In depth Study of Disruptions for next 20 years based on Table of disruptive technologies

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Abstract- ***In this highly commercial and competitive conditions, Disruptive technologies in the industry urge the market into the future. Companies invest huge resources into research to design and engineer such disruptive technologies that would drive the market for the coming years. There have been dynamic shifts and significant leaps in the Industry with Disruptive Technologies. In this research, upcoming technologies that can potentially disrupt the market space have been identified and given insights about. These Disruptive technologies will be instrumental in pushing the Industry forward as well as be the catalyst that drives change in Corporates and the IT industry.***

Indexed Terms- ***disruptive technology, smart planet, data ecosystem, human augmentation, human-machine interaction, extreme automation, distributed ledgers, ambient energy harvesting, Witricity, robotic companions, intension decoding algorithm, autonomous vehicle***

I. INTRODUCTION

In this rapidly materializing environment, technologies emerge each day in almost every field with immense research and analysis. Research and Development capabilities have radically kept going forward with significant evolution in every field of study and research. Advancements are key in moving the world forward. The Democracies that thrust their Countries to utilize resources to design, engineer, produce and adopt these technical shifts in the industry are going to propel their economies up in the Economic World Leaderboard. According to Standard Chartered's long term forecast, India is likely to become the world's second largest economy by 2030, trailing only behind China.

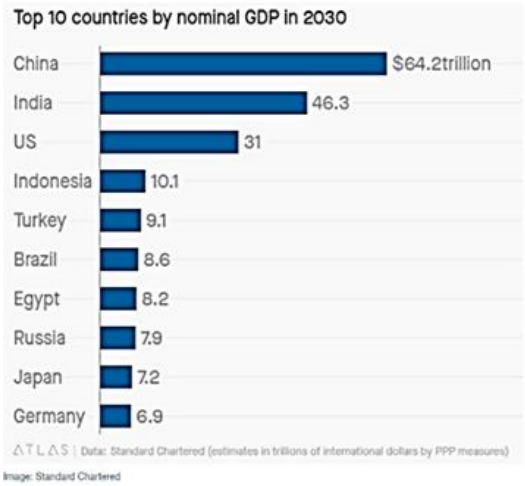

Figure 1.1: Nominal GDP Chart

This paper comprises meticulous research on Disruptive technologies that are emerging and are yet to emerge in the next century. Numerical Gartner Hype Cycles, Magic Quadrants and were analyzed and organized.

1.1 Table of Disruptive Technologies:

The table below contains 100 technologies that are emerging in the market space and those which are under research by various organizations and universities. The whole table is divided into 4 segments based on the time predicted for these technologies to be developed and propelled into the consumer space in the technological world.

Figure 1.2: Table of Disruptive technologies

First horizon (green) contains the technologies that would emerge within 10 years. The second horizon (yellow) depicts the technologies that are to be well-established in 10 to 20 years. These technologies are still under experimentation and are unstable to be used in the current scenario. Third horizon (pink) showcases the technologies that are to be established in later on, it would take more than 20 years, they have been explored, but the human race has barely scratched the surface, there's huge room for improvement and advancements. The fourth horizon (grey) is considered the one with ghost technologies, consisting of fringe science and technologies. These technologies are those defined as highly improbable but not actually impossible. They have been studied and researched on a Theoretical level, but have not been completely understood. There has to be some serious significant development in the Research to support their development. For each technology, it's abbreviation, description, theme and the number will be represented.

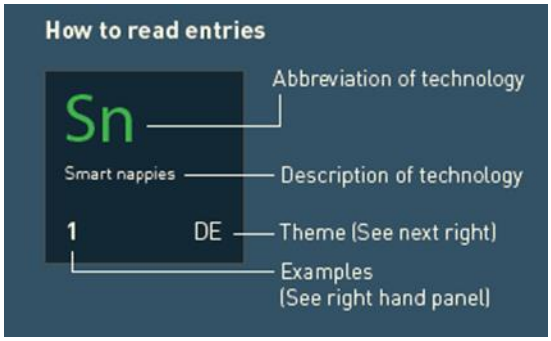

Figure 1.3: example of an entry in the table

1.2 Broad themes for upcoming decades on the Earth:

These 100 technologies are classified under 5 broad themes namely Data Ecosystem, Smart Planet, Extreme Automation, Human Augmentation and Human Machine interaction.

Figure 1.4: Themes for the technologies

This paper assists in the understanding of these fast-emerging technologies. The First horizon(green) is our main area of focus as it is the sector that is more of a prerequisite for the ones that are yet to emerge.

