SEMINAR-2

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AR,VR AND AI FOR AGRICULTURE: A MODERN WAY TO ADDRESS TRADITIONAL PROBLEMS

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II Ph.D.

Objectives of seminar

01

1.To understand the concept of AR, VR & AI

02

2.To explore the different types of AR, VR & AI technologies

03

3.To know the potential areas for applying the AR, VR & AI for agriculture

04

4.To review the literature published on AR, VR & AI for agriculture

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Flow of presentation

- Augmented reality (AR)
- Types of AR
- Characteristics of AR
- Implication of AR
- Virtual Reality (VR)
- What VR makes it possible?
- Modes of virtual reality
- Roles of AR in agriculture
- Artificial intelligence
- Types AI
- Technologies in which AI is used
- Applications of AI in farming
- Research studies

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Augmented Reality

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Introduction

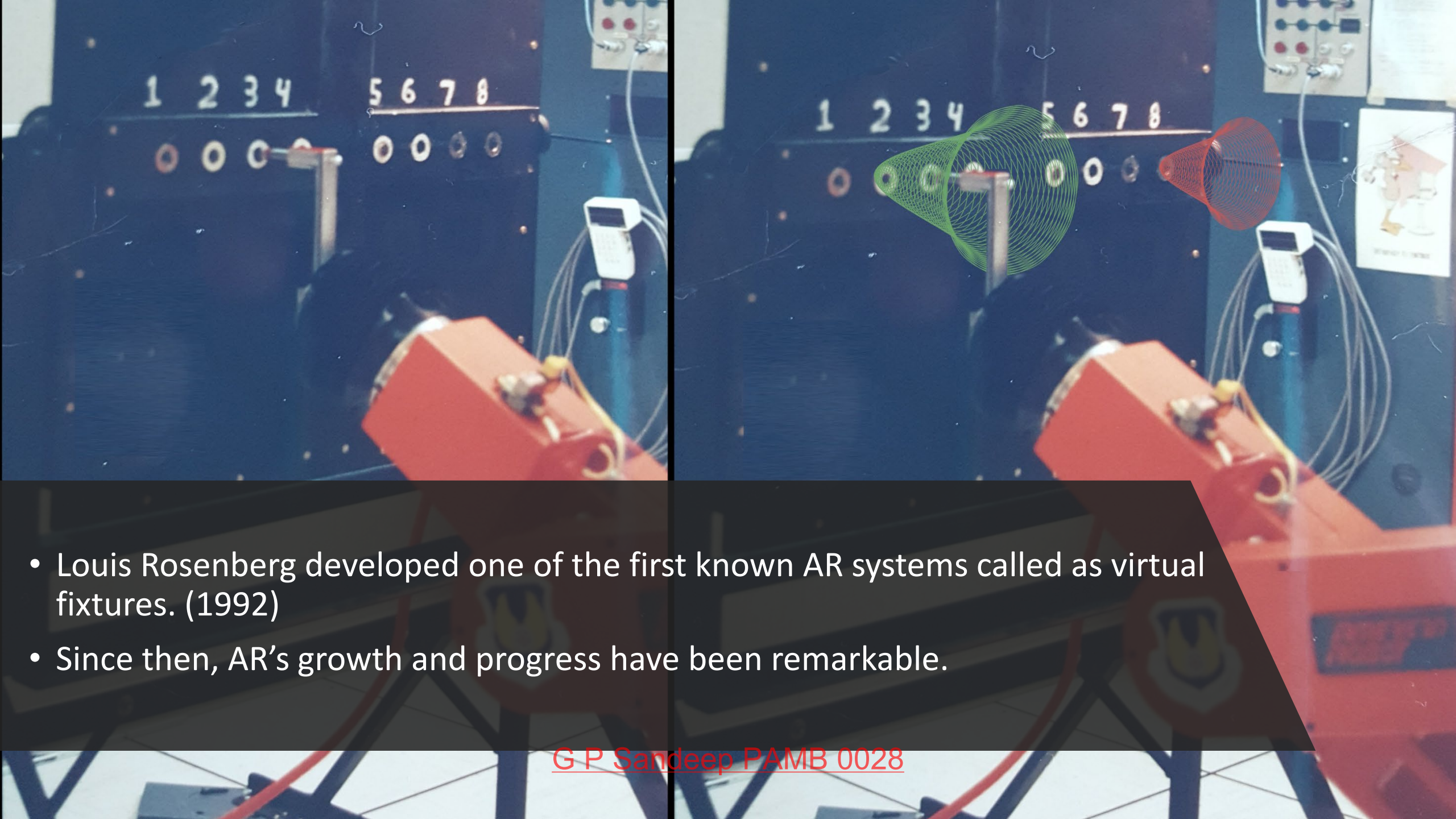
Augmented Reality (AR) is growing area in virtual reality research.

The environment around us provides a wealth of information.

The reality information is used in virtual environments for better understanding the surrounding better way.

The true work of AR was started in 1960 with the efforts of Mr. Sutherland.

He developed the See-through HMD to present 3D graphics



- Louis Rosenberg developed one of the first known AR systems called as virtual fixtures. (1992)
- Since then, AR’s growth and progress have been remarkable.

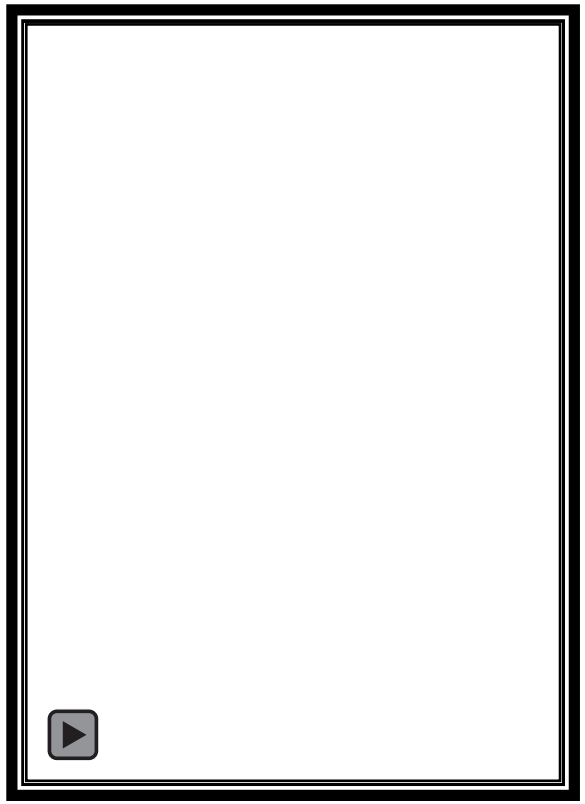
AR

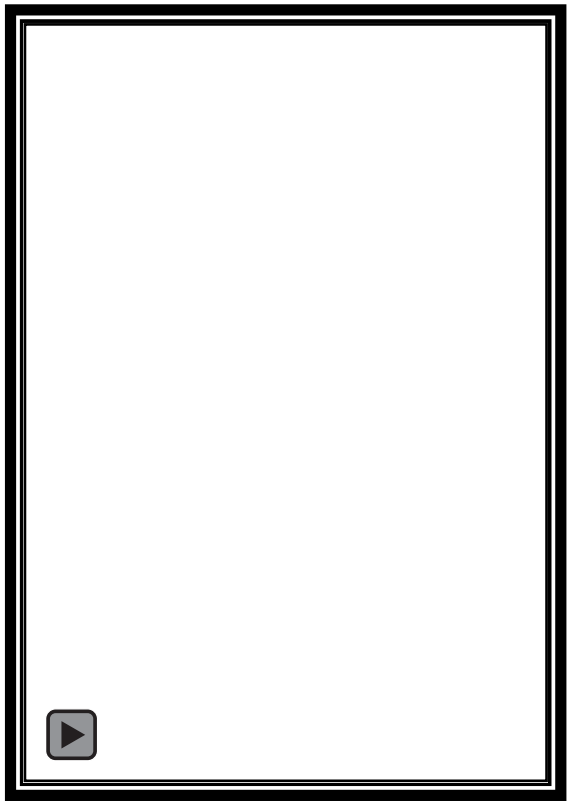
Augmented reality has been a **hot topic** in software development circles for a number of years

Augmented reality is a technology that works on **computer vision-based** recognition algorithms to augment **sound, video, graphics and other sensor-based** inputs on real world objects using the camera of your device.

Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated or extracted real-world sensory input such as sound, video, graphics, haptics or GPS data.

Real Word





Real World

+

Augmentation

Augmented reality

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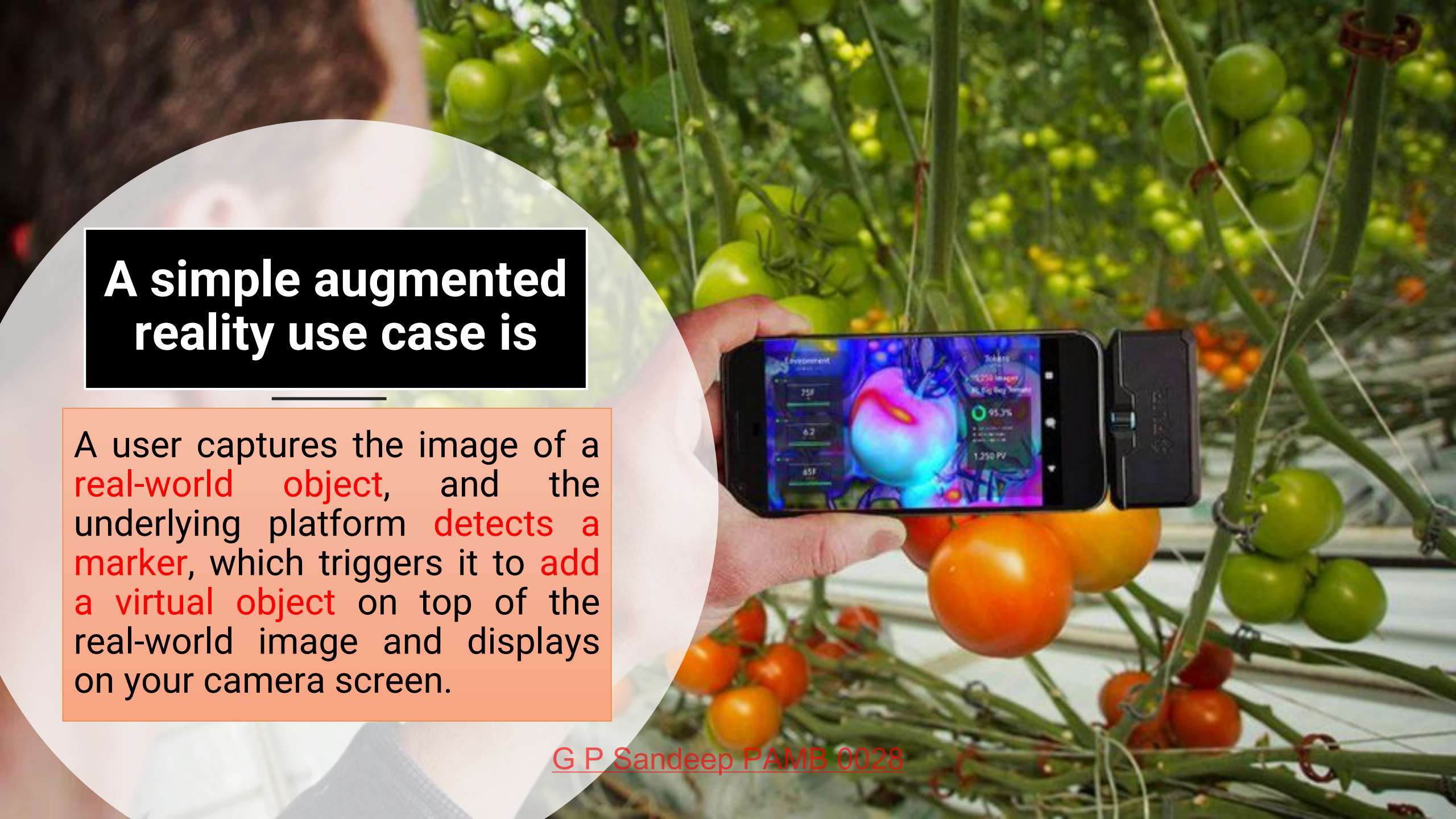
A simple augmented reality use case is

A user captures the image of a real-world object, and the underlying platform detects a marker, which triggers it to add a virtual object on top of the real-world image and displays on your camera screen.



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It is a good way to render real world information and present it in an interactive way so that virtual elements become part of the real world.

Augmented reality displays superimpose information in your field of view and can take you into a new world where the real and virtual worlds are tightly coupled.

It is not just limited to desktop or mobile devices. As mentioned, Google Glass, a wearable computer with optical head-mounted display, is a perfect example.

Types

Marker-based AR

AR without markers

Marker based AR

Early-stage AR technologies were based on markers.

Marker-based AR applications use target images (markers) to position objects in a given space.

These markers determine where the application will place the 3D digital content within the user's field of view.

AR applications are linked to a specific physical image pattern marker in a real-world environment in order to superimpose the 3D virtual object on it.

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Thus, the cameras must continuously scan the input and place a marker for image pattern recognition in order to create its geometry.

In case the camera is not properly focused, the virtual object will not be displayed.

Consequently, a marker-based image recognition system requires several modules, such as camera, image capture, image processing and marker tracking, among others.

Generally, this is a simple and inexpensive system to implement in filters through a custom application to recognize specific patterns through a camera.

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AR without markers

Marker less AR allows virtual 3D objects to be positioned in the real image environment by examining the features present in the data in real time.

This type of guidance relies on the hardware of any smartphone, be it the camera, GPS or accelerometer, among others, while the augmented reality software completes the job.

With this model, there is no need for an object tracking system due to recent technological advances in cameras, sensors and AI algorithms.

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Thus, it works with the digital data obtained by these sensors capable of recording a physical space in real time.

Primarily, markerless analysis uses simultaneous localization and mapping (SLAM) to scan the environment and create appropriate position on which to place virtual objects.

SLAM markerless image tracking scans the environment and creates maps of where to place virtual objects in 3D, even if the objects are not within a user's field of view, do not move when the user moves, and the user does not have to scan new images.

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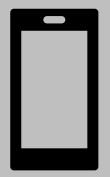
Therefore, this technology can detect objects or characteristic points in a scene without prior knowledge of the environment, for example, it can identify walls or intersection points.

This is a technology that is characterized by its association with the visual effect of combining computer graphics with real-world images.

The first systems using this type of AR used the location and hardware services of a device to interact with the resources provided by the AR software, in such a way that the user's location and orientation in the space where he/she was located was defined.

Another feature of this type of AR is that users can increase the average range of motion while experiencing the experience.



Apple’s ARKit and Google’s ARCore SDK have made markerless AR available on smart devices.

Currently, markerless AR is the preferred image recognition method for applications employing this technology.

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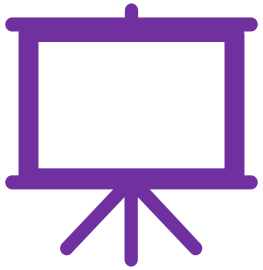
Types of markerless AR

Location-based AR



Projection-based AR

Overlay AR

Contour-based AR

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Location-based AR

Location-based markerless AR aims at the fusion of 3D virtual objects in the physical space where the user is located

Clearly, this technology uses the location and sensors of a smart device to position the virtual object at the desired location or point of interest.

