Chapter 8
Futurology and Future Prospect of Drone CPS

Abstract Our ancestors could reasonably expect the future lives of their children by looking for the lives of their ancestors. Nowadays, artificial intelligence is rapidly replacing most of the jobs that humans have done with natural intelligence in the current generation. However, currently, it is hard to find out formal education about futurism to prepare for the era of artificial intelligence. Memorizing education useless in the era of artificial intelligence has been currently implemented throughout primary school to university education. The 'CPS Revolution' will radically change the hierarchy of human needs defined by Abraham Maslow, which leads to anywhere CPS economy that affects virtually every aspect of human life such as smart home, smart factory, smart city and smart grid etc. Due to the relatively short history, there is no realistic discussion on future prospect of drone CPS in comparison with previous industrial revolutions in terms of futurology. For instance, rather than producing cars by means of transportation, it is believed that much more weight will be devoted to the production of autonomous flying cars to enjoy leisure time. The purpose of this chapter is an attempt to outline future possibilities that are likely to occur in the drone CPS, such as exponential speed in cyber-physical bridging development and an AI instrument to speed up anywhere CPS economy. Subsequently this chapter presented future prospects of drones as a new necessity such as computer, car and smartphone.

8.1 Introduction

A company that has done well until yesterday could be closed today. If so, a company that is doing well right now can turn into a decline path tomorrow. In retrospect, there were no personal computers 35 years ago, no smartphones 15 years ago, and Google 15 years ago. In other words, there has been such a tremendous change in the last 15–35 years. So what will happen in the next 10–20 years? In an industrialized society, teachers have taught students a standardized curriculum to prepare for jobs; an entrance exam, a qualification system, and a multiple choice test method. The world is changing much faster than ever before. For memorization-based knowledge, artificial intelligence is far

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superior to natural intelligence. However, memorization-oriented knowledge transfer is taking place by formal educational systems at all levels, in almost all countries of the world.

This means that people have very immature and largely unexamined pictures of the future in contrast to the comparatively more mature and purposely trained expert ideas for the classical academic subjects, such as history, geography, physics, biology, mathematics and the rest. Of course people do have ideas about the future, but they did not learn from their formal education, but rather almost entirely from the media (TV and films) or written fiction [1]. It is quite apparent that CPS technology is being integrated into our cars soon and becoming the brains of the machine, replacing the traditional internal combustion engine (ICE) powered by fossil fuels. Numerous futurists have faith in that humans will soon construct sky highways filled with personal drone taxi. Such drones flying over multi-tiered aerial roadways portrayed in the science fiction movies eventually will become popular alternatives to current manned cars [2].

The teacher should always be aware of the changes of educational paradigm due to the rapid transformation of future society. The way to succeed in this situation is to develop new teaching methods on what skills they will most need when the current child become adults. Education should not only follow changing realities, but also find new ways and directions for realities that are acting as obstacles to the coming AI era or CPS era. It is no exaggeration to say that the rise and fall of the nation depends on the teacher, as humans need a completely different skill to survive in the AI-based society or the lifelong CPS era. The present chapter is an attempt to identify future possibilities that are likely to occur and provide solutions for what to avoid and what to do. In other words, future forecasting will allow humans to create a selective future by setting visible trends, alternatives and possible future. It will help students not to fall behind the regional or foreign competitors in job seeking by evaluating the internal and external challenges faced by cyber-physical bridging of drone technology.

8.2 Essential Background Concerning Futurology

8.2.1 Our Daily Lives and Prediction

When we make decisions about the future, we all become prophets. When we decide a travel schedule, residential house, university major, future husband/wife and any other commitments, all of these predict the future. All these projections and plans require certain knowledge, a substantial stock of experience and tacit know-how before deciding the event. In our daily lives we move in and out of such different futures without giving much thought to the matter [3]. The future is always the concern of all of us. Everyone wonders from the weather of tomorrow to the fate of the individual, the future of the earth, and the days after death. Future science is a field that not only provides important help for making a bright future for each human

being and human society, but also a way to present a vision to make the country peaceful and energetic.