Figure 1.5: First horizon segment

II. THE FIRST HORIZON

The green zone of the table contains sixteen technologies. These technologies are categorized under five themes mentioned above. The most mentioned theme in the green zone is Smart Planet (SP). There are about seven technologies out of sixteen under this theme. The second common theme is Data Ecosystem (DE). Nearly five out of the remaining nine technologies come under DE. The themes Extreme Automation (EA) and Human- Machine Interaction (MI) has two technologies coming under each of these. The fifth theme Human Augmentation (HA) has a lot to be explored still, so there is no technology in the green horizon coming under HA.

Now let us get into the technologies under each category individually.

A. SMART PLANET:

It is the way that intelligence is infused into the systems and processes that make the world work -into things like: cars, appliances, roadways, power grids, clothes, agriculture.

a. Dw - Deep Ocean Wind farms

A Technology that enables wind farms to be constructed in bodies of water, usually in the ocean, to harvest wind energy and generate electricity. Equinor (Norway), Siemens (Germany), Volturn (US), UMaine (US)


Figure 2.1: Deep ocean wind farms

b. Va - Vertical Agriculture

The method of growing crops in vertically stacked layers.It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics and aeroponics. Corporations such as Green Skies Vertical farms (US), Aero farms (US), Neofarms (Germany), Urban crop Solutions (Belgium) practice Vertical Agriculture on a Massive Scale.


Figure 2.2: Vertical Agriculture

c. We - Wireless Energy Transfer

The technology of wireless power transmission can minimize the use of the wires and batteries, thus increasing the mobility, convenience, and safety of an electronic device for all users. Wireless power transfer is useful to power electrical devices where interconnecting wires are inconvenient, unsafe, or are impossible. Corporations such as WiTricity (US), Poweramt (Israel), Apple/Power by Prox (US), Qualcomm (US), Mojo Mobility (US), Mopar (US), Fulon Innovation (US) are developing this technology.

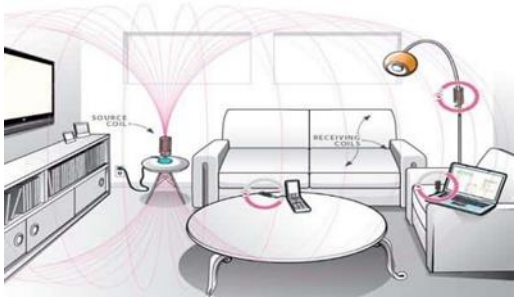

Figure 2.3: Witricity

d. So - Concentrated Solar Power

CSP systems generate solar power by using mirrors or lenses to concentrate the beam of sunlight onto a receiver. Corporations such as Solarreserve (US), Abengoa (Spain), North china Power Engineering (China), Shanghai Electric (China), Zhejiang Supcon Solar (China), NWEPDI (China) are developing this technology.

Figure 2.4: Concentrated Solar power

e. Eh - Micro Scale Ambient Energy Harvesting

Use of very small electric generators and prime movers or devices to convert heat or motion to electricity. These offer the promise of a power source for portable electronic devices which is lighter weight and has a longer operating time than batteries. Pavegen (UK), ECEEN (China) are developing this technology.

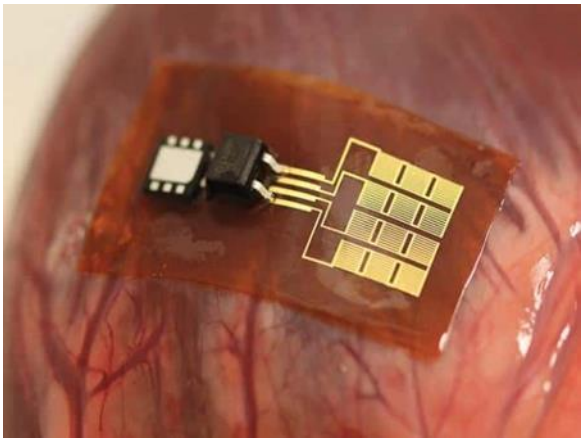

Figure 2.5: Micro-scale Ambient Energy harvesting

f. Cm - Cultured Meat

Cultured meat is meat produced by in vitro cell culture of animal cells. It is a form of cellular agriculture. Corporations such as Impossible Foods (US), Memphis Meas (US), Super Meat (Israel), Finless Foods (US), New Harvest (US) are developing this technology.