The most representative example of this type of augmented reality is the smartphone game Pokémon GO, which uses markerless, location-based AR, bringing the user's environment to life immediately depending on where they look.

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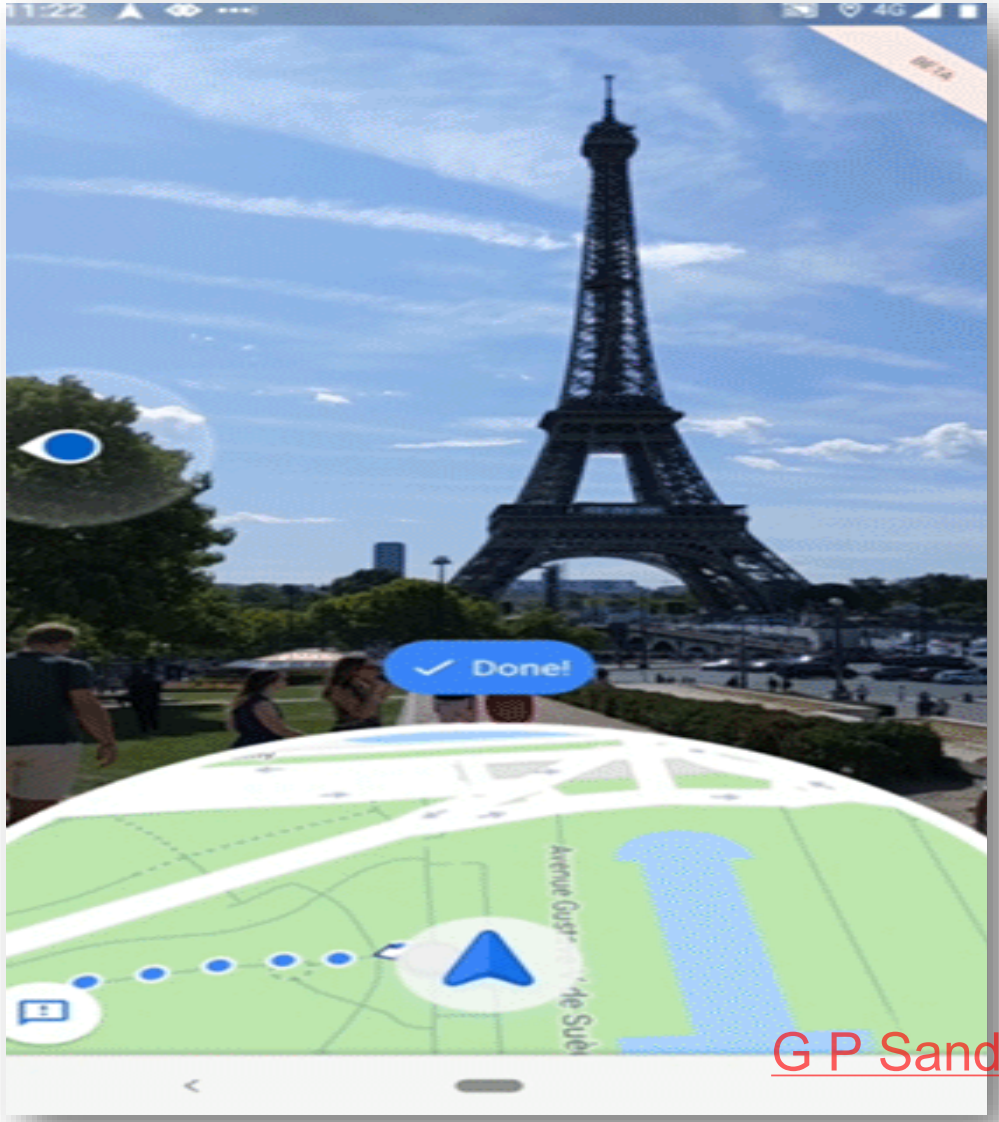
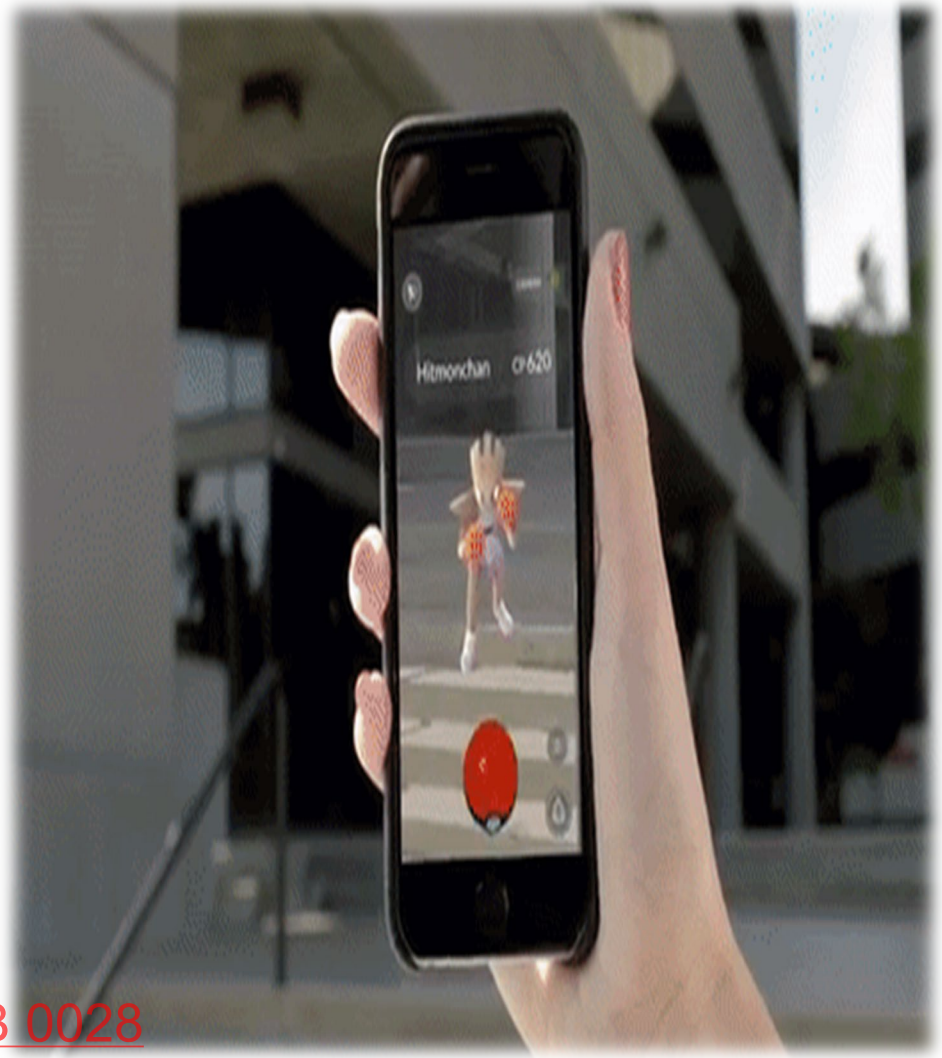
Location-based AR





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This AR links the virtual image to a specific location by reading the data in real time using the camera, GPS, compass and an accelerometer.

Also, as it is based on markerless AR, no image track is required for its operation, as it is able to predict the user's approach to match the data in real time with the user's location.

In addition, this typology allows the option of adding interactive and useful digital content to geographies of interest, which is very beneficial for individuals within a specific area by helping to understand the environment through 3D virtual objects or videos.

Projection-based AR

This methodology is used for the delivery of digital data within a stationary context, i.e. project-based AR focuses on rendering virtual 3D objects within the user's physical space.

Therefore, AR allows the user to move freely around the environment of a specific area where a fixed projector and a tracking camera are placed.

The main use of this technology is to create illusions about the depth, position and orientation of an object by projecting artificial light onto real flat surfaces.

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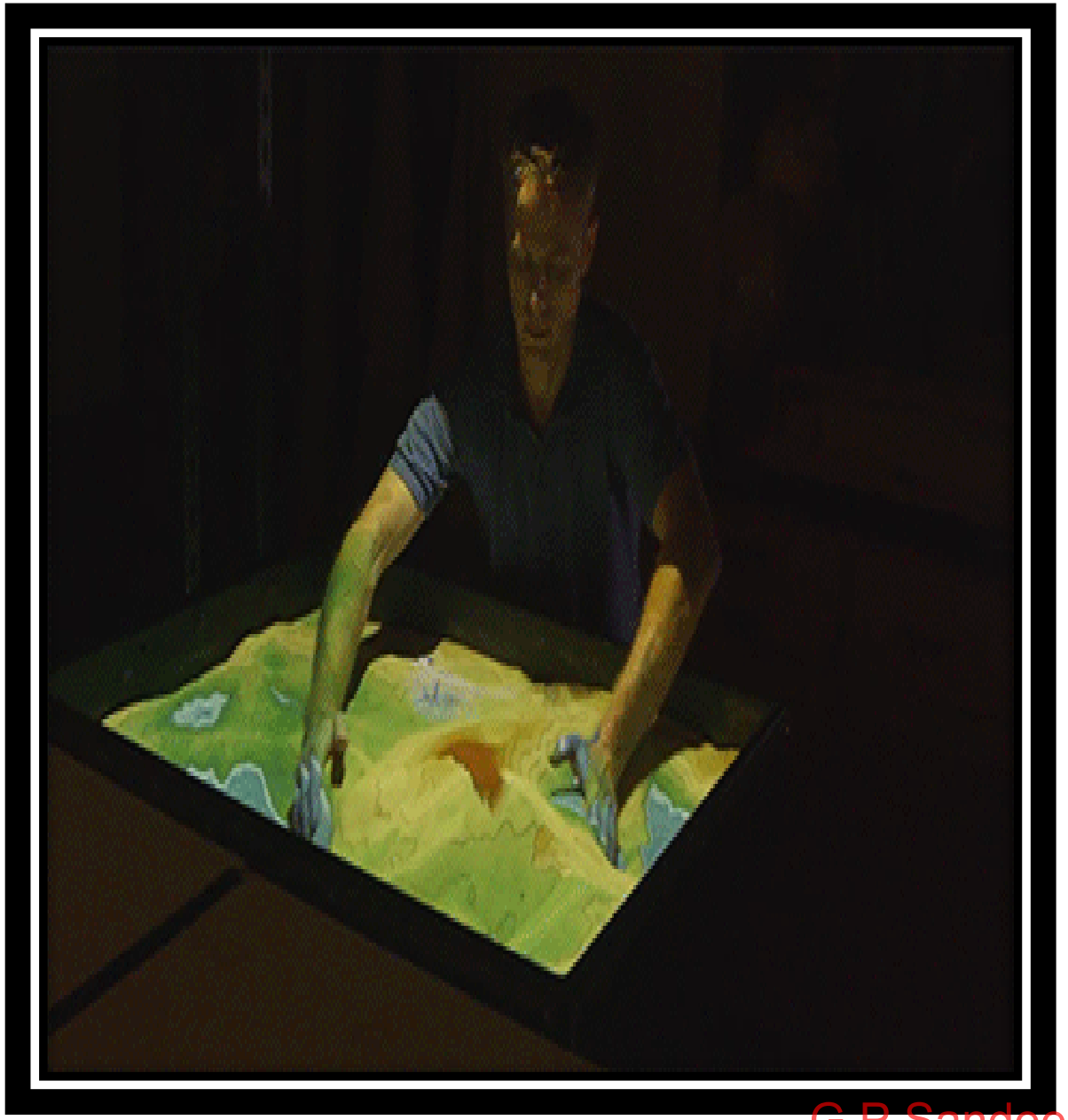

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Overlay AR

Typically, this AR is used to replace the original view of an object with an updated virtual image of that object for the human eye.

Overlay AR provides multiple views of a target object with the option to display additional relevant information about that object.

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Contour-based AR

Essentially, this technology, through the use of special cameras, is used for human eyes to outline specific objects with lines to facilitate certain situations.

For example, it can be used for where the low visibility situations are existing.

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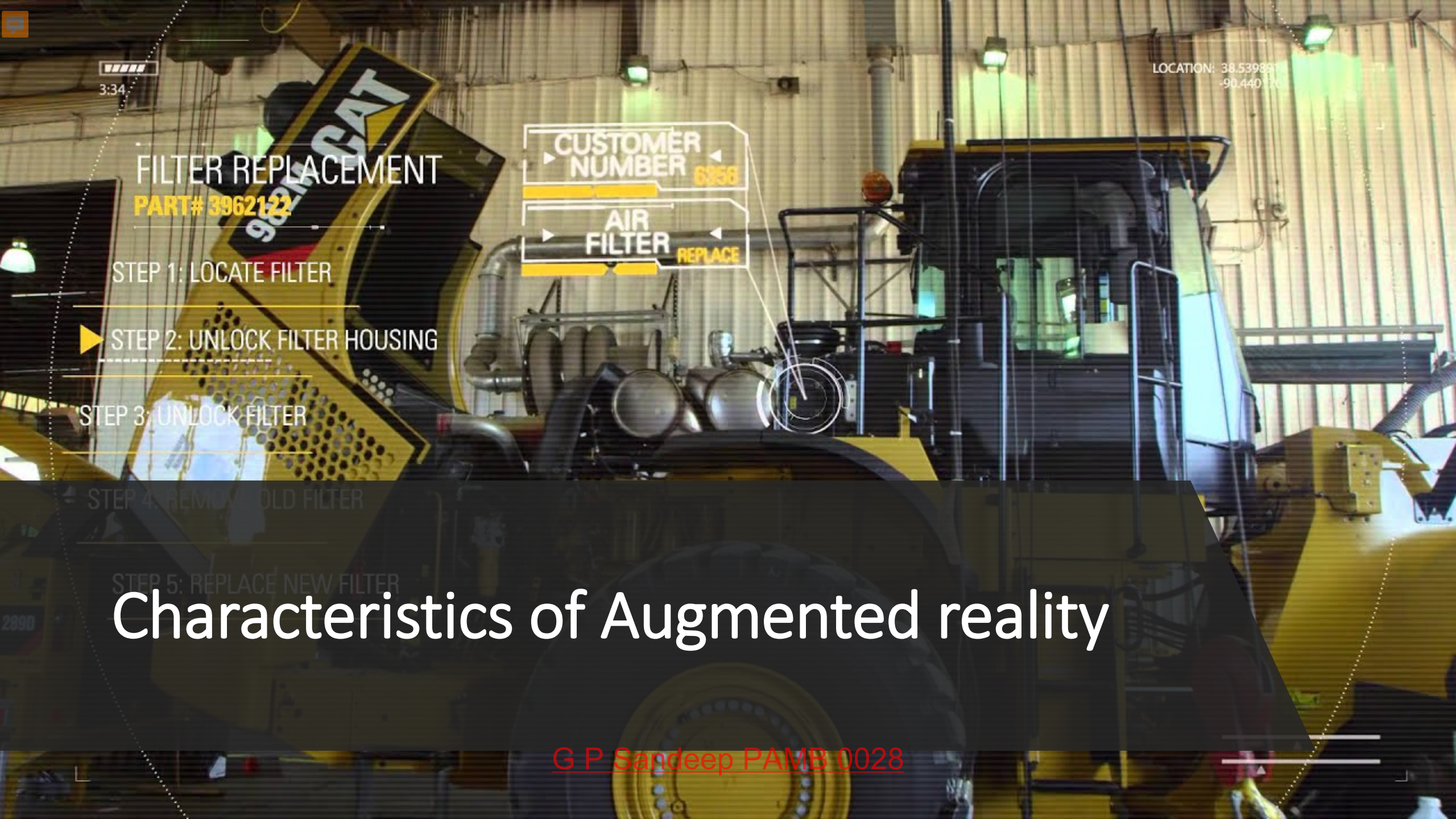