Companies invest enormous amounts of money to develop new products based on future forecasts. Predicting the future occupies a very important position in Government agencies such as forecasts of the national economy, environmental impacts of specific development projects, and the effects of proposed social programs [4]. Forecasting can help people and organizations to plan for the future and to make rational decisions. For example, what would happen if your government raised the income tax? Or what if it increased the minimum wage? [4] Consider the following. You are now working as a taxi driver, what if your government legalized self-driving car? To determine the best course of action, you should have relevant knowledge on the effect that recommended changes would have on your job [4].

While formal educational systems work hard to give students a specific (often "scientific") view of the world around them, they are so lazy in teaching marketable products or idea through the class. This is essential for survival in stronger competition, particularly in the light of very short product life and increasing globalization in the CPS based economy. Awareness of governing relations and principles of futurology is a kind of scientific prediction which enables individuals to overcome challenges that lie ahead in various fields. The future direction for the CPS and its technological advance speed can be grounds for becoming individuals in line with the resistance economy and finding new jobs. Any individual can take actions to surmount obstacles, to turn threats into opportunities, based on the knowledge about CPS. The companies who know the CPS can produce competitive products to survive in intense market competition, for example, escaping from the reliance on the non-CPS-product.

8.2.2 Concepts of Futurology

Future studies, futurology is a discipline that establishes the theory for the future direction by analyzing the past and present changes in the integrated manner. For instance, in order to understand the fourth industrial revolution, we must look to the past third information revolution. Current available IT technologies can begin to understand how they have reached such an innovative exciting point linking online and offline. It is a multidisciplinary study that shows us probable forms of society to come by means of empirical and analytical data of the past and present societies in the time axis. Alternate terms include future studies, futuristics, forecasting, and futurism, strategic foresight, future thinking, futurology, and futurism. What is the word future studies often mentioned is because the uncertainty about future society has spread rapidly among modern people. The cause of anxiety is a sudden environmental change due to the recent remarkable technological innovation such as environmental destruction and rapid climate change etc.

This futurology is fundamentally different from other disciplines because no one can verify the results of future research targeting the future society. Futurology shares many characteristics with successful new religious movements such as charismatic leaders, authoritative texts, an attraction or mystique, and a notion of salvation [5]. The knowledge and methodology used in futurism are much less proven as compared to other natural sciences or even social sciences. Therefore, there is criticism that it is difficult to accept futurology as an independent field of academic discipline. In general, futurism is regarded as a branch of the social sciences and parallel to the field of history. From this point of view, history studies the past and futurism focus on the future.

Futurists can include professional and academic writers from many disciplines, such as economics, history, computer science, engineering, anthropology, environmental science, mathematics, physical sciences, political science, and sociology. Many futurists have not majored futurology from the beginning. The social science profession, technologists, artists, and others with diverse academic backgrounds utilize their methodology established in their respective majors to study the future. Future practitioners use a wide range of models and methods (theory and practice), many of which come from other academic disciplines, including economics, sociology, history, engineering, mathematics, psychology, physics, biology, astronomy, and religious studies. Because of this, quite a number of futuristic theories are criticized for not having a solid scientific basis. As the social science, art and physical science work together in laboratories and studios, the output they produce is unlike anything done by single discipline.

8.2.3 Historical Background for Futurology

There was a time when the future was considered a subject for prophecy rather than industrial rationality and empirical analysis. From the last decades of the twentieth century, futuristic speculation began to exceed the category of astrology and Christianity forth-tellers [6]. Ancient civilizations such as Greece, Romans, Egypt, Persia, India and China all shared in the belief that human fate is associated with the stars, traced back some 4000 years. Futuristic speculations have relied on astrology to guide their decisions, calm down their gods in the upcoming natural disaster (such as earthquake, storm and famine) and safeguard their collective prosperity. A first change in this ancient knowledge system occurred when Aristotle began to shift his commitment from astrology to the science of astronomy [3]. Christianity and the rise of natural science later have further confronted for the collective appreciation and acceptance of astrology as a means to tell the future. But they had absolutely not eradicated its popularity. Prophecy is a much larger biblical genre than most people think. The prophets of Old Testament (e.g. Samuel, Isaiah, Daniel) and New Testament (the twelve Apostles) actually involved God's messengers speaking the word of God to a contemporary culture. As such, these prophets were forth-tellers who deliver messages needed to cease its resistance to the word of God.

