Sixth Sence Technolgy Has Potential to Become the Ultimate "Transparent" User Interface for Accessing Information About Everything Around Us

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Abstract: Sixth Sense is a wearable gestural interface that augments the physical world around us with digital information and lets us use natural hand gestures to interact with that information. Sixth Sense recognizes the objects around us, displaying information automatically and letting us to access it in any way we need. The Sixth Sense prototype implements several applications that demonstrate the usefulness, viability and flexibility of the system. It allows us to interact with this information via natural hand gestures. This has the potential to become the ultimate "transparent" user interface for accessing information about everything around us. The key here is that Sixth Sense recognizes the objects around you, displaying information automatically and letting you access it in any way you want, in the simplest way possible. We can incorporate to get rid of color markers, camera and projector inside mobile computing device. Whenever we place pendant- style wearable device on table, it should allow us to use the table as multi touch user interface. In this paper, we have presented the technology behind the sixth sense technology and its application and advantage.

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Key words: Sixth Sense; Interface; Gesture; Transparent;

1. Introduction

We've evolved over millions of years to sense the world around us. When we encounter something, someone or some place, we use our five natural senses to perceive information about it; that information helps us make decisions and chose the right actions to take. But arguably the most useful information that can help the right decision is not naturally perceivable with our five senses, namely the data, information and knowledge that mankind has accumulated about everything and which is increasingly all available online. Although the miniaturization of computing devices allows us to carry computers in our pockets, keeping us continually connected to the digital world, there is no link between our digital devices and our interactions with the physical world. Information is confined traditionally on paper or digitally on a screen. Sixth Sense bridges this gap, bringing intangible, digital information out into the tangible world, and allowing us to interact with this information via natural hand gestures. 'Sixth Sense' frees information from its confines by seamlessly integrating it with reality, and thus making the entire world your computer.

Sixth Sense technology is the science of tomorrow with the aim of connecting the digital world with the physical world seamlessly, eliminating hardware devices. Pranav Mistry's flirtations with the digital world began in the early 2000s when he pieced together four mouse rollers with pulleys and springs to give shape to a motion sensing device.

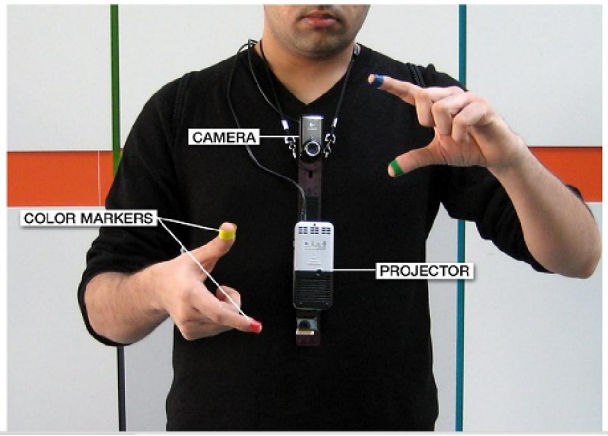
It is similar to telepointer, a neck worn projector/camera system developed by Media Lab student Steve Mann (*which Mann originally referred to as "Synthetic Synesthesia of the Sixth Sense*"). What the researchers have done is combine a number of standard gadgets including a webcam, projector, and mobile phone, to form a brand new interaction experience. In its current form the battery-powered projector is attached to a hat, the webcam is hung around the neck (or also positioned on a hat), and the mobile phone provides the connection to the Internet.

The wearer uses hand gestures combined with the gadgets to perform actions. So, for example, they could make a circle over their wrist with the fingers of one hand. WUW *(Wear Your World)* would recognize this action and project a clock face on to their wrist. Make a picture frame with both your hands and WUW will take a picture as if it was a camera. Stand near a wall and you can get a projected desktop allowing you to open applications, view the pictures you've taken, or surf the 'Net.