Characteristics of Augmented reality

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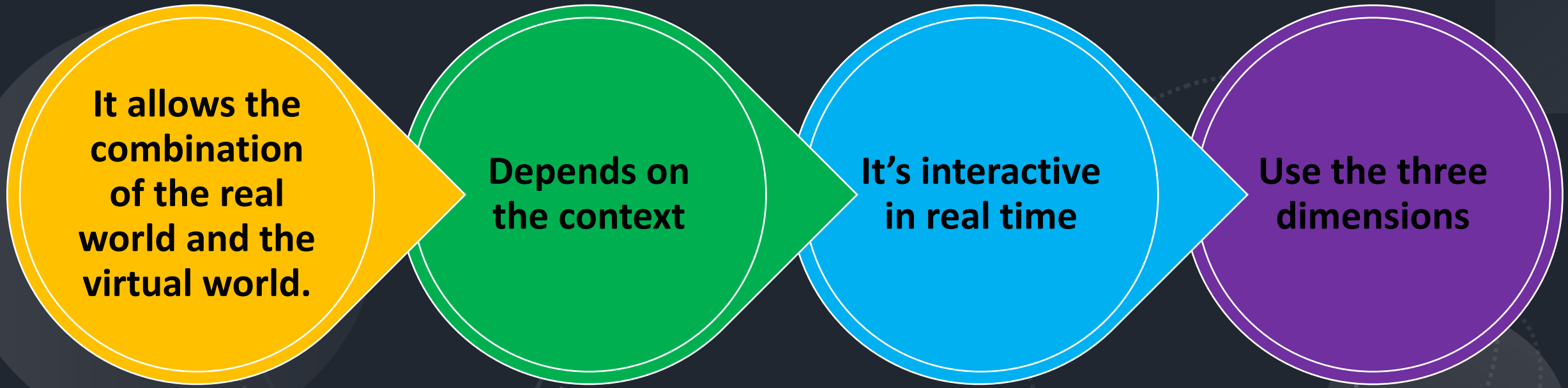

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Monitoring farms visually

01

Fertility inspection.

02

Check the fertility of their lands to select the most suitable crop they want to sow in the farm.

03

Visualize the entire farm in a single dashboard.

04

Monitor the overall production quality

05

Detect the presence of any pest or insect infestation.

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Training new farmers

AR can enable new farmers to get familiar with agricultural equipment through immersive e-learning environments.

AR will help new farmers to visually learn the use of complex agriculture tools minimizing at the same time serious accidents.

It will also facilitate remote collaboration with and training from farmers who are experts in using advanced precision agricultural methods and techniques. G P Sandeep PAMB 0028

Facilitating tools assessment

In agricultural production there are multiple tools available to perform single tasks.

AR devices can help select optimal tools for a specific task based on the needs and requirements of the farmer and the task itself.

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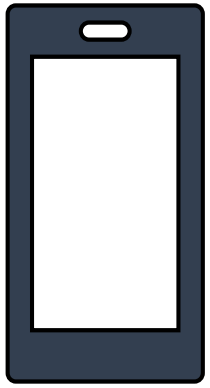
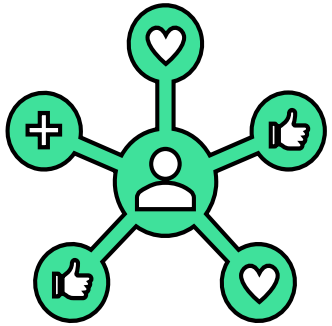
Advantages of AR

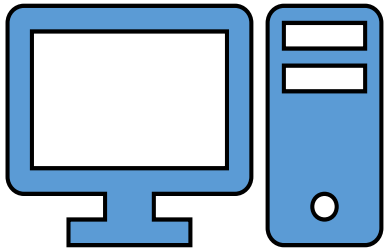
Enhanced experience



AR will be easy to use



Supports many activities



Improved Technology

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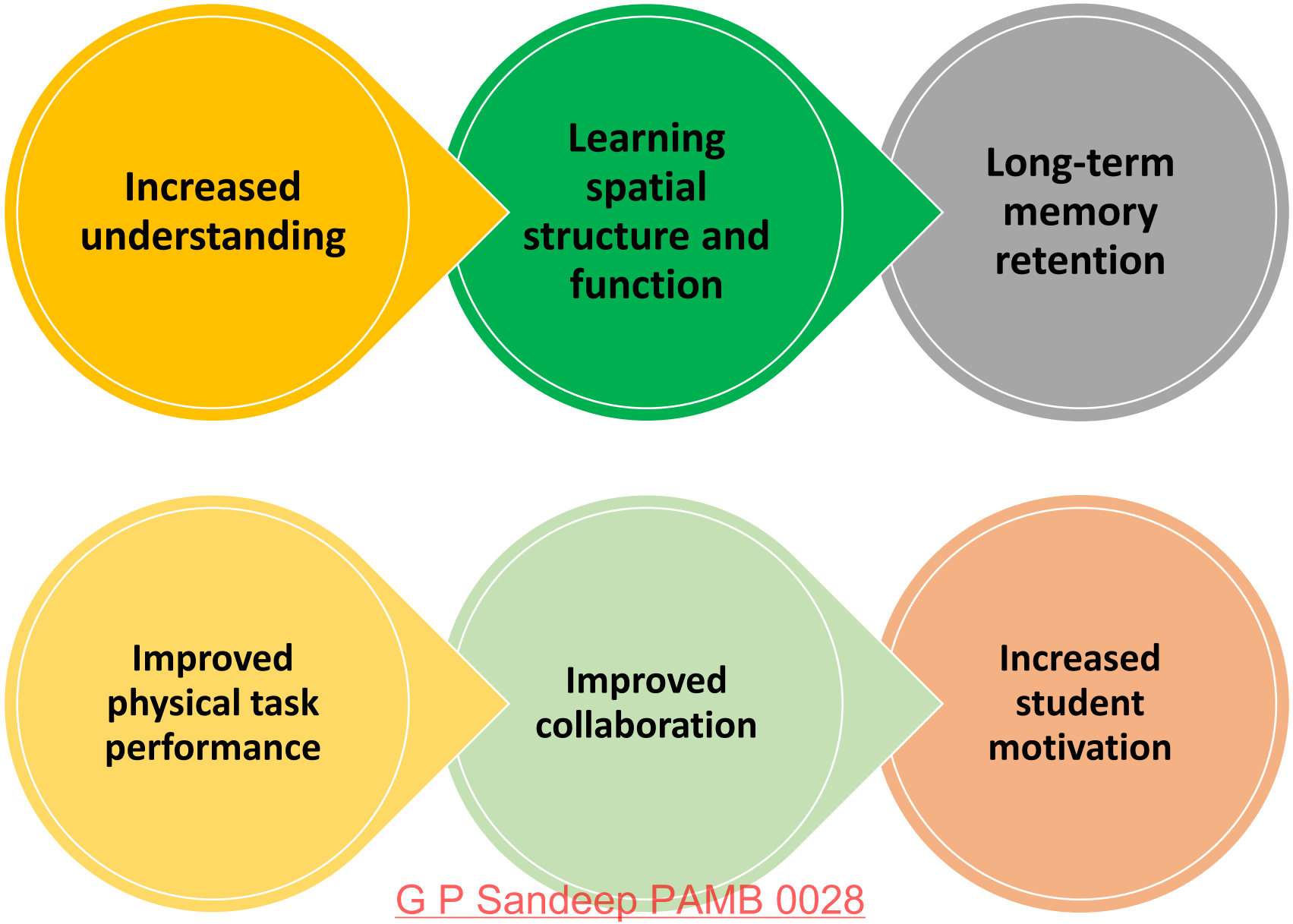

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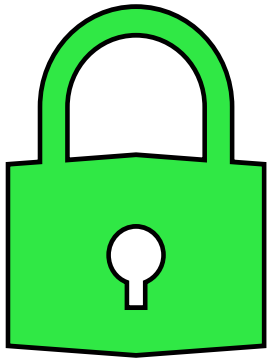
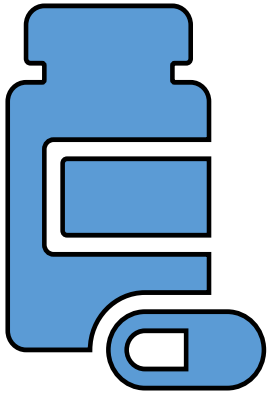
Disadvantages of AR

Unaffordable



Privacy and Security Problems



Addiction

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Virtual Reality

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Virtual Reality

Virtual reality means feeling the **imaginary** (Virtual) world, rather than real one.

The imaginary world is a **simulation** running in a computer.

Virtual reality is the term used for **computer generated 3D environments** that allow the user to enter and interact with alternative realities.

Virtual means “Near”.

Reality is what we experience as human being.

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What VR makes it possible to?

1

Visualize and manipulate things that you cannot see in the real world

2

Take on different perspectives

3

Visualize 3D concepts

4

Interact in real time

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What VR makes it possible to?

5

Explore dangerous situations

6

Present realistic or abstract scenarios

7

Promote different learning styles and teaching methods

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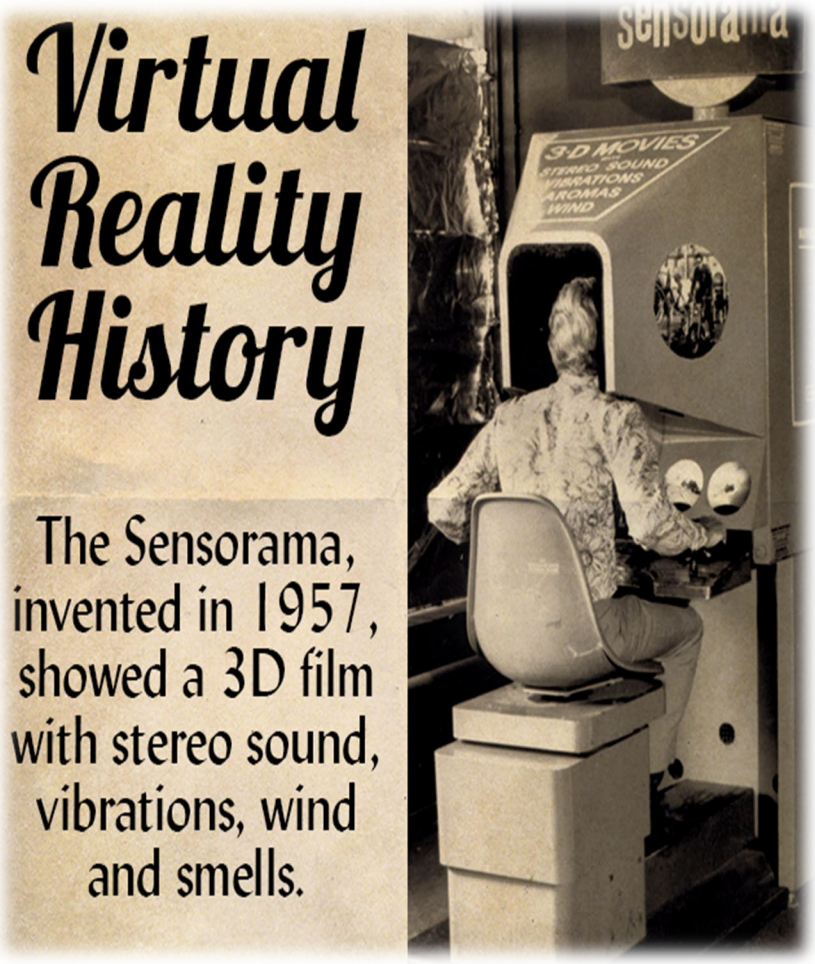
History

The Sensorama was a machine that is one of the earliest known examples of immersive, multi-sensory (now known as multimodal) technology.

This technology, which was **introduced in 1957 by Morton Heilig**, is considered one of the earliest virtual reality (VR) systems.



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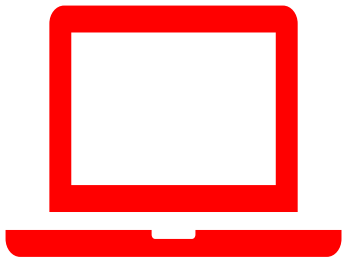
Let us consider a common example

Have you ever been to a 3D cinema?

Got amazed by having a real time movie experience.

A 3D or 5D cinema hall is an application of virtual reality.

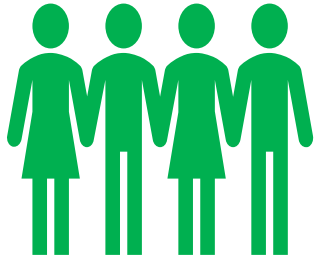
Mode of Virtual Reality used in Agriculture



Virtual Practical

Virtual Theory Programs

Virtual Courses



Virtual culture

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What is the role of Virtual Reality in Agriculture?

- Create 3D visualization
- Less training costs
- Free resources
- Help to connect with global market
- Learn with the best faculty of world
- Helps in understanding soil profile
- Reduces cost of plant protection tools

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Create 3D visualization

Virtual reality helps in recreating a 3D work environment.

This helps the farmers to lear how to carry out pre-plantation activities or harvesting.

This further helps him to learn about his strong and weak hand in the technique.

Less training costs

Less expensive than the real hand training.

Highly helpful in where equipment is too costly, and a trainee farmer or agriculturist cannot afford them.

It is bit less practical than real hand experience.

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Help to build budding agriculturists

Virtual reality due to its advanced technology has the power to convince its audience.

Thus, virtual learning programs are able to attract GenZ in the agriculture field.

It innovates more users to pursue agricultural studies and practices as their career.

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Help to connect with global market

Virtual reality with the aid of the internet helps the producer to connect with the global market.

This connection of the world helps the users to learn about global technologies and equipment.

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Learn with the best faculty of world

Virtual reality helps to connect farming students with the best global faculty.

This strengthens their learning and understanding ability.

Also, when a student learns from a best teacher, he builds a better nation.

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Helps in understanding soil profile

Virtual reality collects the data of different geographic locations and its soil profile.

This data further helps to draw observations related to the nature of soil, minerals present in the soil, water retaining capacity of soil, and soil deficiency.

Thus, virtual reality helps in understanding farmers the best suitable crops for their fields.

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Reduces cost of plant protection tools

After studying the agricultural patterns, farmers can learn more about crops and their protection methods.

This analysis report allows farmers to purchase only required tools.