In the second half of the twentieth century, these efforts to predict the future grew more ambitious and sophisticated. Improvements in computational power, data gathering, and analysis were all attempted to open the veil on the future. Some of these made considerable improvement over the last 30 years. For instance meteorologists have drastically improved computer models for weather forecasting. Banks developed statistical techniques to estimate the risk of complex bundles of securities, based on their past performance. Businesses, government institutions gained a reputation for using qualitative futurology to improve their ability to react to the unexpected. But the last decade has not been kind to current futurology. Forecasts of banks and insurance companies turned out to be drastically wrong, destroying the financial system. Political visions for long–term stable economic growth leaded to a long stagnation [7]. Futurology is a relatively new field of study, and the term futurology was first used during World War II by political scientist Ossip Flechteim, to describe this new field of knowledge based on a probable and systematic analysis for the future [8]. Futurology first emerged as a popular non-fiction genre in the early 1970s, with Alvin Toffler's best-selling book, Future Shock [9] and The Limit to Growth that announces wake-up call for the environmental contamination and warns some natural limits to growth [10].

8.2.4 Major Forecasting Principles

Economic theory shows a few different approaches to the conceptualization of the future (Table 8.1). The disclosure or release of the future take many forms: the form of prophecy, prediction, projection, forecast, futurology, plan, scenario and prospective analysis [12]. Forecasting is usually understood as a basis for a plan or strategy, while planning and strategizing is understood as anticipative behavior. Such a wide range of different concepts of the future is often the source of misunderstandings [13]. Futures studies is often summarized as "three Ps and a W", or possible, probable, and preferable futures, plus wildcards, which use a diverse range of forecasting methods; Scenario method, Delphi method, system dynamics, GIS (Geographic Information System), multiple spatial regression modelling, cross-impact analysis, technology road mapping, social network analysis, trend analysis and morphological analysis.

Table 8.1 Different approaches to main concepts of the future

Concept	Definition
Prophecy	Statement of the future made irrationally by superstition or by divine inspiration
Prediction	A prediction is often based upon experience, know-how, or data, information and knowledge. (informed guess or opinion [11])
Projection	Extension of the past behavioral pattern into the future
Forecasting	Forecasting as a basis for a planning is understood as predicting based on specific trustworthy data.
Planning	Planning as a purely socialist phenomenon concerns what the world should look like (anticipative behavior), while forecasting is about what it will look like.

The choice of an appropriate forecasting method depends on the goals of the research project and the context in which this research takes place. For example, for long-range forecasting of the environment or of the market, econometric methods are often appropriate. For short-range forecasting of market share, extrapolation methods are useful. Forecasts of new-product sales could be made critically by experts. Decisions by parties in conflict, such as companies and their competitors, can be predicted by role-playing [4]. Forecasts are divided into three categories according to the temporal range; long-range forecasts (covering several decades), medium-range forecasts (covering the coming decade) and short-range forecasts (covering a few years). Future forecasting is often summarized as three different principles: Principle of continuity, Principle of non-continuity, Principle of Intuitive Forecasting. Viewed historically, futurology has gone through various phases which are closely coupled with these three different ways of understanding the future. This evolution has consisted on the one hand in a shift away from purely quantitative techniques to more qualitative and/or combinative techniques which are often more appropriate for dealing with the complexity of the future [14].