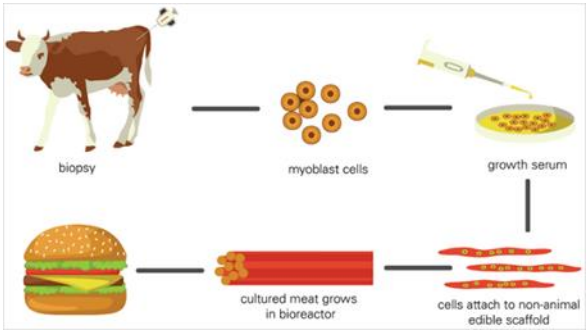

Figure 2.6: Cultured Meat processes

g. Pa - Precision Agriculture

A farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources. Corporations such as Blue River Technology (US), Hortau (Canada) are developing this technology.

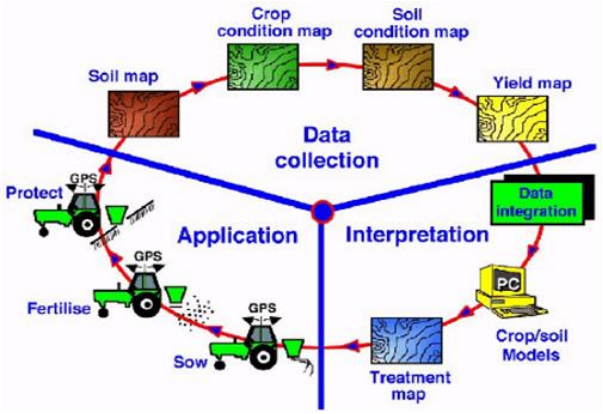

Figure 2.7: Precision Agriculture

B. DATA ECOSYSTEM

a. Sn - Smart Nappies

It is a connected care system to monitor a baby. This includes a special "smart" diaper, which tracks baby's urinal discharges and sleep patterns, a mobile app, and a video monitor. Corporations such as Monit (South Korea), Abena Nova (Denmark), Siempre Secos (Spain).

Figure 2.8: Smart nappies

b. Cr - Crypto currencies

A digital asset intended to function as a medium of exchange for secure financial transactions, control the production of additional units, and verify the transfer of assets. Crypto currencies use decentralized control. Corporations such as Bitcoin (Japan), Ripple (US), Litecoin (US) are leading the Crypto Front.

c. Pp - Predictive Policing

It refers to the utilization of mathematical, predictive analytics, and other analytical techniques in law enforcement to identify potential criminal activity. It is a revolutionary innovation capable of "stopping crime before it starts. Corporations such as PredPol(US), ECM Universe(US) are developing this technology.

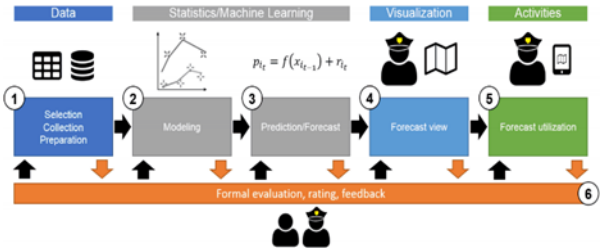

Figure 2.9: a depiction of preventive policing process

d. Sc - Smart control Appliances

An IoT-based appliance control system for smart homes. Corporations such as Amazon (US), Alphabet (US), Philips (Netherlands), Samsung (South Korea), Dyson (UK), Miele (Germany), iRobot (US) are developing this technology.

Figure 2.10: Smart homes

e. Dl - Distributed Ledgers

An agreement of replicated, shared, and synchronized digital data topographically spread across multiple sites, countries, or institutions. There is no central administrator or centralized data storage. Corporations such as Everledger (UK), Stampery (spain), Brickblock (Germany), slock.it (Germany) are developing this technology.

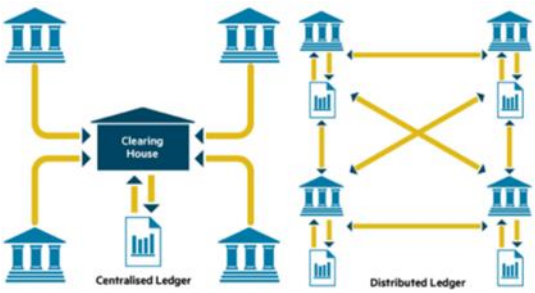

Figure 2.11: Distributed Ledgers

C. EXTREME AUTOMATION

a. Ro- Delivery Robots and Passenger Drones. An autonomous vehicle, often an unmanned aerial vehicle (UAV), used to transport goods, food or packages.

Corporations such as Wing/Alphabet (US), Starship Technologies (UK),Volocopter (Germany), eHang (China), Piaggio (Italy) are developing this technology.

Figure 2.12: Delivery drones

b. Av - Autonomous Vehicle

A vehicle that has the ability to sense its environment and move safely with little or no human input. Corporations such as Google/Waymo (US), Voyage (US) and NVidia Automotive (US) are developing this technology.