With the invention of intuitive computer interfaces, the digital and physical worlds came together closer than ever. One just has to place an object (anything from a flight boarding pass to a key)

on a Tangible Public Map (TaPuMa) on its horizontal smart screen to get inside-out information about it. Keep a coffee cup on a particular spot on the map and a whole range of cafés in the area is brought to you on a platter. All you have to do to get seamlessly connected with the digital world is wear simple pendant-like equipment consisting of a camera and a portable battery-powered projection system with a mirror (a more modish version is just round the corner).The device (now known as the Sixth Sense Device) when connected to a cell phone acts as a computation and communication tool. The camera tracks hand gestures and helps gather "meta information" (information from the surroundings) and articulates it with the digital domain. Wearing marker caps on ones fingers (a more stylish option is to paint the said fingernails in a different color each) and making gestures with them, one can use any interface (Yes! Any interface! No longer is the human race tied to the bulky world of computer screens) to access and modify data. Clicking a picture is as easy as conjuring up a rectangle in the air aimed at the object of visual desire with the thumb and index fingers. A few finger motions help edit and resize pictures and another set of gestures later, the pictures find themselves E-mailed to recipients.

Our paper is organized as follows. In section 2, we present the concept of sixth sense technology. Section 3 explores the different component and its perspective. In section 4, we address the gestures and its type. Section 5 explores the working principle of it. Section 6 discusses the technology related to sixth sense technology. We elaborate of its application and advantage in section 7 and 8. Finally we make a conclusion and the future enhancement which we can implement on it.



2. What is Sixth Sense?

'Sixth Sense' is a wearable gestural interface that augments the physical world around us with digital information and lets us use natural hand gestures to interact with that information. By using a camera and a tiny projector mounted in a pendant like wearable device, 'Sixth Sense' sees what you see and visually augments any surfaces or objects we are interacting with. It projects information onto surfaces, walls, and physical objects around us, and lets us interact with the projected information through natural hand gestures, arm movements, or our interaction with the object itself. 'Sixth Sense' attempts to free information from its confines by seamlessly integrating it with reality, and thus making the entire world your computer. All of us are aware of the five basic senses – seeing, feeling, smelling, tasting and hearing. But there is also another sense called the sixth sense. It is basically a connection to something greater than what their physical senses are able to perceive. To a layman, it would be something supernatural. Some might just consider it to be a superstition or something psychological. But the invention of sixth sense technology has completely shocked the world. Although it is not widely known as of now but the time is not far when this technology will change our perception of the world.

The Sixth Sense prototype is comprised of a pocket projector, a mirror and a camera. The hardware components are coupled in a pendant-like mobile ear able device. Both the projector and the camera are connected to the mobile computing device in the user's pocket. The device projects visual information, enabling surfaces, walls and physical objects around the wearer to be used as interfaces; while the camera recognizes and tracks the user's hand gestures and physical objects using computer-vision based techniques. The software program processes the video stream data captured by the camera and tracks the locations of the colored markers at the tip of the user's fingers using simple computer-vision techniques. The movements and arrangements of these fiducially are interpreted into gestures that act as interaction instructions for the projected application interfaces. The maximum number of tracked fingers is only constrained by the number of unique fiducially, thus Sixth Sense also supports multi-touch and multi-user interaction.

The Sixth Sense prototype implements several applications that demonstrate the usefulness, viability and flexibility of the system. The map application lets the user navigate a map displayed on a nearby surface using hand gestures, similar to gestures supported by multi-touch based systems, letting the user zoom in, zoom out or pan using intuitive hand movements. The drawing application lets the user draw on any surface by tracking the fingertip movements of the user's index finger. Sixth Sense also recognizes user's freehand gestures (postures). For example, it implements a gestural camera that takes photos of the scene the user is looking at by detecting the 'framing' gesture. The

user can stop by any surface or wall and flick through the photos he/she has taken. Sixth Sense also lets the user draw icons or symbols in the air using the movement of the index finger and recognizes those symbols as interaction instructions. For example, drawing a magnifying glass symbol takes the user to the map application or drawing an '@' symbol lets the user check his mail. The Sixth Sense system also augments physical objects the user is interacting with by projecting more information about these objects projected on them. For example, a newspaper can show live video news or dynamic information can be provided on a regular piece of paper. The gesture of drawing a circle on the user's wrist projects an analog watch. The current prototype system costs approximately $350 to build.

The device sees what we see but it lets out information that we want to know while viewing the object. It can project information on any surface, be it a wall, table or any other object and uses hand / arm movements to help us interact with the projected information. The device brings us closer to reality and assists us in making right decisions by providing the relevant information, thereby, making the entire world a computer.