Principle of Non-continuity is different from conventional scientific beliefs, which are factual and objective in their grounds. The scientific forecasting is understood as predicting based on specific trustworthy data. If there are no past and existing aggregates of facts, the future cannot be predicted [3]. Predicting the social phenomenon is hindered by limited past observations. Socio-historical and economic phenomenon clearly does not provide us with equivalent laws. The social past does not determine the social future. History is not a reliable guide to what is to come. Unexpected social change, innovation and progress mean that predicting social futures by scientific means is a far more unjustified business [3]. In this manner of viewing things, our present knowledge is taken to be inadequate for predicting future developments. The future tracks a chaotic, uncontrolled, and random path. This paradigm assumes that a purposeful control of future events is impossible. Instead, up-and-coming strategies or case by case are the appropriate manner of dealing with future courses of events.

Principle of Intuitive Forecasting means that the future is flexible. In this view, the course of future events is not predictable, but neither is its development fully chaotic. The development of the future is open to intentional manipulation and can thus be influenced (at least in part) by our actions. This paradigm puts its trust in strategies of intervention aimed at shaping the future, with an emphasis on the role of those who take action, along with their goals and decision-making processes in shaping the future [14].

Principle of Continuity means that the future is predictable and controllable. Whatever will come to pass in the future can (in principle, at least) be calculated from our knowledge of the present and past. The more knowledge we gather in the present, the more certain is our diagnosis of the future course of events [14]. Principle of continuity is understood as predicting based on specific trustworthy data and depends on above all on a statistical trend extrapolation. For example,

scientists refer to cyclical and regularly occurring natural events. Water will always freeze at zero degrees centigrade. If one has full and extensive past knowledge of such processes, one can predict that event in the same status-quos will occur in the same way in the future. The source of knowledge for such predictions is a collection of past observations projected into the future. The past is the basis on which scientific laws are established [3].

8.3 Future Prospect of Drone CPS

This uncertainty and inadequacy of established forecasting tools for the Fourth Industrial Revolution has made our demanding projections and future scenario dependent daily on media such as TV and newspaper. Forecasting attempts to predict future states from current trends and it is a common futurology methodology. Scientific forecasting is not an attempt to predict future technological innovations which are essentially unpredictable, but an examination of possible variants of future technology developments. If we can grasp the situation from the past to the present (back-casting), we can predict the future to some extent. Back-casting often extrapolate present technical and societal trends and assume they will develop at the same rate into the future. But technical progress and social transformation, in reality, take place in different areas at different rates. We had experienced the information society, but we have not yet foreseen where this revolutionary technology development may lead to in the future. Without certainty of past facts scientists had no basis upon which to calculate the future.

In order to understand the CPS future we must look to the past, through research into the origins of the past industrial revolution. Economists divide the factors of production into four categories: land, labor, capital, and entrepreneurship. The past industrial revolution was to increase labor productivity by utilizing new technologies such as steam engine and information technology. The Fourth Industrial Revolution has the same viewpoint as the previous industrial revolution since it is to decrease the demand for labour by utilizing new technologies such as artificial intelligence. Division of labour into AI would lead to the greatest improvement in the productive powers of labour.

8.3.1 Adam Smith versus Thomas Robert Malthus

It was a time when the future was considered a subject for prophecy and science fiction rather than empirical analysis [6]. The sustainable economic growth was a major social issue in the first Industrial Revolution era, with the pessimism of Thomas Malthus contrasting with the optimism of Adam Smith [15]. It began in 1776 when Scottish economist Adams Smith published his Wealth of Nations. In contrast, an Essay on the Principle of Population written by British economist Thomas Robert Malthus In 1798 predicted a grim future economy due to population

explosion. Smith was concerned about the nature of economic growth. Malthus, Ricardo and other classical economists were concerned about the question of distribution. The adjective "Malthusian" is used today to describe a pessimistic prediction of human life quality miserable due to starvation via overpopulation.