Figure 2.13: Autonomous Vehicle

D. HUMAN – MACHINE INTERACTION

- Id - Intension Decoding algorithm

This uses the responses of multiple voxels in the brain evoked by stimulus then detected by fMRI in order to decode the original stimulus. This is possible by using human neuroimaging to decode a person's conscious experience.It is based on non-invasive measurements of an individual's brain activity. Corporations such as Amazon (US), Google/Alphabet (US), Philips (Netherlands), Samsung (South Korea), Dyson (UK), Miele (Germany), iRobot (US) are developing this technology.

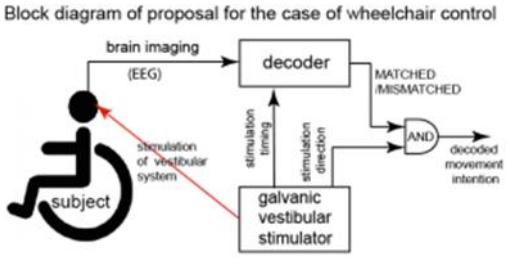

Figure 2.14: Intention decoding algorithm

- Rc - Robotic Care companions

A companion robot is a robot created with the motivation of creating real or genuine companionship for human beings. Target markets for companion robots include the elderly people and single children. Corporations such as Softbank (Japan), AIST Japan, Blue Frog robotics (France), Care-0-bot (Germany), Riken/sumitomo Riko (Japan), Mayfield Robotis (US) are developing this technology.

Figure 2.15: Robotic Companions

III. DISRUPTIVE TECHNOLOGIES IN AUTOMOTIVE INDUSTRY

Out of these sixteen technologies, more than fifty percent of them can be designed and opted for the automotive industry as well. These technologies include Distributed Ledgers, Micro-Scale Ambient Energy Harvesting, Wireless electricity, Robot care companions, Intention decoding algorithm and Autonomous vehicle. We will now get to know about these technologies with deeper concise.

a. Distributed Ledgers:

Distributed Ledgers are designed as a peer-to-peer distributed system composed by several nodes. Each node propagates transactions and ledger updates to all other nodes and fulfils one or more of the below roles:

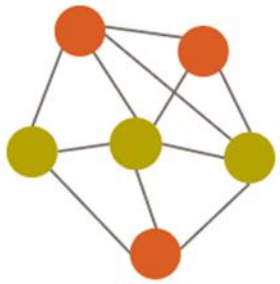

Figure 3.1: Participants and validators representation

- Participant: Responsible for transactions input. Based on the implementation, have the option to either store the full copy of the ledger or not. Wallet in Bitcoin terminology.
- Validator: Verify transactions and update the ledger. Miner in Bitcoin terminology.

- General ledger vs distributed ledgers:

The difference between the general ledger and distributed ledgers is that, the general ledgers is safe stored centrally by the service provider. Participants do not have access to the ledger. Whereas distributed ledger is the one where every participant in a service has a copy or can have access to a copy of the ledger supporting this service, which gets updated throughout the day. It has no central server.

Figure 3.2: General vs Distributed Ledgers

- Working of Distributed ledgers:

The working of distributed ledgers is very simple. Transactions are broadcasted to all nodes by participants. Validators verify all transactions and reach a consensus amongst themselves on what transactions to include in the ledger. Various consensus methods exist (e.g., Proof of Work for Bitcoin). Once consensus is reached new set of transactions is included in the ledger by all participants.

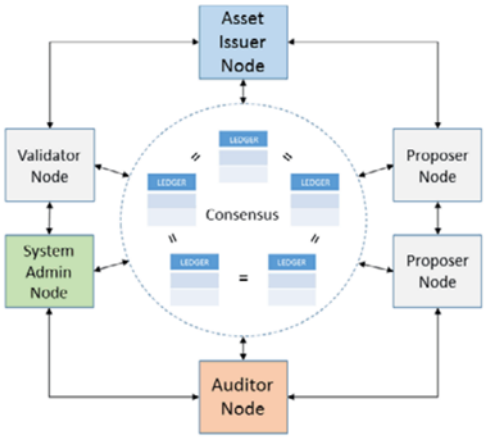

Figure 3.3: Ledger distributed across multiple nodes

By using distributed ledgers various types of data can be exchanged. Online - platform assets like digital currencies, off-platform asset references like fiat currencies, securities etc. and obligations, right contract (smart) and agreements like estate ownership can also be exchanged in the safer and more vigilant manner.