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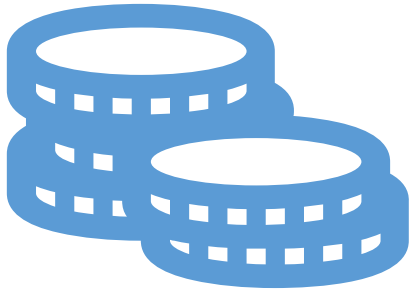
Advantages of VR

Exploring places and things without actually being there

Lowest risk

Increases interest and engagement toward a subject



Cost-effective

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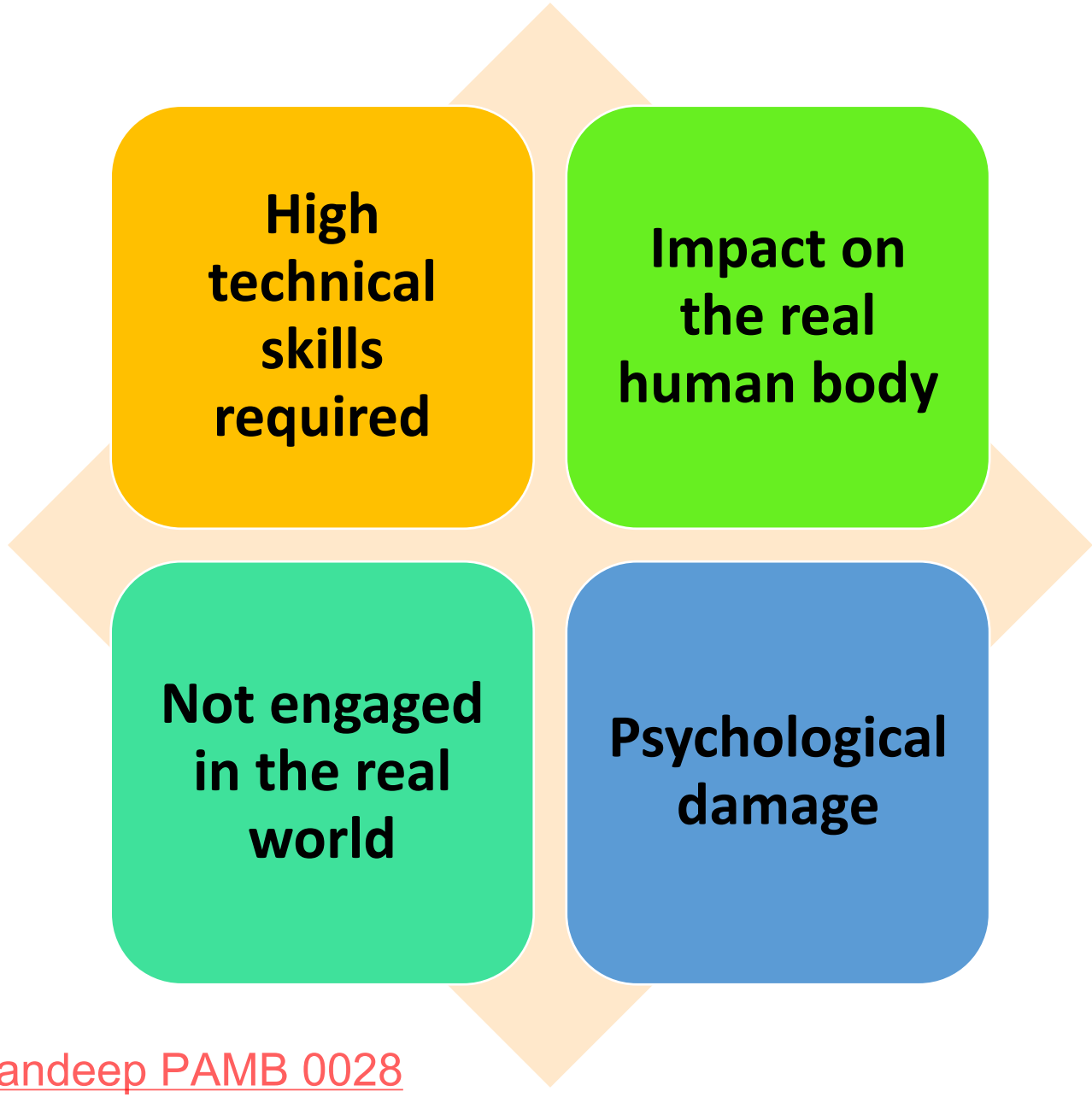
Disadvantages of VR



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Definition:

Artificial Intelligence is defined as a “field of computer science, which focuses on the creation of machine systems which behave intelligently and show behavior to the same level as human beings think and act to achieve human-like performance in all cognitive works and fields using precise logical reasoning.”

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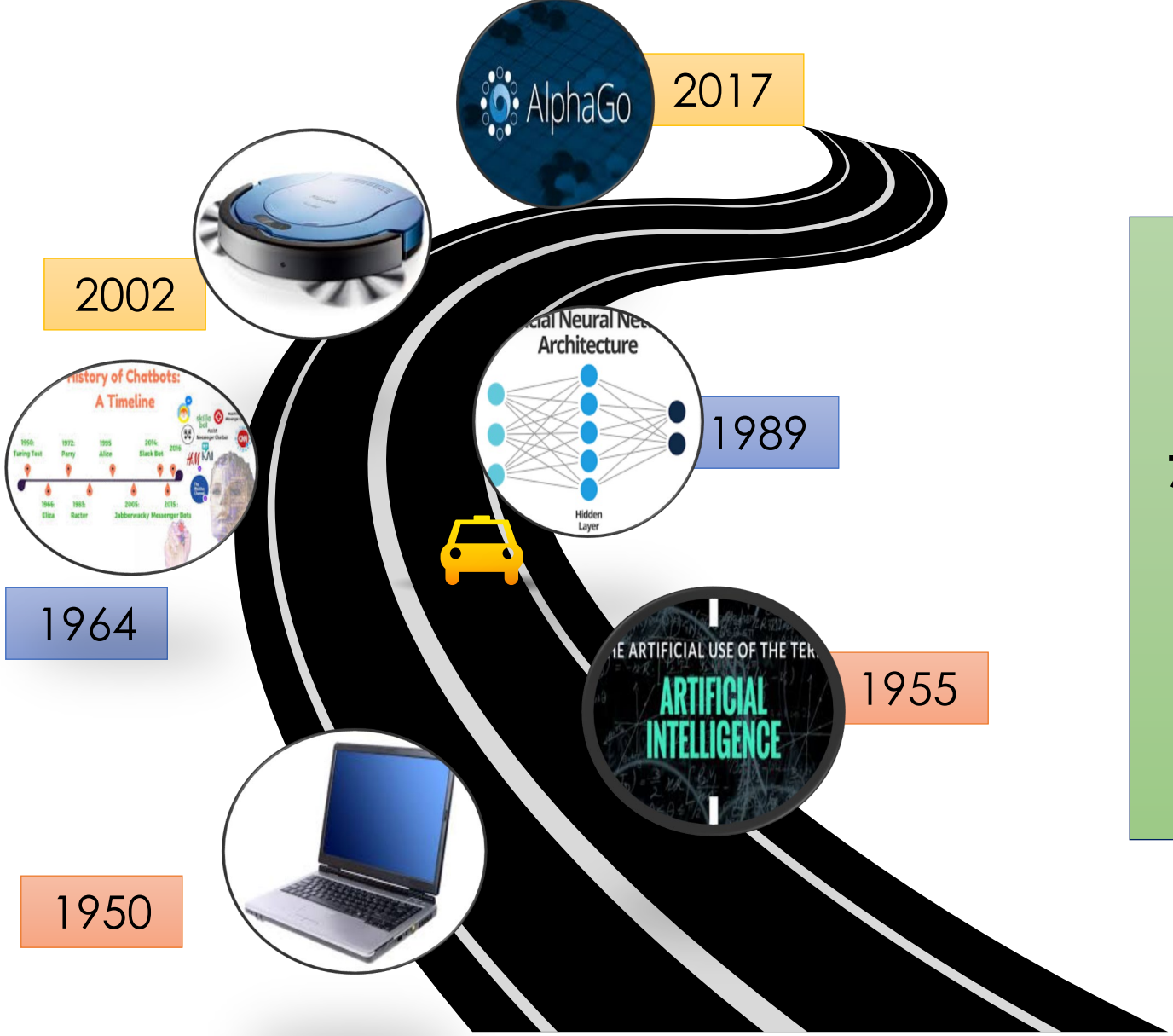
History of Artificial Intelligence

From2000: a new bloom

1980-1990: Expert systems

1940-1960: Birth of AI in the wake of cybernetics



7 decades of Artificial Intelligence

Types of Artificial Intelligence

Reactive Machines

Limited Memory

Theory of Mind

Self-aware

Artificial General Intelligence (AGI)

Artificial Super Intelligence (ASI)

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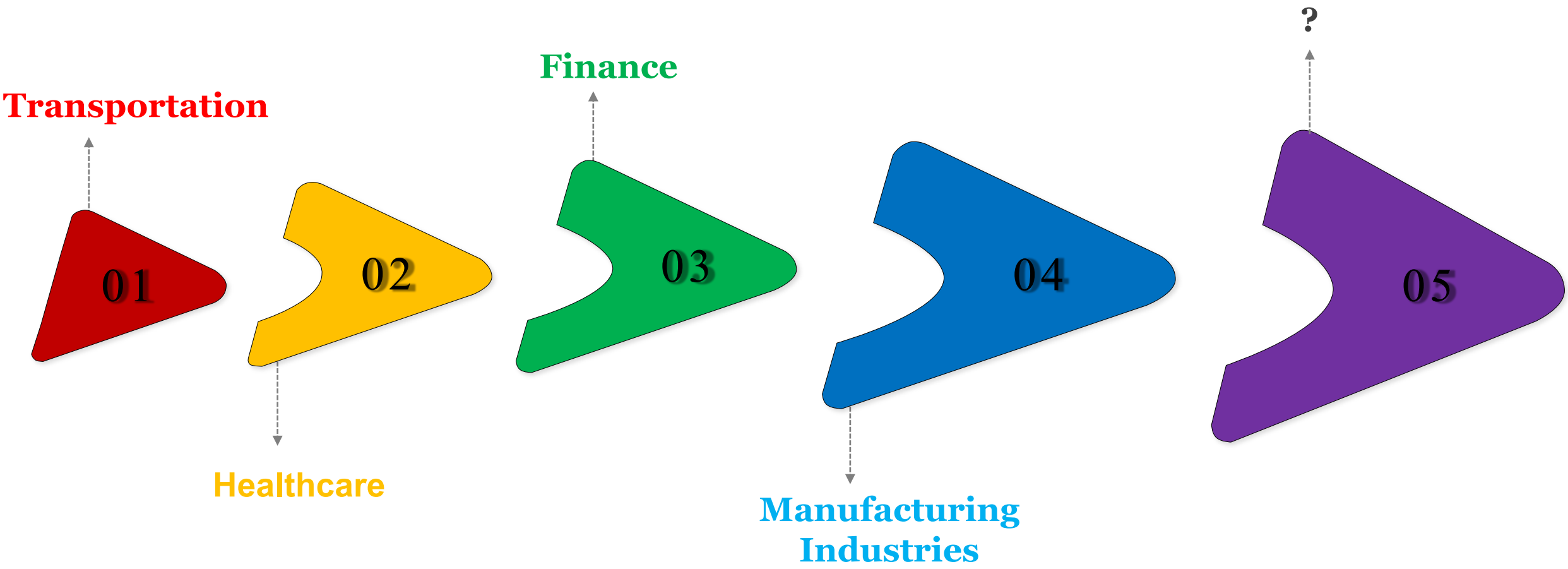
Major Sectors using AI



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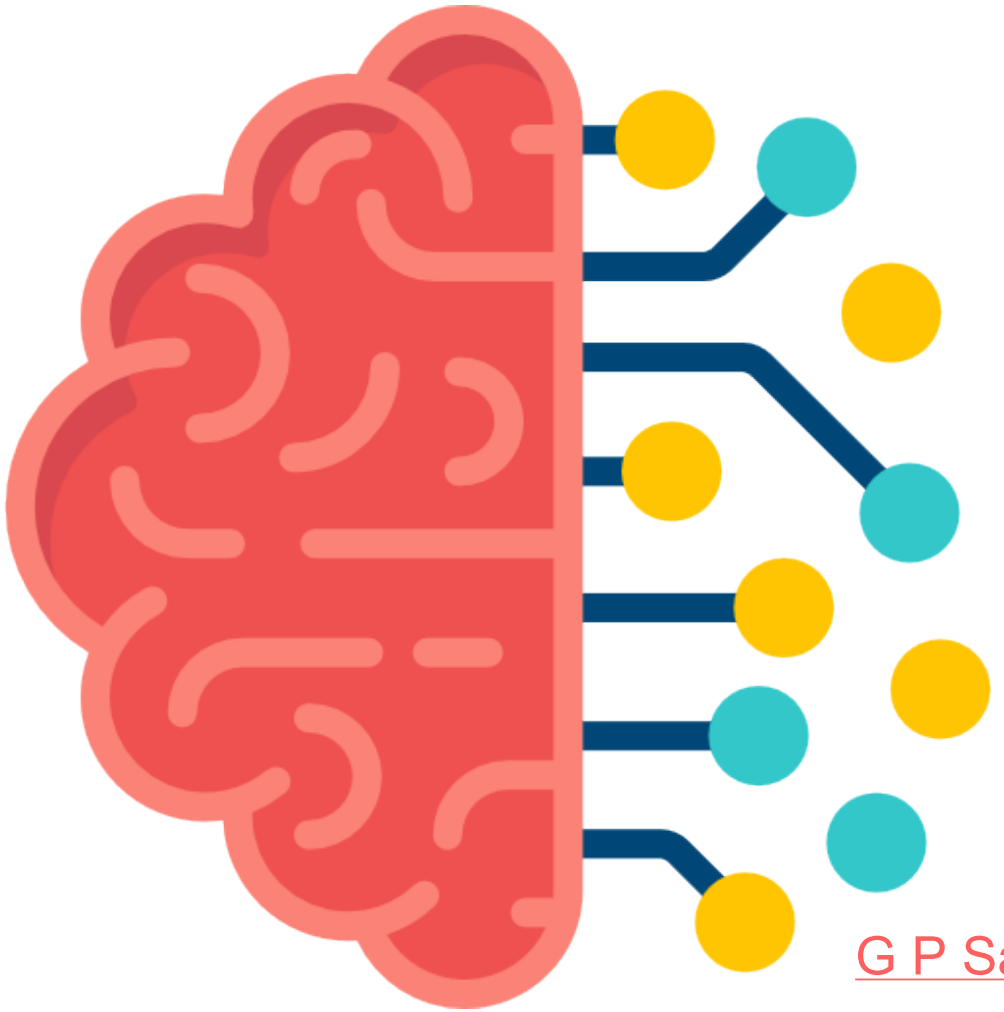
Technologies in which AI used



