowerVR GE8300 GPU, Google Edge TPU ML accelerated coprocessor, and Micro HDMI display. N10 Rock Pi 7. Through the physical characteristics it offers, the design and development of this single-board computer directly illustrate the concepts of artificial intelligence and deep learning. It comes in 4GB, 6GB, and 8GB LPDDR3RAM configurations. The Rockchip RK3399 NPU is primarily developed for AI and DL applications. It has a microSD card slot for storage. A M.2 SSD connection is also included in the hardware of the Rock Pi N10. SSD storage of up to 2TB is supported via this interface.

HiKey 970:
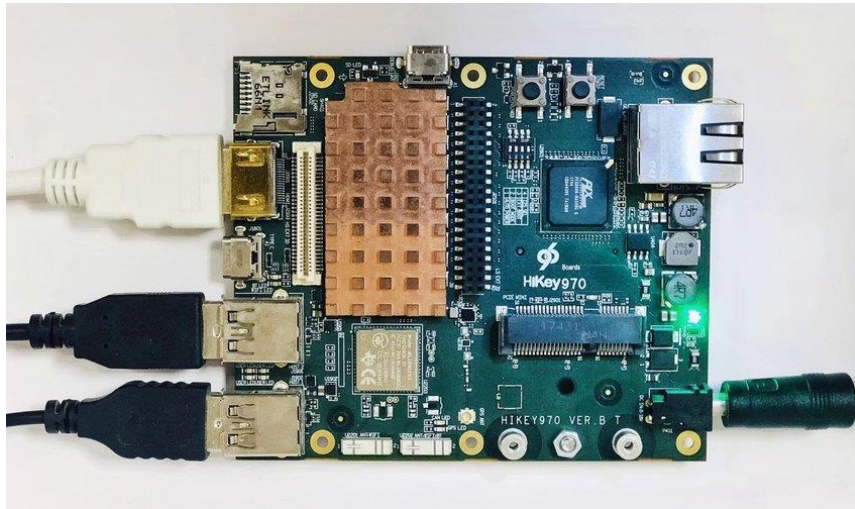
Figure 9: HiKey 970

This SBC hardware board's layout and architecture make it perfect for AI projects. The HiAI architecture and the HiSilicon Krin 970 SoC are all included in this single physical offering. This SBC also comes with optional hardware modules for GPS, Wi-Fi, Bluetooth, 128 GB of UV 2.1 storage and 1866 MHz LPDDR4X RAM. Additionally, supported by this SBC chip are Linux and Android-based operating systems. [11][12] It is regarded as a viable alternative for AI and DL, especially for those searching for robotics projects, in spite of its $400 price tag and excellent appropriateness for AI projects. The AI NPU, PCIe gen2, GPS, and Gigabit Ethernet capability are notable benefits. Connectivity, 128 GB of UFS storage, four Cortex-A55 and four Cortex-A75 CPUs, eight gigabytes of LPDDR4 memory, and hardware supporting AI, deep learning, and robotics are all included. The $400 price tag is the only real negative.

Advantages:

- LPDDR4 RAM in 8GB
- Processors with quad-core Cortex-A75 and quad-core Cortex-A55
- Storage with 128GB UFS
- Excellent connectivity, including Gigabit Ethernet, GPS and PCIe gen2
- Dedicated AI NPU
- Able to do AI, deep learning, robotics and other tasks

Disadvantages:
- Expensive

Specification for the Hikey 970:

- RAM of 8GB LPDDR4
- Storage with 128GB UFS
- the Gigabit Ethernet
- GPS
- PCIe gen2
- Committed NPU

4. IoT Key Challenges and Issues:

Due to the different technologies used to transport data between embedded devices and the IoT-based systems' engagement in many facets of human life, this process has become intricate, which creates several issues and obstacles. In a society with advanced smart technology, these problems provide a difficulty for IoT developers as well. The demands for an advanced IoT system change along with technology. IoT developers must thus consider new issues and find solutions for them. [16]

6. CONCLUSION:

Researchers and developers in the area are interested in recent developments in the Internet of Things. IoT researchers and developers collaborate to advance technology and benefit society. They also cover key IoT application areas. May be applied to create better IoT systems. Smart robots are the way forward, and their combination with IoT can have incredibly beneficial benefits. This can speed up the response time, reducing it unnecessarily. Avoid wasting time explaining or offering answers to questions to someone who already knows this and works anywhere, 24/7, non-stop. In another way, there are many reasons why chatbots are best suited to communicating through IoT interfaces.

- You don't need to remember how different IoT applications work:
- Chatbots can teach in natural language:
- Chatbots can refine user requests for further communication through IoT interfaces:

If you receive information about something from your device, you can ask it a question using natural language, and if you are knowledgeable, the asmart chatbot can answer your query. It simplifies interacting with chatbots through the IoT, while traditional design interfaces struggle with information abstraction.

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