The distributed ledgers can also be divided into public and permissioned. Public Ledger is that anyone, without permission, may submit and validate transactions (eg, bitcoin). Permissioned Ledger are

those only known and trusted actors may submit and/or validate transactions. These ledgers are permissioned Validation by consensus, not proof-of-work, Validators chosen by contract, reputation,

Organization, Faster, more efficient than proof-of-work, faster (but less secure) than POW algorithm, Requires high level of trust between participants.

There are so many merits to be considered to use the distributed Ledgers. Firstly, Information propagation i.e., there is efficient means of keeping a full network up to date with latest information. Secondly, Full traceability where the Participants are able to trace information flows back through the entire chain. Thirdly, Simplified reconciliation which helps the Local access to complete and verified data easing reconciliation processes. Fourthly, trusted disseminated system, this is the ability to trust authenticity of data on the ledger without recourse to a central body. And Lastly, High resiliency i.e., this system Operates seamlessly and removes dependency on a central infrastructure for service availability.

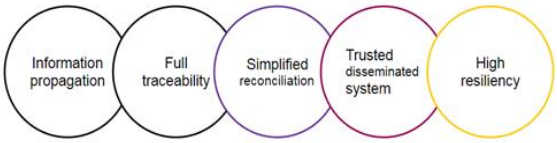

Figure 3.4: Key strength of DL

There are many top leading companies that are using Distributed ledgers. They are represented in the Tabulation below.

Table 3.1: Major users of DL at present

	Domain	Traceability	Dispute Resolution	Cargo Integrity & Security	Digitalization	Compliance	Trust & Stakeholder Management	Create Industry Standard
Port of Antwerp	Port	X		X	X		X	
Maersk & IBM	Container Shipping	X	X	X	X		X	X
Accenture	Freight and Logistics Consortium	X		X	X	X		
BiTA	Transportation and Logistics Consortium					X		X
UPS	Logistics	X	X		X	X	X	
Walmart & IBM	Food	X			X	X	X	X
Carrefour	Food	X			X	X	X	
MediLedger	Pharmaceuticals	X			X	X	X	X

- Case Study 1: WALMART

How Walmart brought transparency to the food supply chain with help of Hyper ledger Fabric.

Challenge:
When an outbreak of a food-borne disease happens, it can take days, if not weeks, to find its source. Better traceability could help save lives by permitting companies to act quicker and protect the livelihoods of farmers by only disposing produce from the affected farms.

Approach:
Walmart thought that block chain technology might be a good fit for the decentralized food supply ecosystem. To test this hypothesis, a food traceability system is created based on Hyper ledger Fabric.

Example: for mangoes in the US, the time needed to trace their provenance went from 7 days to 2.2 seconds.

Figure 3.6: foods Walmart is tracking with Hyperledger

Results:
Walmart would now be able to follow the origin of more than 25 items from 5 distinct providers utilizing a framework controlled by Hyperledger Fabric.

- Case Study 2: MAERSK

The three biggest freight shipment organizations are presently all utilizing a solitary blockchain record to follow vessels – and their payload holders – around the globe in real time. The electronic shipping ledger records subtleties of payload shipments as they leave their starting point, show up in ports, are moved abroad and ultimately got by producers and others. Focal point empowers contending transporters to associate, share data and team up across the transportation store network biological system. Individuals pick up a complete perspective on their information and can carefully work together as freight moves far and wide, making a straightforward, secure, unchanging record of exchanges.

b. Micro Scale Ambient Energy Harvesting

Energy harvesting (also known as power harvesting or energy scavenging) is the process by which energy is derived from external sources. The resources that are considered for the harvesting of ambient energy are solar, wind, thermal and kinetic.

Figure3.6: Ambient Energy sources

- Harvesting energy from Temperature variation:

Power can be generated from temperature variation by the use of Pyroelectric Generators. Pyroelectric voltage at time t can be calculated as:

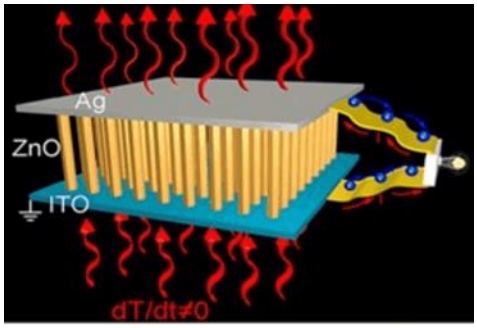

Figure 3.7: Pyroelectric generators

PV is pyroelectric voltage coefficient, rd is the Debye length of ZnO and ΔT (t) is variation of temperature at time interval of [t-1; t] in Kelvin. The detectable current i(t) of a pyroelectric material is proportional to the rate of change of its temperature and can be expressed as:

$$i(t) = P_C \times A \times \left(\frac{dT(t)}{dt}\right)$$

Figure 3.8: Expression for detectable current of Pyroelectric material

Pc is the pyroelectric current coefficient and A is the surface area of the electrode connected to the pyroelectric material.