- Expert systems
- Robots
- Drones
- IOTs

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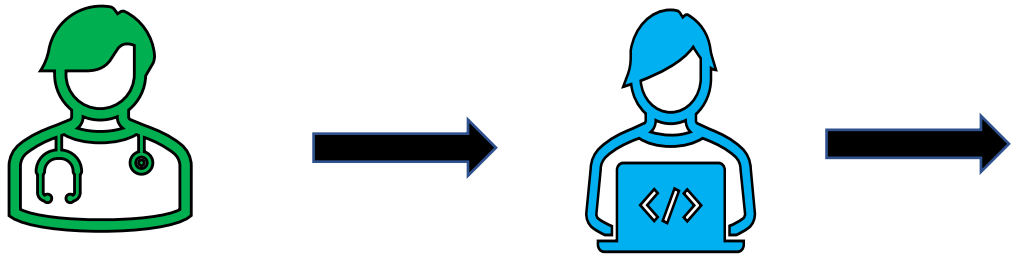
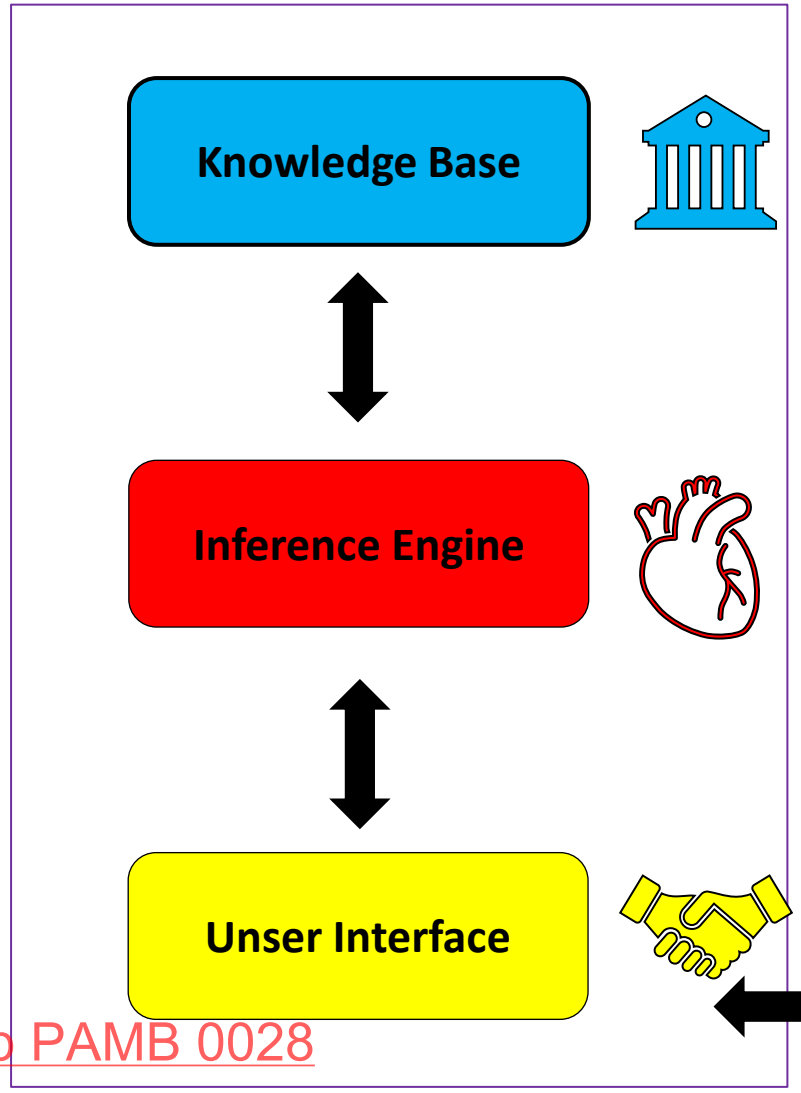
Expert systems





Definition:

Expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

Expert System In Agriculture

S.No	Author	Name of ES	Software/ Shell used	Uses
1.	Fermanian et al. (1985)	PLANT/tm	Not mentioned	Diagnosis of weed in turf
2.	Jones and Haldeman (1986)	CHAMBER	Not mentioned	Management of environmentally controlled crop research facility
3.	Lemmon (1986)	COMAX	Not mentioned	ES for cotton crop management
4.	Palmer (1986)	COMAX	PROLOG	Soybean crop variety selection
5.	Shroyer et al. (1987)	WHEAT WIZ	Not mentioned	Cultivator selection tool
6.	Bennett and Sneed (1988)	COMAX	PASCAL	Planning, design and evaluation of irrigation systems
7.	Floris etal. (1988)	COMAX	PASCAL	Real-time operation; real-time meteorological data handling
8.	Getforth and Macvicer (1988)	OASIS	OASIS	Operation of control structures; real-time meteorological data handling

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Expert System In Agriculture

S.No	Author	Name of ES	Software/ Shell used	Uses
9.	Haie and Irwin (1988)	EXSYS	PASCAL	Drainage diagnosis
10.	Halterman et al. (1988)	ES	Not available	Double cropping management
11.	Boggess et al. (1989)	FinsARS	Not available	Financial analysis for farm business management
12.	Stone and Toman (1989)	COT FLEX	PASCAL	Cotton crop management; coupled with SOYGRO model
13.	Batchelor et al. (1989)	SMART SOY	Insight 2+	Soybean crop management
14.	McClendon et al. (1989)	SMART SOY-IRRIG	Insight 2+	Soybean irrigation
15.	Morgan et al. (1989)	CUE	SELECT	Crop variety selection
16.	Hart et al. (1989)	CUE	LISP	Irrigation system selection
17.	Hershaeur et al. (1989)	CUE	LISP	Canal water distribution; canal network incorporated
18.	Bhatty (1990)	RESEXP	PROLOG	Reservoir operation; DP model integrated
19.	Helms et al. (1990)	CIRMAN	Not available	Crop insurance strategies

Expert System In Agriculture

S.No	Author	Name of ES	Software/ Shell used	Uses
20.	McGregor and Thornton (1990)	CVSES	CRYSTAL	Wheat crop variety selection
21.	Oswald (1990)	TANK	PROLOG	Tank systems diagnostic analysis
22.	Han et al. (1991)	ES	Not available	Sprayer diagnostics
23.	Hasbini et al. (1991)	PUMP	PASCAL	Operational guidelines for center pivot systems
24.	King et al. (1991)	MKBS	Turbo C	Fertilizer and irrigation applications
25.	Nevo and Amir (1991)	CROPLOT	Rabbi	Multiple crop selection
26.	Srinivasan et al. (1991)	ESIM	EXSYS	Delivery system operation; canal network incorporated
27.	Clarke et al. (1992)	IRRIGATOR	PC PLUS	Irrigation scheduling; ET method selection
28.	Elango et al. (1992)	BDM-EXPERT	IITM RULE	Drought management integrated with CASIMBOL model
29.	Kumar et al. (1992)	KBS	Level 5	Economic planning; LP model integrated

Expert System In Agriculture

S.No	Author	Name of ES	Software/ Shell used	Uses
30.	Nakamura and Tsukiyama (1992)	ES	Not available	Irrigation canal renovation project planning
31.	Plant et al. (1992)	CALEX/cotton	CALEX	Cotton irrigation scheduling
32.	Raman et al. (1992)	BDM-EXPERT	Insight 2+	Crop planning under droughts; LP model inferencing
33.	Bralts et al. (1993)	ES	Not available	Hydrologic analysis of micro irrigation system
34.	Mohan and Arumugam (1994)	CROPES	IITM RULE	Multiple crop selection
35.	Nevo et al. (1994)	CROPLAN	PROLOG	Optimal crop planning; LP model integrated
36.	Pasqual (1994)	ES	Not available	Identification and control of weeds in wheat, barley and oats
37.	Arumugam (1995)	TANKES	VP-EXPERT	Tanks system operational guidelines; real-time operation

Expert System In Agriculture

S.No	Author	Name of ES	Software/ Shell used	Uses
38.	Mohan and Arumugam (1995)	ETES	VP-EXPERT	ET estimation method selection
39.	Yialouris et al. (1997)	VEGES	AUA-ES	A multilingual Expert System for the diagnosis of pests and diseases and nutritional disorders of six greenhouse vegetables
40.	Ganesan (2002)	AGRES	Not available	Diagnosis of pests and diseases of major crops of Kerala
41.	Balasubramani(2004)	RUBEXS-04	VB	Disease and Diagnosis in rubber plants

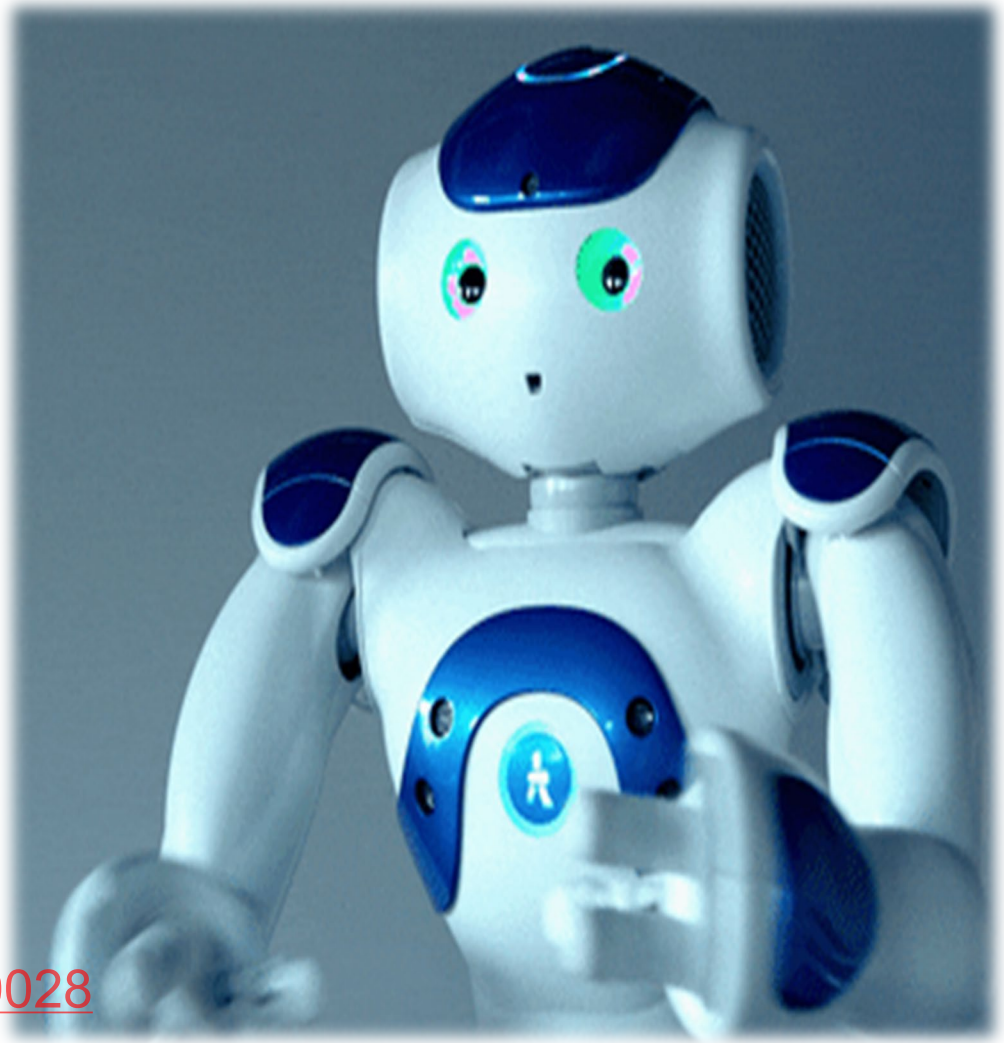
Expert System In Agriculture (Indian cases)

System Name	Crop Name	Description
AGREX	Fruits, Vegetables, Paddy	In Kerala, The Centre for Informatics Research and Advancement (CIRA) has built an expert system program named as AGREX which can support the farmers to receive well-timed and trustworthy guidance. This expert program finds increased use in paddy, vegetables, postharvest technology, and fruits in the field of crop protection, fertilizer application, disease diagnostics, and irrigation scheduling.
TEAPEST	Tea	It is an object-oriented, rule-based expert system that can identify serious insect pests of tea and therefore suggest a suitable control mechanism.
JAFexpert	Jute	Central Research Institute for Jute and Allied Fibres (ICAR- CRIJAF) developed a web-based expert system called JAFexpert. It is capable of providing data for management and accurate identification of injurious organisms and abiotic damages for jute and allied fibre crops.
AMPRAPALIKA	Mango	This expert system program is utilized for making a diagnosis of a specific disease of mango. The system's knowledge base includes information about the indicators and therapies of 14 mango tree illnesses that exist during the non-fruiting and fruiting seasons.
Rice-Crop Doctor	Rice	The National Institute for Agricultural Extension Management (MANAGE) developed this expert system program which is used to detect diseases and rice pests and then suggest the cure.
AGPEST	Wheat, Rice	This expert system is designed for the detection of diseases triggered by wheat plants and rice pests respectively. It also aids the decision support module with a collaborative console base UI for analysis made alongside the questions relating to some specific disease symptom.

Robots

A robot is a type of automated machine that can execute specific tasks with little or no human intervention and with speed and precision.

Robotics is a branch of engineering that involves the conception, design, manufacture and operation of robots.



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Uses of Robots used in Agriculture

1. Harvesting
2. Weed control
3. Spraying
4. Monitoring trees
5. Forester robot- Cutting wood
6. Fruit picking robot

Harvesting

- ✓Drive by itself without any human supervision.
- ✓Demeter (robot name) has cameras on it that can detect the difference between the crop that has been cut and crop that hasn't.

Weed Controlling

1. Remove or destroy the weed.
2. Crops that are grown in rows can be weeded by running a hoe between the crop rows

Spraying

- Efficient Spraying, especially when they cover large areas.
- Both liquid sprays and fertilizer and regulate itself according to current weather conditions.
- If it became too windy then the gantry could just stop and wait until conditions improved.

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Crop monitoring

- A mobile robot is helping scientists monitor environmental changes in forests.
- Tree robot consists of combine networked sensors, a web cam, and a wireless net link.
- It is solar-powered and moves up and down to take samples and measurements for vital analysis.

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Forester Robot

- Cutting up of wood, tending trees, and pruning of trees and for harvesting pulp and hard wood and in the forests.
- It employs a special jaws and axes for chopping the branch.

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Fruit Picking Robot

- Distinguish between fruit and leaves by using video image capturing.
- Pick ripped fruits without damaging the branches or leaves of the tree
- camera is mounted on the robot arm, and colours detection
- If fruit is hidden by leaves, an air jet can be used to blow leaves out the way
- The shape of the gripper depends on the fruit being picked.