The world has shrunk. Distances have dissolved. Communication lines and interaction with countless systems have been rendered feasible. However this technological overhaul has been peripheral and not so much related to the human body; researchers and innovators have constantly grappled with the issue of bridging the gaps which limit the human-environment contact. This device, tentatively name as the Sixth Sense, is a wearable machine that assists unexplored interactions between the real and the virtual sphere of data. It consists of certain commonly available components, which are intrinsic to its functioning. These include a camera, a portable battery-powered projection system coupled with a mirror and a cell phone. All these components communicate to the cell phone, which acts as the communication and computation device. The entire hardware apparatus is encompassed in a pendant-shaped mobile wearable device. Basically the camera recognizes individuals, images, pictures, gestures one makes with their hands and the projector assists in projecting any information on whatever type of surface is present in front of the person. The usage of the mirror is significant as the projector dangles pointing downwards from the neck. To bring out variations on a much higher plane, Pranav Mistry uses colored caps on his fingers so that it becomes simpler for the software to differentiate between the fingers, demanding various applications. The software program analyses the video data caught by the camera and also tracks down the locations of the colored markers by utilizing single computer vision techniques. One can have any number of hand gestures and movements as long as they are all reasonably identified and differentiated for the system to interpret it, preferably through unique and varied. This is possible only because the 'Sixth Sense' device supports multi-touch and multi-user interaction. There was once a clear divide between the virtual world and the real world, but that line is getting blurrier every day.

3. Hardware Components

Camera

The camera is the key input device of the sixth sense system. The camera acts as a digital eye of the system. It basically captures the scene the user is looking at. The video stream captured by the camera is passed to mobile computing device which does the appropriate computer vision computation. The major functions of the camera can be listed as:

- Captures user's hand movements and gestures (used in reorganization of user gestures)
- Captures the scene in front and objects the user is interacting with (used in object reorganization and tracking)
- Takes a photo of the scene in front when the user performs a 'framing' gesture)

Projector

The projector is the key output device of the Sixth Sense system. The projector visually augments surfaces, walls and physical objects the user is interacting with by projecting digital information and graphical user interfaces. The mobile computing device provides the projector with the content to be projected. The projector unit used in prototype runs on a rechargeable battery. The major functions of the projector can be listed as:

- Projects graphical user interface of the selected application onto surfaces or walls in front.
- Augments the physical objects the user interacting with by projecting just-in-time and related information from the Internet

Mirror

The mirror reflects the projection coming out from the projector and thus helps in projecting onto the desired locations on walls or surfaces. The user manually can change the tilt of the mirror to change the location of the projection. For example in application where the user wants the projection to go on the ground instead of the surface in front, he can change the tilt of the mirror to change the projection. Thus, the mirror in the Sixth Sense helps in overcoming the limitation of the limited projection space of the projector.

Colored Markers

There is color markers placed at the tip of users finger. Marking the user's fingers with red, yellow

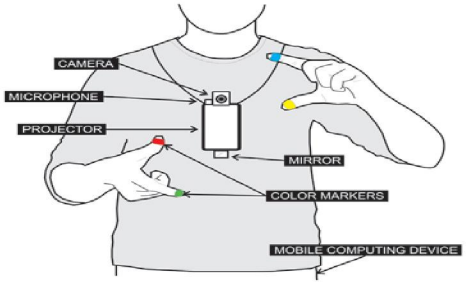
green and blue colored tape helps the webcam to recognize the hand gestures. The movements and arrangement of these markers are interpreted into gestures that act as an interaction instruction for the projected application interfaces.

Microphone

The microphone is an optional component of the Sixth Sense. It is required when using a paper as a computing interface. When the user wants to use a sheet of paper as an interactive surface, he or she clips the microphone to the paper. The microphone attached this way captures the sound signals of user's touching the paper. This data is passed to computing device for processing. Later, combined with the tracking information about user's finger, the system is able to identify precise touch events on the paper. Here, the sound signal captured by the microphone provides time information whereas the camera performs tracking. The applications enabled by this technique are explained earlier.