- Harvesting energy from Pressure variation:

Power can be harvested from atmospheric pressure variation

- For a fixed volume V of gas, the change in energy ΔE due to a change in pressure ΔP is (reference): ΔE= ΔPV (pressure in Pascal)
- For example, local pressure can change around 30−40 mbar (3−4 kPa) during cyclonic weather events, a more typical daily pressure change is 3 mbar (300 Pa). With a device volume of 1 cm^3 this will provide 300 mJ/cm3 (around 3nW per day)

- It will provide the pressure in mbar or hPascal. In the above formula, we need pressure in Pascal. Each mbar or hPascal is equal to 100 Pascal.
- The output of barometer in two time slots t1 and t2 which is P1and P2, respectively, can be used to calculate ΔP= P2-P1

- Harvesting energy from Humidity variation:

Power can be harvested from relative humidity changes

- The ability to obtain a potential difference across membranes separating two aqueous solutions of differing salt concentrations has been known for over half a century.

$$\Delta V = \frac{RT}{zF} \ln \frac{\text{peak humidity}}{\text{initial humidity}}$$

Figure 3.9: Expression for potential generated

- ΔV is the theoretical membrane potential (J C-1 or V), R is the gas constant (J mol -1 K-1), T is the absolute temperature (in Kelvin, K), z is the electrochemical valence, F is Faraday's constant (C mol-1).
- 1% variation in humidity can creates around maximum of 0.4mV potential difference.

c. Wireless Electricity:

Wireless energy transfer or Wireless Power is the process that takes place in any system where electrical energy is transmitted from a power source to an electrical load without interconnecting wires. Wireless transmission is useful in cases where instantaneous or continuous energy transfer is needed but interconnecting wires are inconvenient, unsafe, or impossible.

The forgotten invention is reborn in 2007 whereas the idea of wireless electricity has been around since the early days of the Tesla coil. But a group of MIT scientists, "WiTricity" (as these scientists call it) is now one step closer to practical reality.

WiTricity technology is—transferring electric energy or power over distance without wires. With the basics of Electricity and Magnetism.

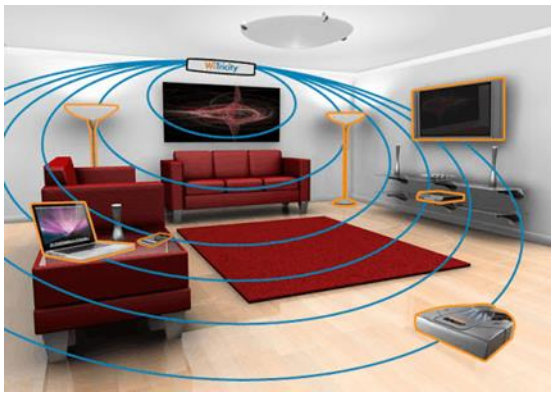

Figure 3.10: Wireless electricity

Working:

- Imagine a coil there is a capacitor to it too.
- And if u can cause that coil to resonate, what will happen, it pulses at alternating frequency, at fierily high frequency.
- And if u can bring another coil, close enough to source that will only work exactly at resonate frequency, you can actually get them to what is called strongly couple and transfer energy between them.
- Theoretically one stationary coil in a room could power multiple devices with receiving coils.
- No more messy wires, and with widespread enough use it could even eliminate costly batteries.

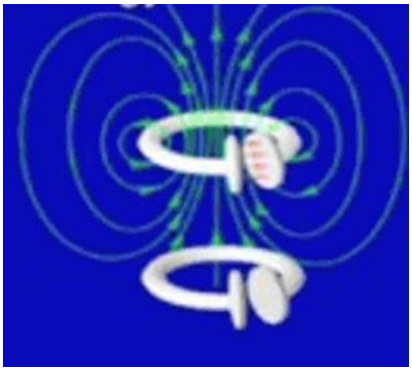

Figure 3.11: Working of witricity

Features and Benefits:

- Highly Resonant Strong Coupling -High Efficiency Over Distance
- Energy Transfer via Magnetic Near Field - Penetrates and Wraps-Around Obstacles
- Non- Radiative Energy Transfer -Safe for People and Animals

- Scalable Design –From mill watts to Kilowatts
- Flexible Geometry - Devices That Can Fit into OEM Products
- WiTricity's technology is more than Traditional Magnetic Induction
- WiTricity's technology is different than Radiative Power Transfer
- WiTricity's technology is different than Magnetic Resonance Imaging (MRI)

d. Robotic care companions

Softbank in JAPAN, has been very active in developing humanoid robots that can be used as companion for kids, elderly and more.