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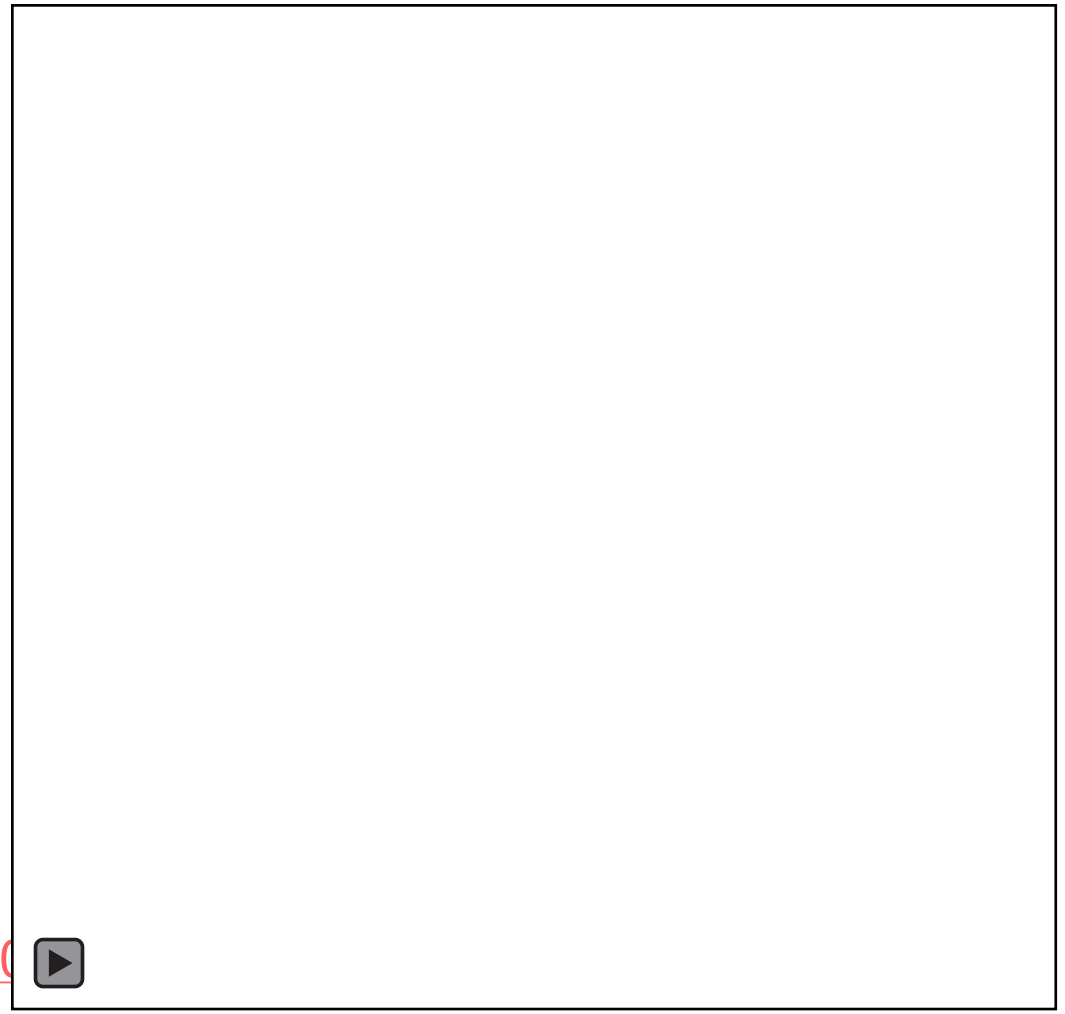

Drones

Drones are more formally known as **unmanned aerial vehicles** (UAVs) that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with onboard sensors and GPS.

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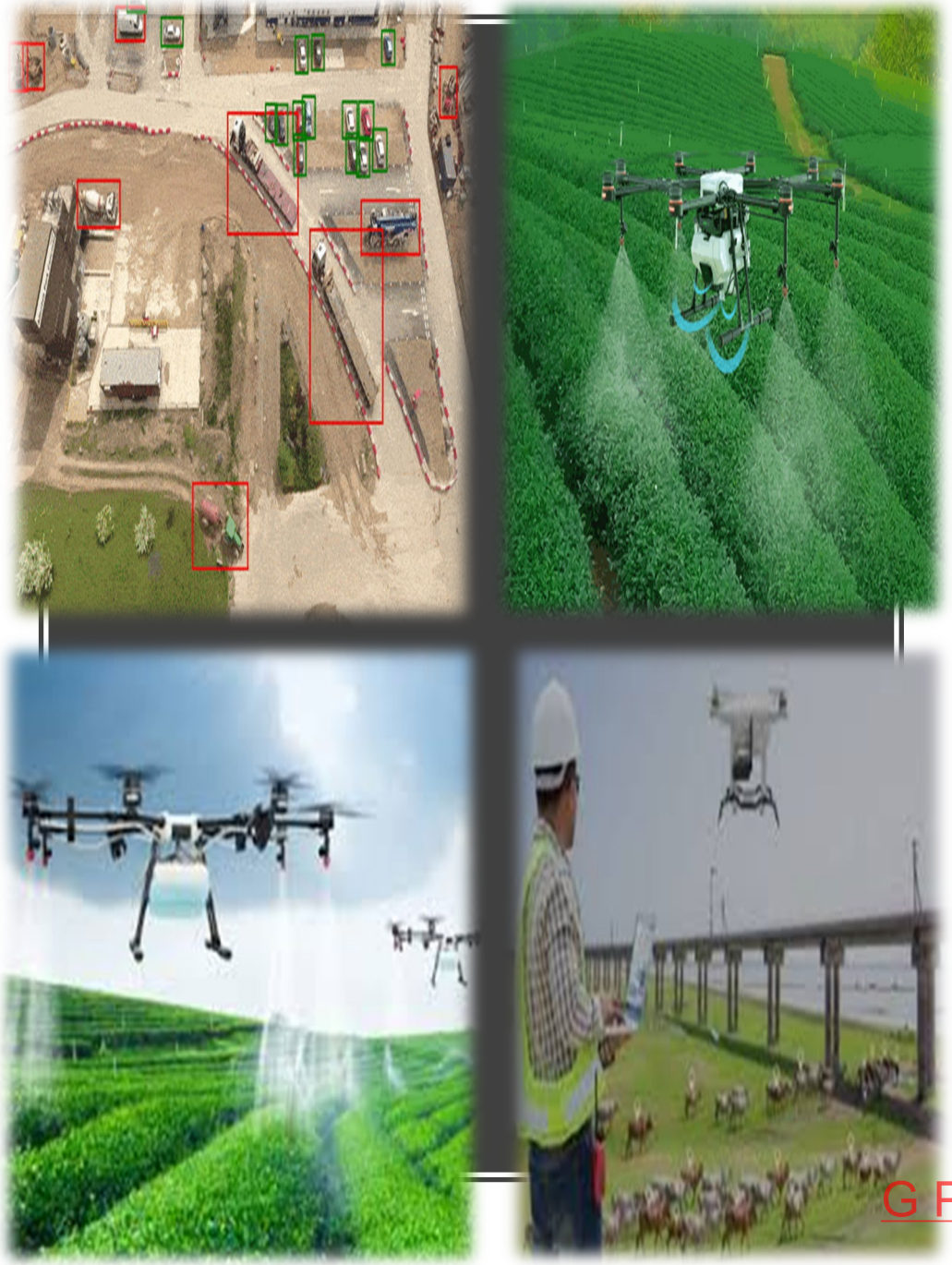

- Mapping/Surveying
- Crop Spraying/Dusting
- Irrigation management
- Livestock Monitoring

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Internet of Things (IoT's)

IoT is an environment where objects, animals or people are equipped with unique identifiers capable of data transmission over Internet network without the need for human-human or human-computer interaction.

- (Gluhak et al., 2011)

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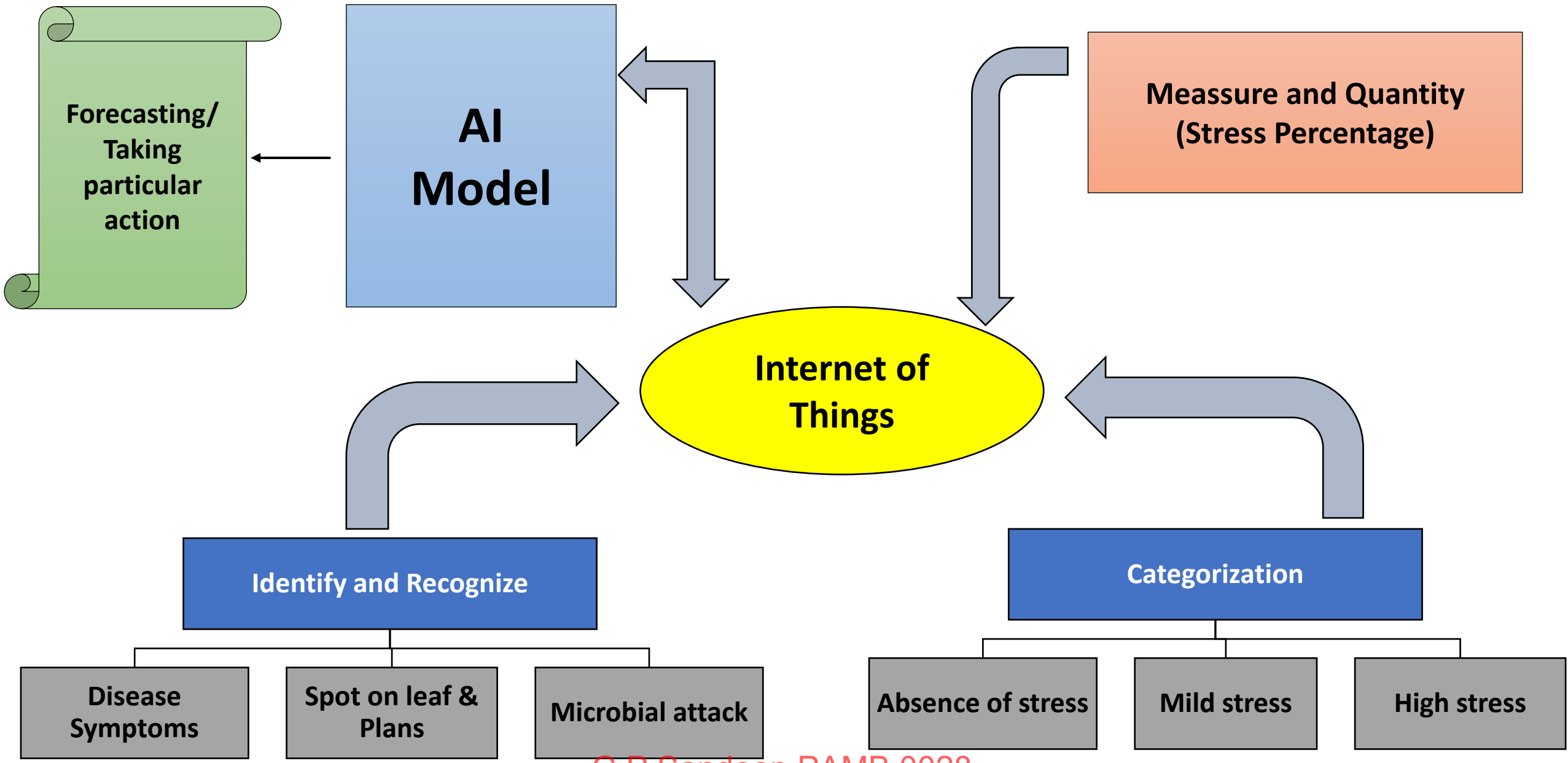

Applications of AI in farming

Social analysis and monitoring	Crop Sowing	Crop monitoring	Weed and pest control
Crop harvesting	Livestock management	Weather forecasting	Mobile Application

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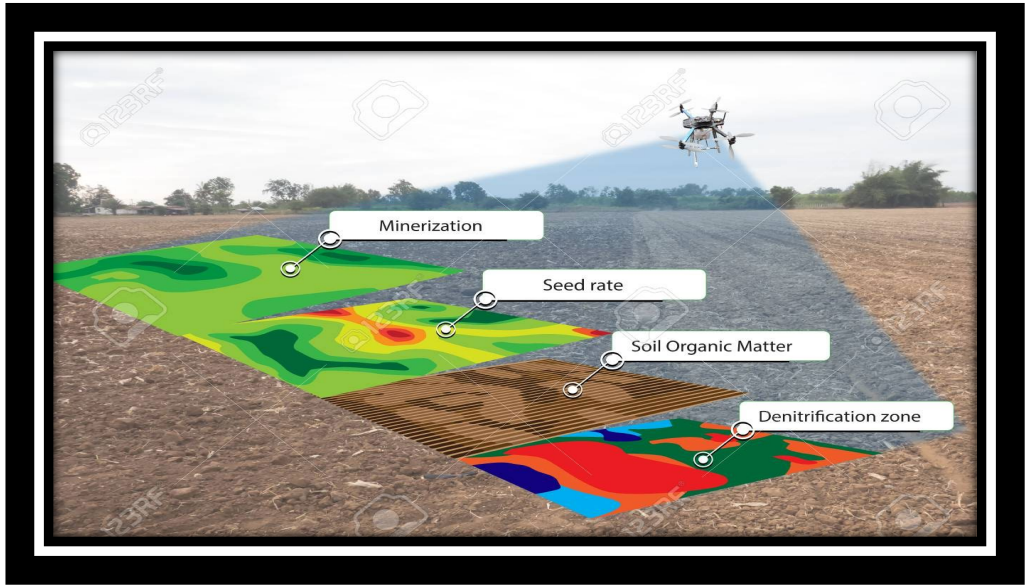
Soil Analysis and Monitoring

AI can be used to monitor soil health with the help of sensors and cameras that scan the soil for its nutritional properties

AI also helps in understanding the reaction of specific seeds to different soils, the impact of weather changes on the soil

With such data in hand, the efficiency of crop inputs is improved, leading to cost savings and productivity gains for farmers.



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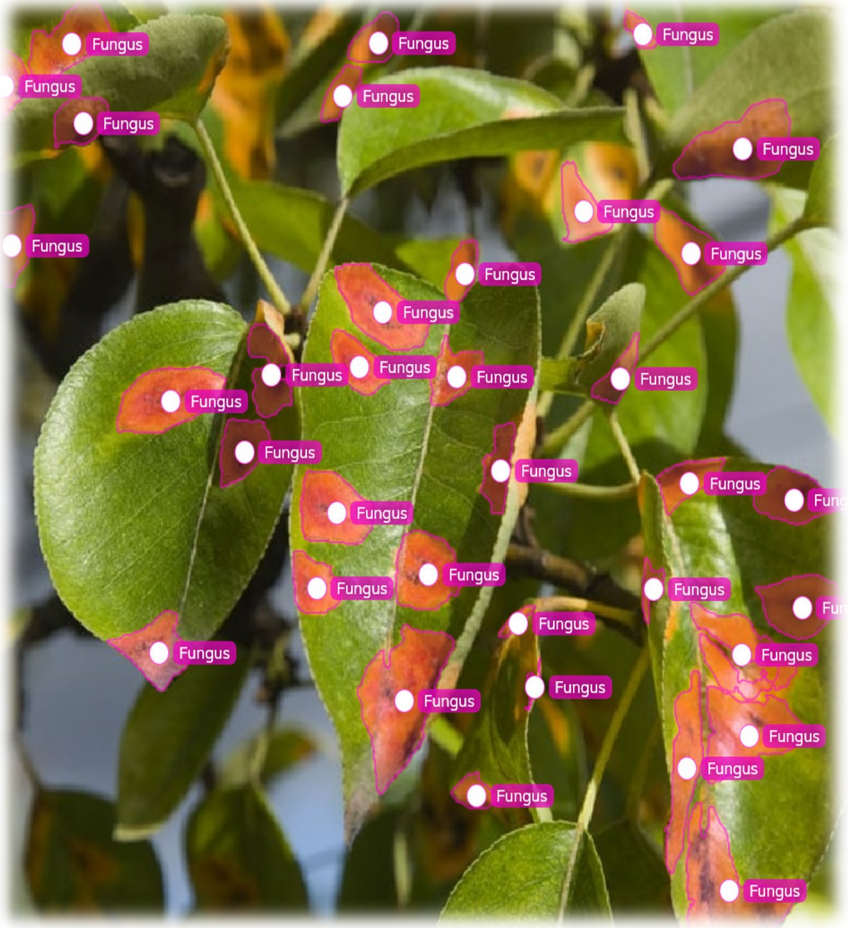
Crop monitoring

crop health will both the quantity and quality of yield.

AI models can inform farmers of specific problem areas so that they can take immediate action.