Mobile Computing Device

The Sixth Sense system uses a mobile computing device in user's pocket as the processing device. The software program enabling all the features of the system runs on this computing device. This device can be a mobile phone or a small laptop computer. The camera, the projector and the microphone are connected to this device using wired or wireless connection. The mobile computing device is also connected to the Internet connection.



Now that you have all these pieces, you need a way to combine them. We recommend using Lego strips to form the base. The projector, camera, and mirror assembly can be directly put onto this base. You can also use Velcro to combine the products.

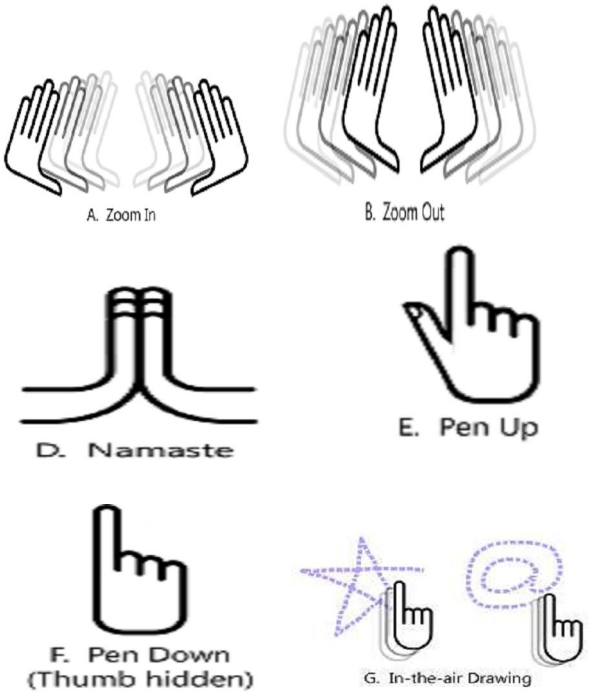
4. Gestures & It's Types

The software recognizes three kinds of gestures:

Multi-Touch Gestures: Like the ones we see in the iPhone-where we touch the screen and make the map move by pinching and dragging.

Freehand Gestures: Like when you take a picture or Namaste gesture to start the projection on the wall.

Iconic Gestures: Drawing an icon in the air. Like, whenever we draw a star, shows us the weather details. When we draw a magnifying glass, shows us the map.



5. How it works

The Sixth Sense prototype is comprised of a pocket projector, a mirror and a camera. The hardware components are coupled in a pendant like mobile wearable device. Both the projector and the camera are connected to the mobile computing device in the user's pocket. The projector projects visual information enabling surfaces, walls and physical objects around us to be used as interfaces; while the camera recognizes and tracks user's hand gestures and physical objects using computer-vision based techniques.

The software program processes the video stream data captured by the camera and tracks the locations of the colored markers at the tip of the user's fingers using simple computer-vision techniques. The movements and arrangements of these fiducially are interpreted into gestures that act as interaction instructions for the projected application interfaces. The maximum number of tracked fingers is only constrained by the number of unique fiducially, thus Sixth Sense also supports multi-touch and multi-user interaction.

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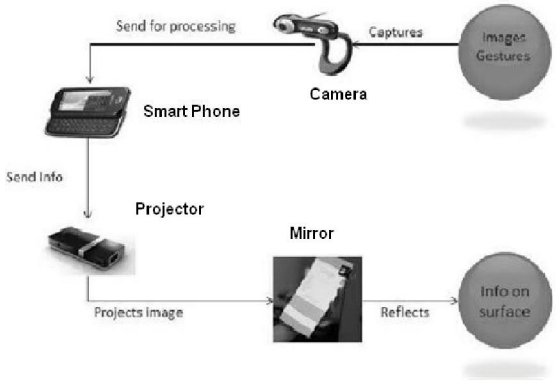
program processes the video stream data captured by the camera and tracks the locations of the colored markers at the tip of the user's fingers using simple computer-vision techniques. It also supports multi touch and multi user interaction.

The technology in itself is nothing more than the combination of some stunning technologies. The technology is mainly based on hand gesture recognition, image capturing, processing, and manipulation, etc. The software of the technology uses the video stream, which is captured by the camera, and also tracks the location of the tips of the fingers to recognize the gestures. This process is done using some techniques of computer vision. However, instead of requiring you to be in front of a big screen like Tom Cruise, Sixth Sense can do its magic—and a lot more—everywhere. The camera recognizes objects around you instantly, with the micro-projector overlaying the information on any surface, including the object itself or your hand. Then, you can access or manipulate the information using your fingers.