Pepper has been designed to be a social companion, at home and at the office. By 2017 there are more than 10,000 Pepper around the world, most of them in Japan & South Korea, Singapore and California shows increased sale volume (Pepper does not sell, it attracts more people to the store). A key feature of Pepper is its capability to understand the emotional level of the person interacting with it and adapting to fit those emotions. This is at the root of our social behaviour. Its humanoid, childlike design, is also creating an empathy with people interacting with it.

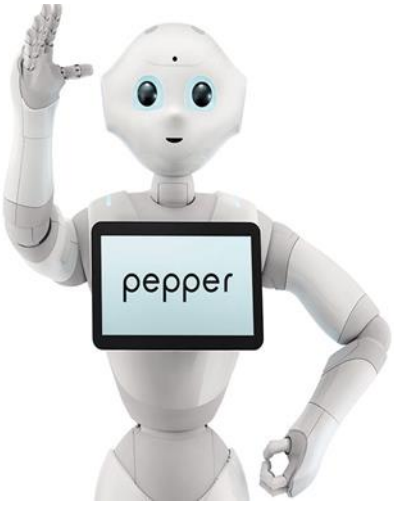

Figure 3.12: Pepper robot

Buddy is an open-source companion robot designed to become part of your family.

It weights around 10 kg and has a battery that support up to 10 hours operation (and it goes back automatically to the charging station when needed). It can serve as a security monitoring, detecting unexpected presence at home, it connects to appliances making your home smarter, it has local and remote social interactions & can be used as a personal assistant (planning, reminder, alarm clock) and as an elderly support.

Care-o-bot is a modular service robot, designed to interact with people and adapt to their needs and to the ambient. It has been designed to operate in a home environment and interact with humans using natural language.

e. Intention Decoding algorithm

Uses "mirror neurons "- they make us feel what other might feel and this helps in social behavior. This is important to help people with motor disability (paralyses) and communications disabilities, because by intercepting their brain "thoughts" it becomes possible to drive a robot. The whole sector of ecommerce is a lot keen in capturing the intentions of potential buyers to prompt them with the right product and that is the reason Amazon is so interested in this area.