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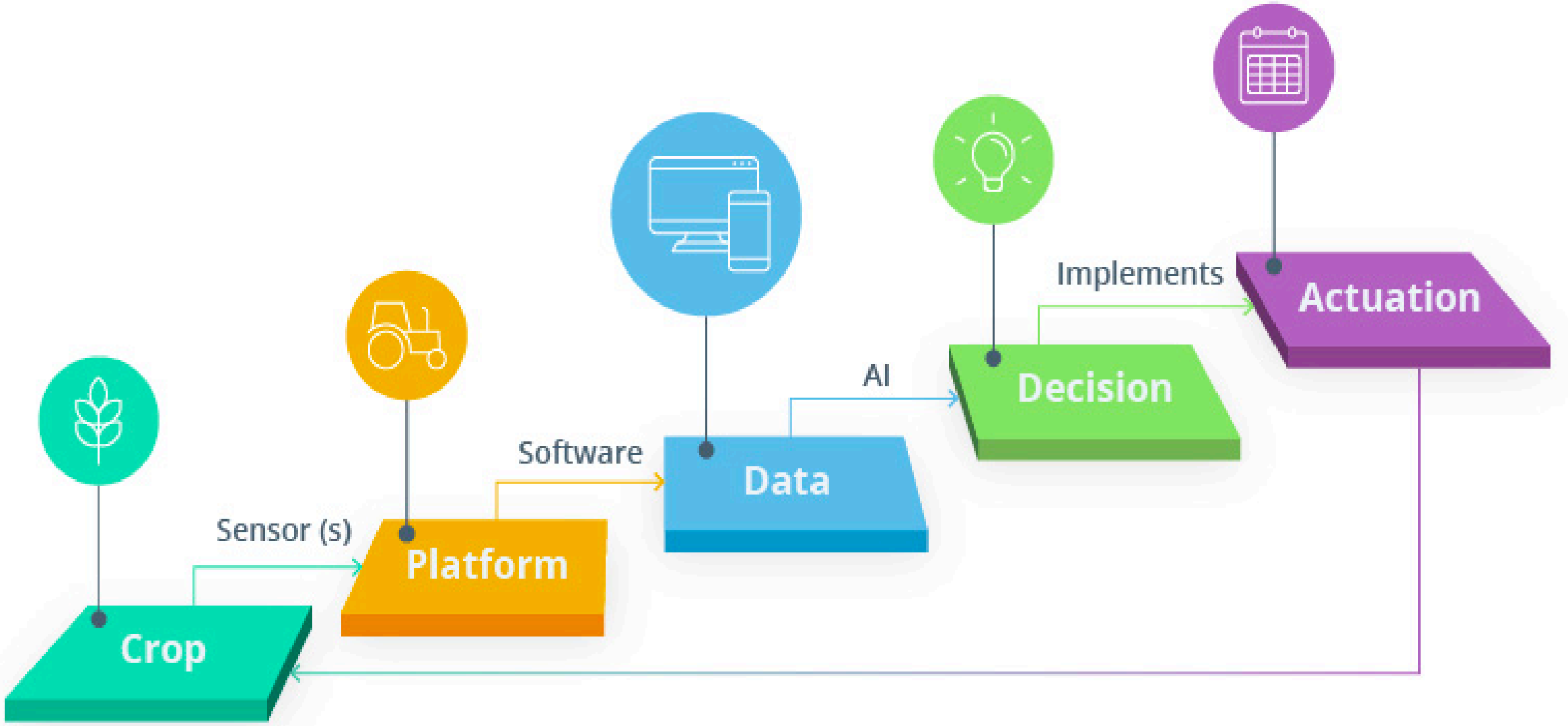

Workflow of AI in making decision

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Crop sowing

AI in crop sowing is used essentially to drive predictive analytics to determine when and how to sow.

It helps in making predictions on the right time to plant, apply fertilisers, till, harvest and bale, etc.

Crops can also be sowed using AI-aided machinery at equidistant intervals and at optimal depths.

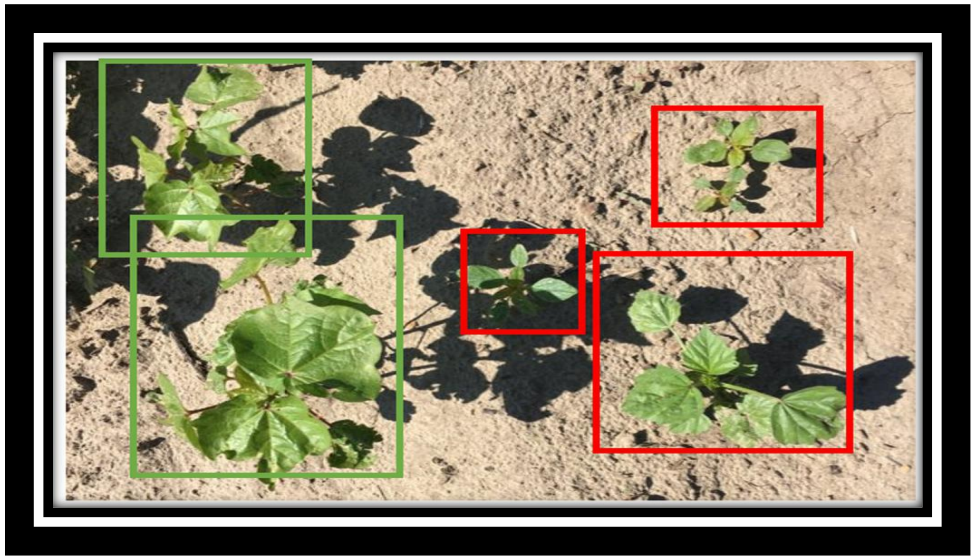
Weed and Pest control

Identification of weed and pest

Generating data

Removal of weeds

Forecasting



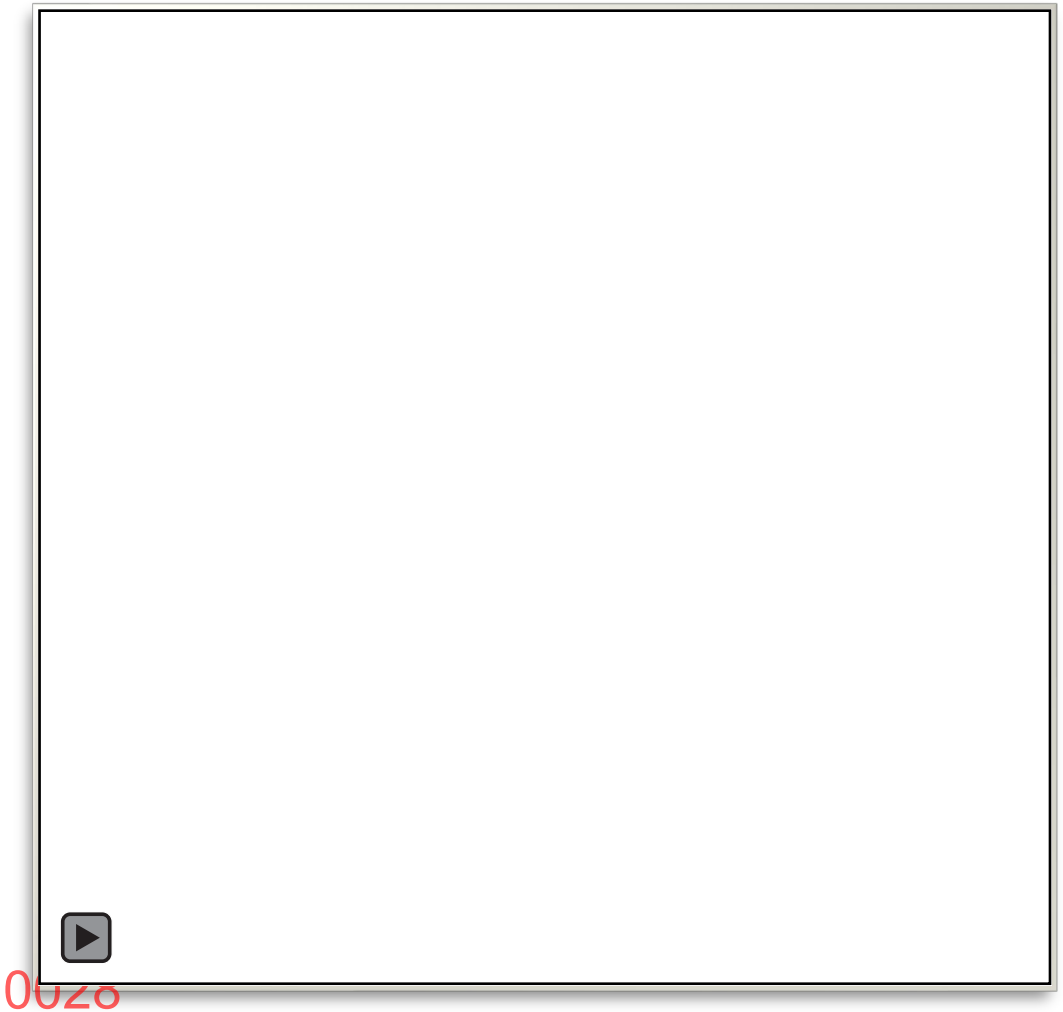
Crop Harvesting

Livestock Management

AI will help livestock farms accumulate and analyze data to accurately predict consumer behavior, like buying patterns, leading trends, etc.

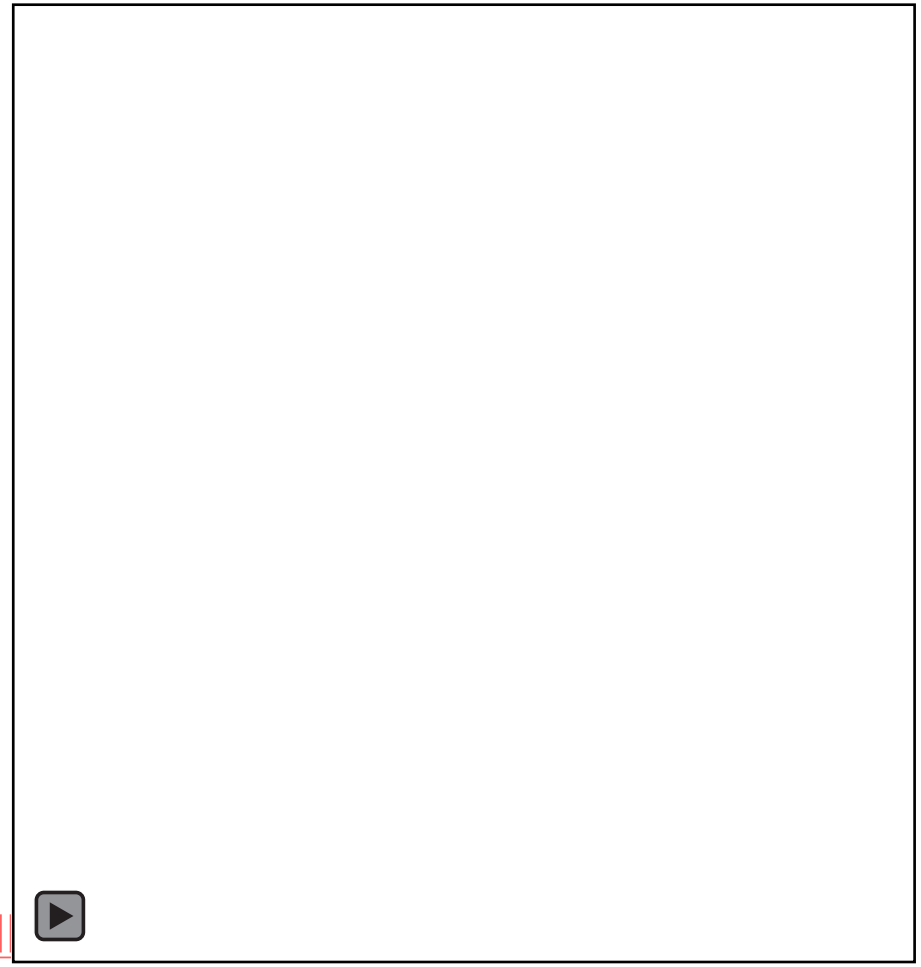
Better planning

With increased investments, farms will be enabled to automate processes, reduce major costs and improve the quality of livestock products like milk.



Agricultural Mobile applications

- Data analysis
- Data forecasting
- Predicting
- Disseminating appropriate information to users



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Mixed reality

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The Impact of an Augmented Reality Application on Learning Motivation of Students

Khan *et al* (2019)

Advances in Human Computer Interaction, 2019, 1-14.

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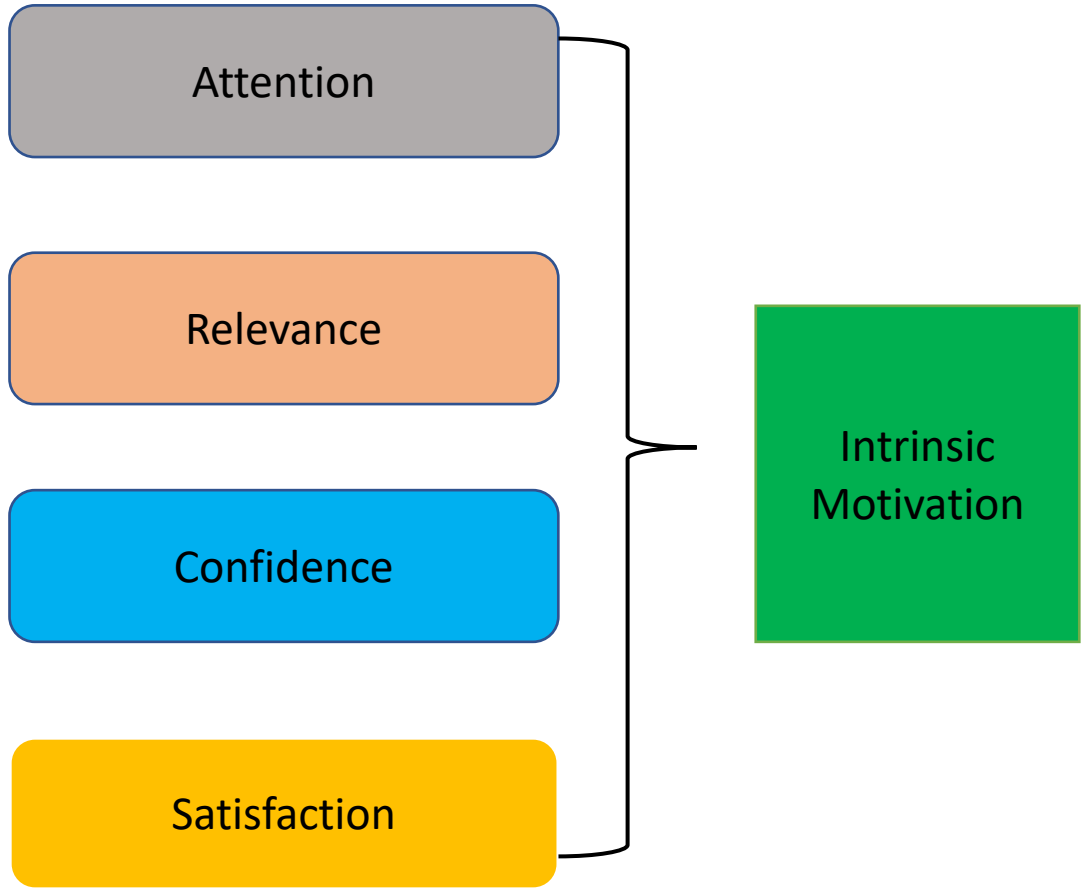
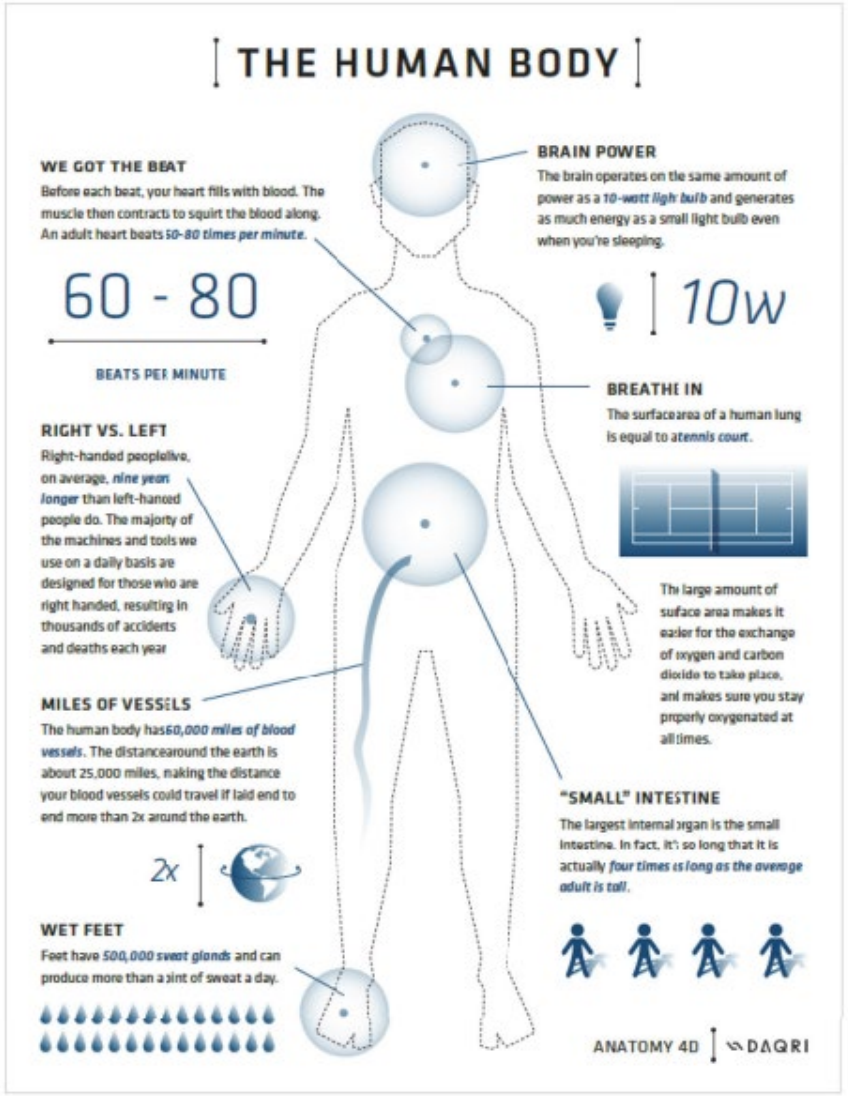
Methodology