The key here is that Sixth Sense recognizes the objects around you, displaying information automatically and letting you access it in any way you want, in the simplest way possible. Clearly, this has the potential of becoming the ultimate "transparent" user interface for accessing information about everything around us. If they can get rid of the colored finger caps and it ever goes beyond the initial development phase, that is. But as it is now, it may change the way we interact with the real world and truly give everyone complete awareness of the environment around us.
The overall structure of the system is shown as follows:



The Sixth Sense technology works as follows:

1. It captures the image of the object in view and tracks the user's hand gesture.
2. There are colour markers placed at the tip of user's finger. Marking the user's fingers with red, yellow green and blue coloured tape helps the webcam to recognize the hand gestures. The movements and arrangement of these markers are interpreted into gestures that act as a interaction instruction for the projected application interfaces.
3. The smart phone searches the web and interprets the hand gestures with help of the coloured markers placed at the finger tips
4. The information that is interpreted through the smart phone can be projected into any surface.
5. The mirror reflects the image on to a desire surface.

6. Technologies related to sixth sense technology

Augmented Reality: The augmented Reality is a visualization technology that allows the user to experience the virtual experience added over real world in real time. With the help of advanced AR technology the information about the surrounding real world of the user becomes interactive and digitally usable. Artificial information about the environment and the objects in it can be stored and retrieved as an information layer on top of the real world view. When we compare the spectrum between virtual reality, which creates immersive, computer-generated environments, and the real world, augmented reality is closer to the real world. Augmented reality adds graphics, sounds, hepatic feedback and smell to the natural world as it exists. Both video games and cell phones are driving the development of augmented reality. The augmented systems will also superimpose graphics for every perspective available and try adjusting every movement of the user's head and eyes. The three basic components of an augmented reality system are the head-mounted display, tracking system and mobile computer for the hardware. The main goal of this new technology is to merge these three components into a highly portable unit much like a combination of a high tech Walkman and an ordinary pair or eyeglasses. The head-mounted display used in augmented reality systems will enable the user to view superimposed graphics and text created by the system. Another component of an augmented reality system is its tracking and orientation system. This system pinpoints the user's location in reference to his surroundings and additionally tracks the user's eye and head movements. Augmented reality systems will need highly mobile computers. As of now many computers aren't there to satisfy to provide this option.

Gesture Recognition: It is a technology which is aimed at interpreting human gestures with the help of mathematical algorithms. Gesture recognition technique basically focuses on the emotion recognition from the face and hand gesture recognition. Gender recognition technique enables humans to interact with computers in a more direct way without using any external interfacing devices. It can provide a much

better alternative to text user interfaces and graphical user interface which requires the need of a keyboard or mouse to interact with the computer. An interface which solely depends on the gestures requires precise hand pose tracking. In the early versions of gesture recognition process special type of hand gloves which provide information about hand position orientation and flux of the fingers. In the Sixth Sense devices colour bands are used for this purpose. Once hand pose has been captured the gestures can be recognized using different techniques. Neural network approaches or statistical templates are the commonly used techniques used for the recognition purposes. These techniques have a high accuracy usually showing accuracy of more than 95%. Time dependent neural network will also be used for real time recognition of the gestures.

Computer Vision: Computer vision is the technology in which machines are able to interpret/extract necessary information from an image. Computer vision technology includes various fields like image processing, image analysis and machine vision. It includes certain aspect of artificial intelligence techniques like pattern recognition. The machines which implement computer vision techniques require image sensors which detect electromagnetic radiation which are usually in the form of ultraviolet rays or light rays. The computer vision find itself applicable in varies field of interest. One such field is bio medical image processing. The computer vision technique basically includes four processes.

1. Recognition: One of the main task of computer vision technique is to determine whether the particular object contain the useful data or not.
2. Motion Analysis: Motion analysis includes several tasks related to estimation of motion where an image sequence is processed continuously to detect the velocity at each point of the image or in the 3D scene.
3. Scene Reconstruction: Computer vision technique employs several methods to recreate a 3D image from the available images of a scene.
4. Image Restoration: The main of aim of this step is to remove noise from an given image. The simplest method involves using simple filters like low pass or median filters. In order to get better quality images more complex methods like In painting are used.