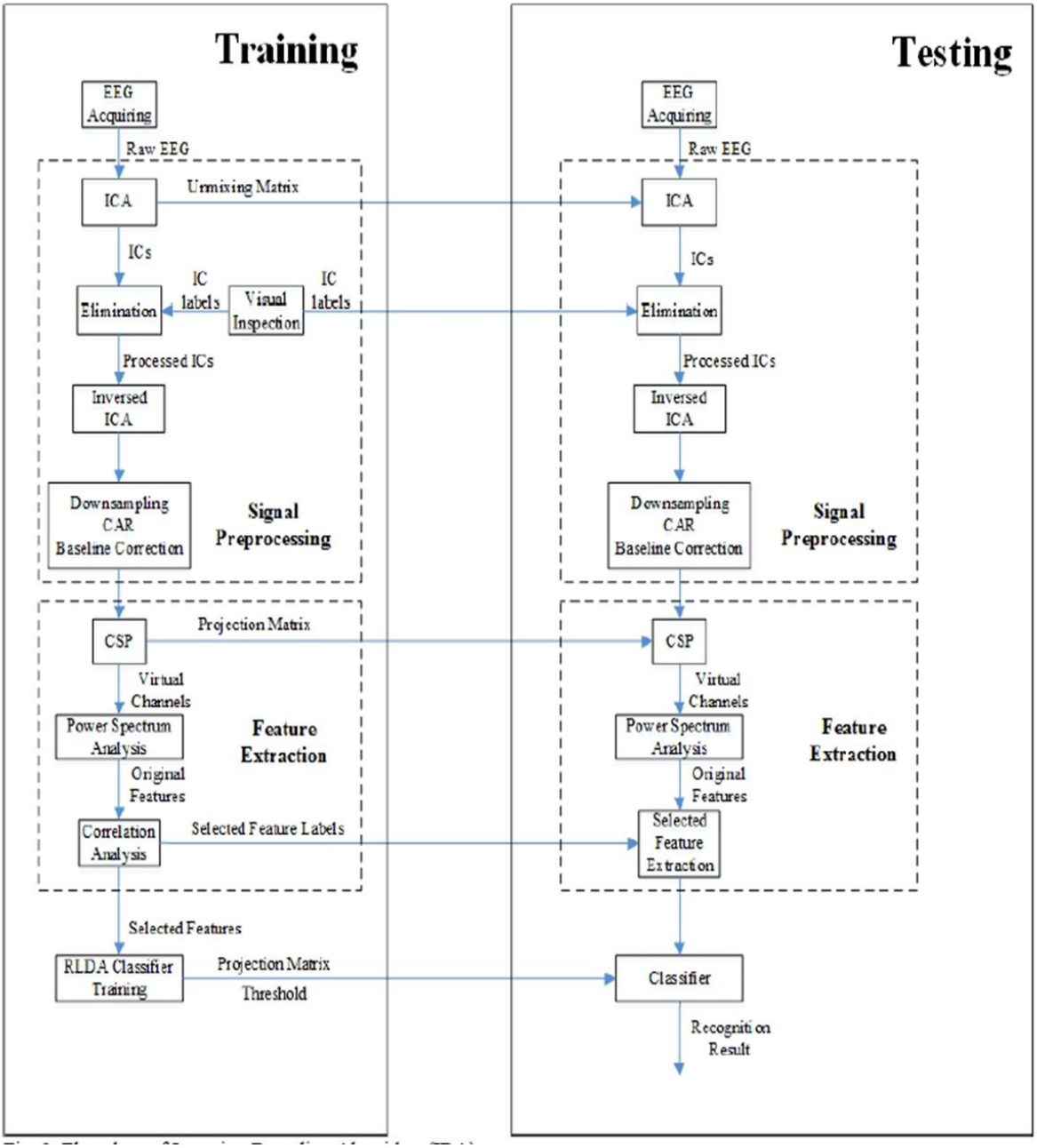

Figure 3.12: Intension decoding Algorithm

ICA - Independent Component Analysis, CSP - Common Spatial Pattern regularization
RLDA - Regularization Linear Discriminant Analysis Classifier, CAR - Common Average Reference

An Example for the intention decoding algorithm is given below. It is a Hierarchical organization of the task of parking a car. Neuroergnomic approach for Car Parking.

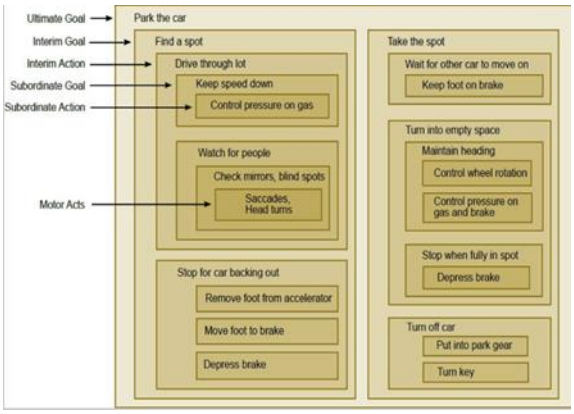

Figure 3.13: Hierarchical organization for car parking

f. Autonomous Vehicle

Today's world, the automotive industries are under heavy research to set up them self in the market and to secure a sustainable place. There are so many companies launching their autonomous vehicle but there is very less rate of success for them in the market. Both Two- wheelers and four-wheeler manufacturing are trying hard to establish their position, while there are many leading companies which has set an example for the autonomous vehicle from the past decade onwards. Here are few bold Companies Leading the Way:

- Liger Mobility - modified scooter - self-balance - park itself.
- BMW- In 2018 - autonomous BMW R 1200 GS - drove off, accelerated, drove through the winding test track - came to a stop - on its own.
- Kawasaki- Kanjo engine, means "emotion" - interact with the rider during the ride. In addition to voice-controlled commands - speech recognition - monitor rider status during the ride for safety.
- Honda - Riding Assist e-motorcycle – autonomously move toward a rider and park itself. This provides greater safety & convenience for riders. Rather than using gyroscopes - adjusts fork angles and the wheelbase to preserve balance.
- Yamaha - Motoroid is the company's premier project - with AI - features include facial recognition, rider movement detection, and autonomous parking abilities - ability to stand up from its kickstand and move toward its rider.

CONCLUSION

The Technologies we have understood and studied are being developed and the Corporations developing them are competing with each other on the Global front to engineer and patent these products before the rest of the corporations. This kind of race to patent more technologies and use them keeps pushing the World forward in terms of technological advancements. With these Disruptive technologies emerging in the IT Industry and the Automobile industry, there are huge growth opportunities in terms of Disruptive Technologies for the next century. The Technologies that are emerging in the next 10 years has been covered explicitly in this paper.

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