- Sample size 78 medical students.
- Pre test and post test is used
- Percentages and Z test were used to analyze study.
- Google form questionnaire is used to collect data.
- Used Keller's ARCS model of motivational design





Text book

AR Enabled

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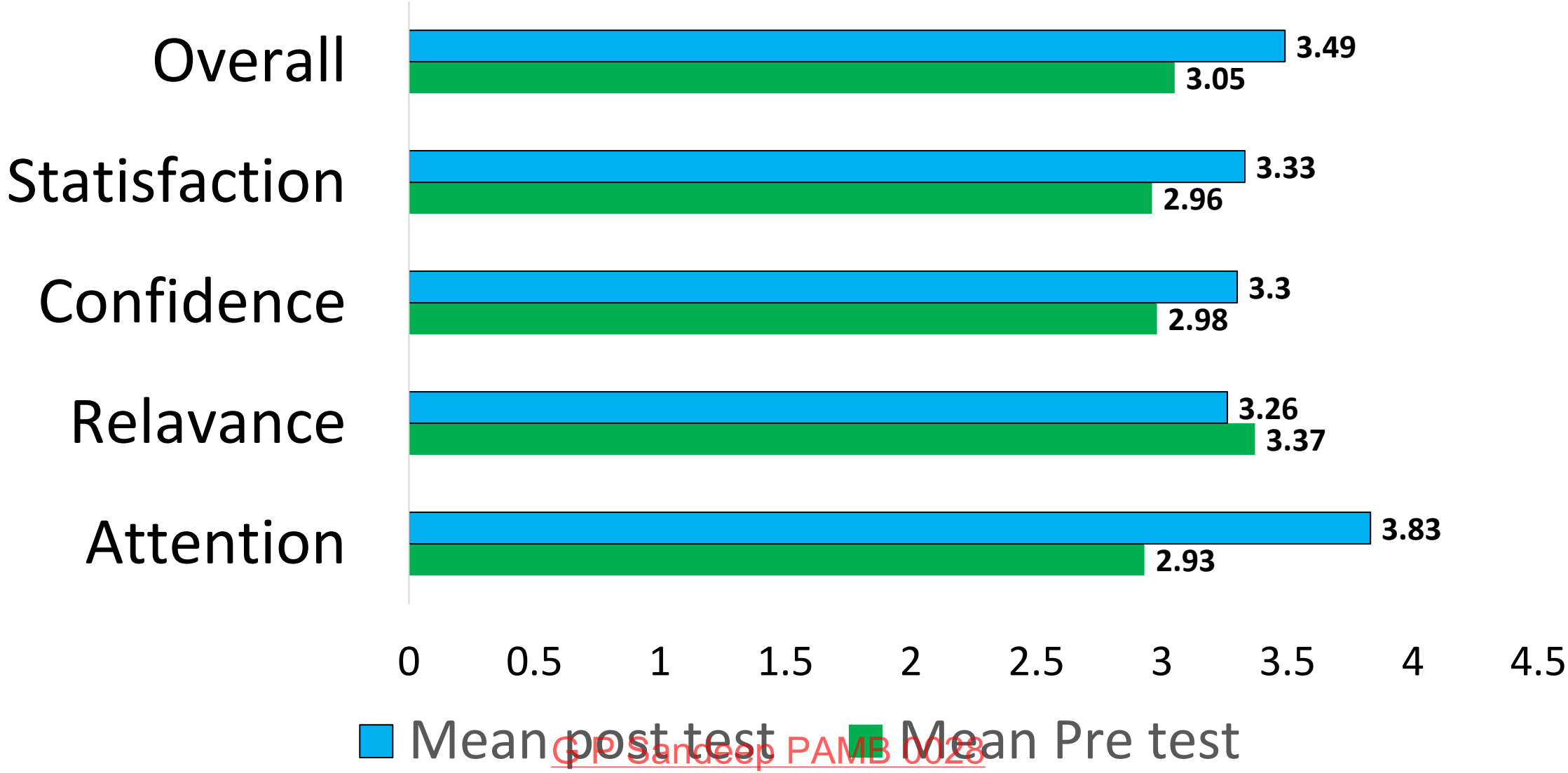
Results



Results

Table 1 Significance of differences in mean values *(n=78)*

S. No	Indicator	Mean Pre test	Mean Post test	Z Value
1.	Attention	2.93	3.83	7.03**
2.	Relevance	3.37	3.26	-0.76
3.	Confidence	2.98	3.30	2.17*
4.	Satisfaction	2.96	3.33	2.44*
5.	Overall	3.05	3.49	3.06**

Table 2 Difference of results with literature

S. No	Indicator	Di Serio et al 2013	Chiang et al 2014	Current investigation	Variance with average
1.	Attention	15%	11%	31%	18%
2.	Relevance	5%	15%	-3%	-13%
3.	Confidence	7%	11%	11%	2%
4.	Satisfaction	13%	11%	13%	1%

Learning in virtual reality: Effects on performance, emotion and engagement

Devon and Adrian (2018)

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Methodology

- All the participants are 1st year students of UK.
- 34 students were exposed to VR content of nuclear cell, 34 students were exposed to video content and 31 students were exposed to general text book content.
- Pre and post test methodology used to know the difference
- 17 biology knowledge questions were marked as correct or incorrect and used in the calculation of an overall percentage correct, separately for each participant.

Results

Table 1 Results of change in knowledge levels among the respondents

Condition	n	Pre-test	Post test	Difference
Virtual	34	28.1%	56.5%	28.5%
Video	34	27.9%	43.9%	16.1%
Textbook	31	25.3%	50.2%	24.9%

Fig 1 Remembering levels responds

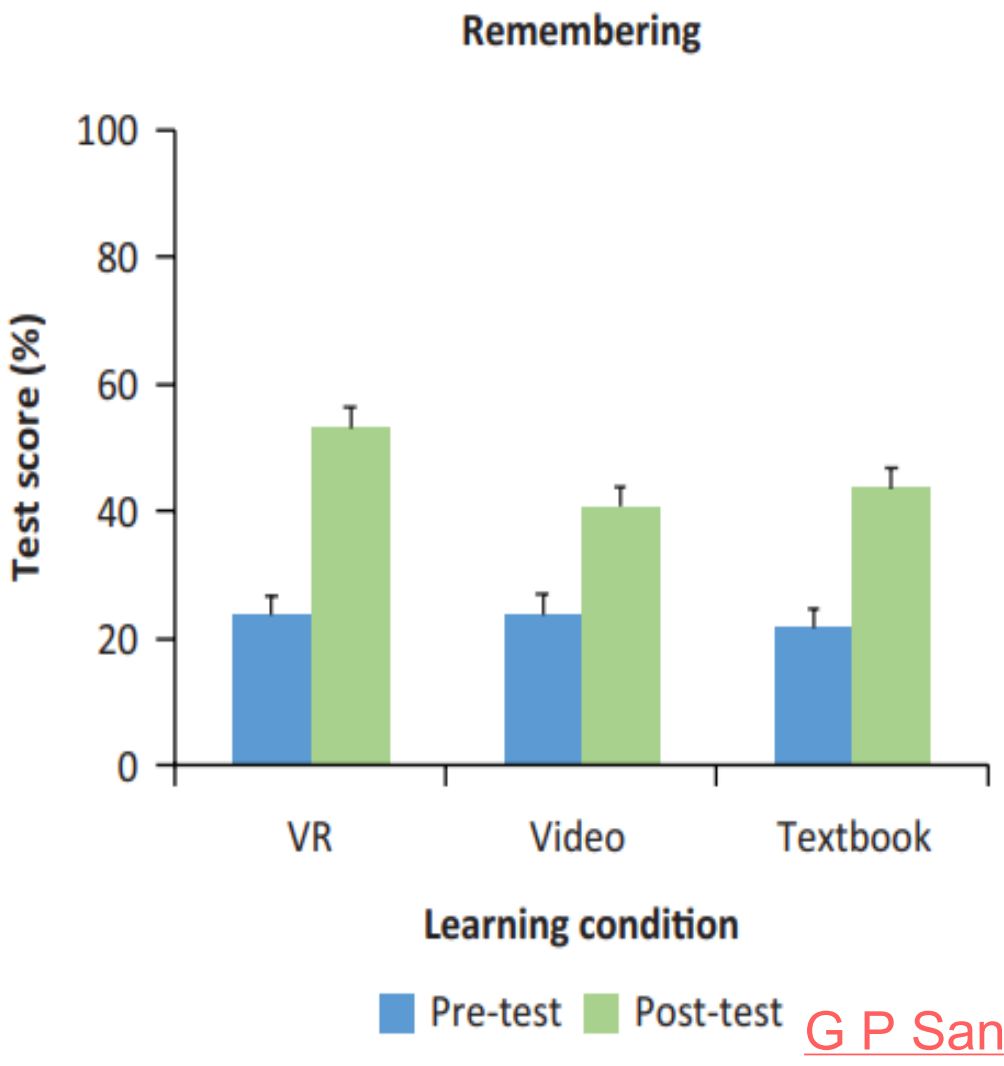
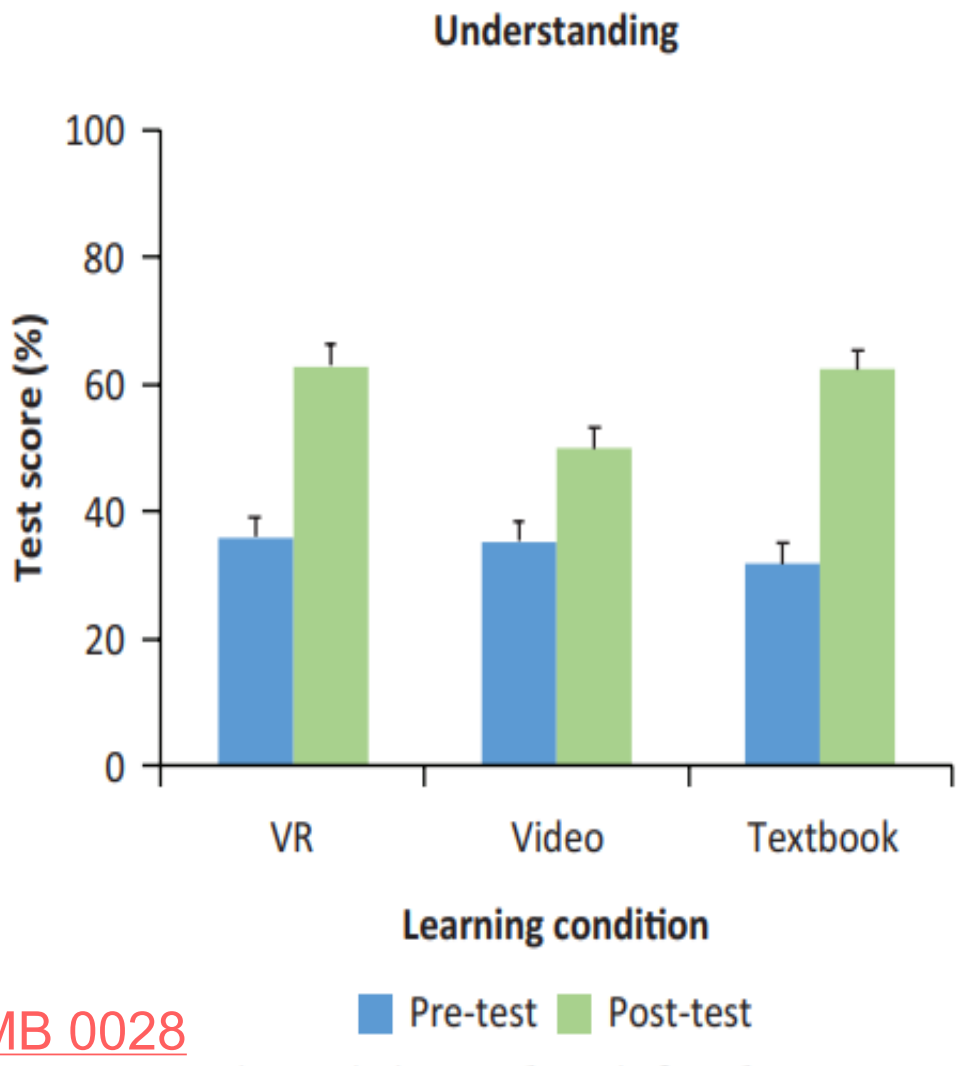


Fig 2 Understanding levels responds



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Conclusion

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