7. Application

There are several applications to this Sixth Sense Technology:

Taking Pictures: The implementation of a gestural camera, is application of sixth sense device. This camera takes the photo of the location; user is looking at by detecting the framing gesture. So, why to take camera on your holiday? No tension for the photo space as this sixth sense computer will work like your camera. It captures the photo, when you make a square with your fingers, highlighting which one you want to frame. After taking the desired number of photos we can project them onto any surfaces and then use gestures to sort through those photos and organize and resize them.

Viewing Map: With the help of a map application the user can call upon any map of his/her choice and navigate through them by projecting the map on to any surface.

Know About Weather: If a person draws a star like shape in air the Sixth Sense Device will treat as if the user wants to know about weather.

Make a call: You can use the Sixth Sense to project a keypad onto your hand, and then use that virtual keypad to make a call.

Draw Applications: The drawing application allows the user you to draw on any surface by tracking the fingertip movements of the user's index finger. The pictures that are drawn by the user can be stored and replaced on any other surface.

Check the Time: Draw a circle on your wrist to get a virtual watch that gives you the correct time.

Create Multimedia Reading Experiences: Sixth Sense can be programmed to project related videos on newspaper articles you are reading.

Zooming Features: The user can zoom in or zoom out using intuitive hand movements.

Get Product Information: Sixth Sense uses image recognition or marker technology to recognize products we pick up, and then feeds us information on those products.

Get Book Information: The system can project Amazon ratings on that book, as well as reviews and other relevant information.

Get Flight Updates: The system will recognize your boarding pass and let you know whether your flight is on time and if the gate has changed.

Information about People: The system will project relevant information about a person such as what they do, where they work, and so on.

8. Advantage

Portable: One of the main advantages of the sixth sense devices is its small size and portability. It can be easily carried around without any difficulty. The prototype of the sixth sense is designed in a way that it gives more importance to the portability factor. All the devices are light in weight and the smart phone can easily fit into the user's pocket.

Support multi touch and multi user interaction: Multi touch and multi user interaction is another added feature of the sixth sense devices. Multi sensing technique allows the user to interact with system with more than one than one finger at a time.. Sixth sense devices also in-cooperates multi user functionality. This is typically useful for large interaction scenarios such as interactive table tops and walls.

Cost effective: The cost incurred for the construction of the sixth sense proto type is quiet low. It was made from parts collected together from common devices. And a typical sixth sense device cost up to $300. The sixth sense devices have not been made in large scale for commercial purpose. Once that happens it's almost certain that the device will cost much lower than the current price.

Connectedness between real world and digital world: Forming a connection between the real world and the digital world was the main aim of the sixth sense technology.

Data access directly from the machines in real time: With help of a sixth sense device the user can easily access data from any machine at real time speed. The user doesn't require any machine-human interface to access the data. The data access through recognition of hand gestures is much easier and user friendlier compared to the text user interface.

Mind map the idea anywhere: With the advent of the sixth sense device, requirement of a platform or a screen to analyze and interpret the data has become obsolete. We can project the information into any surface and can work and manage the data as per our convenience.

Open source software: The software that is used to interpret and analysis the data collected by the device is made open source. This enables other developers to contribute to the development of the system.

4/13/2013

Conclusion

Sixth Sense recognizes the objects around us, displaying information automatically and letting us to access it in any way we need. The Sixth Sense prototype implements several applications that demonstrate the usefulness, viability and flexibility of the system. The key here is that Sixth Sense recognizes the objects around you, displaying information automatically and letting you access it in any way you want, in the simplest way possible.

Clearly, this has the potential of becoming the ultimate "transparent" user interface for accessing information about everything around us. If they can get rid of the colored finger caps and it ever goes beyond the initial development phase, that is. But as it is now, it may change the way we interact with the real world and truly give everyone complete awareness of the environment around us. We can incorporate to get rid of color markers, camera and projector inside mobile computing device. Whenever we place pendant- style wearable device on table, it should allow us to use the table as multi touch user interface. We can use this in gaming, education systems etc. To make sixth sense work as fifth sense for disabled person.

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