In the Wealth of Nations, Smith made it clear that machinery can increase productivity since the tasks performed through various steps previously can be simplified through the division of labor. Adam Smith had noted the tendency for machinery to replace and displace human labor in industrial society. The machine is most recognized as systems toward mass production since the same number of workers could produce substantially more output by utilizing machine. Adam Smith saw this introducing machine as a key to economic progress by providing a cheaper and more efficient means of producing goods. Malthus was convinced that, in spite of any technical improvement, the growth of population would inevitably be more aggressive than the growth of production [15]. Malthus emphasized the fact that every resource is limited, and he predicted that as the population grew, resources would become even more limited. Spiraling population growth would eventually outpace the increase in food supply, leading to famine and epidemics of disease. He argued that population will grow in geometric progression (i.e. 1, 2, 4, 8, 16…), while food supply increases arithmetically (i.e. 1, 2, 3, 4, 5,…). His ideas were essentially restricted to the conditions of a predominantly agrarian economy, because his analysis underestimated technological change as a powerful force transforming the productivity conditions both in agriculture and in industry.

The Industrial Revolution made and production of goods more efficient and the lives of people easier. Technological innovations in agriculture also amplified crop yields supporting the population increase. In an industrialized country hunger has disappeared, food expenditure occupies no more than a quarter of the average personal expenditure, expectation of life at birth is well above 60 years. Critics have been tireless in pointing out that Thomas Malthus' economic predictions have not been proved by tangible facts [16]. As Kurzweil points out, history has repeatedly demonstrated that the more technologically advanced cultures have triumphed over the less technologically advanced cultures [2].

8.3.2 CPS as an Automated Invisible Hand: Drones as a New Necessity

CPS (for instance, smart factory) is a system that operates almost automatically to produce the greatest good for the greatest number. The theory for the CPS states that if each CPS is allowed to choose automatically what to buy and each producer is allowed to choose automatically what to sell and how to produce it. Moreover, the CPS would constantly endeavor to improve the quality of products and to organize production in the most efficient and least costly manner possible. This CPS system acts as an "automated invisible hand" that converts private interests into what is most agreeable to the interests of the whole society as Adam Smith indicated in the Wealth of Nations [17].

It is expected that human has little to do with the CPS based economy since the self-regulating behavior of the CPS can make profit and maximize it by minimizing the need for human intervention. The greatest beauty of it can lead to the almost complete lack of human guidance or direction by augmenting AI performance into mutually consistent and complementary activities. Freedom from the human labor economy is compatible with the nature of the CPS economy in which the welfare of each person, as well as the welfare of all society would be maximized. CPS left on their own AI would work for the human-interests as if by an autonomous invisible hand to achieve the maximum good for society. While various CPS such as the self-driving car and drone are engaging in their enterprises for the purpose of earning money, they are also providing products that people want. Such a system, Adam Smith argued, creates wealth not just for the car owner and ground pilots of the drone, but for the nation as a whole when that nation is populated with citizens working productively to better themselves and address their financial needs [18].

As the fourth industrial societies will develop increasingly efficient production techniques, continuing rises in productivity would lead to reduced working hours and expanded leisure time [19]. As CPS will be utilized in everyday life, the quantitative concept of working time and leisure time will be reversed. People would be more likely to spend more time to enjoy leisure (full time) while working time would be the smaller portion in entire human lifespan (marginal). At this stage, many people will have jobs that are not related to the production process of the commercial commodities such as cars. As CPS is dedicated to production of commercial commodities, people will try to spend money to realize the needs of life that were not important in the past. Abraham Maslow defined a Hierarchy of Human Needs. The hierarchy stated that the lower needs (e.g. food) must be met before an individual can strive to meet the higher needs (e.g. enjoying leisure) [20]. As shown by Maslow's famous hierarchy of needs, in the past, most resources have been spent to meet the basic human needs like security, nourishment, clothing and warmth. There will be a time when people will spend money to meet the humans desire to fly over the sky in the not too distant future (Fig. 8.1).

For instance, rather than producing cars by means of transportation, it is believed that much more weight will be devoted to the production of autonomous cars to enjoy leisure time. Ultimately, the end of labor, and the rise of the leisure society is actually forthcoming [19]. There are a number of products that people have consumed a lot of money based on traditional life value standards. However, there is a high possibility that these products will be undervalued based on totally different value standards. The current car can become very cheap or even disappear when unmanned flying cars are released. There is a high probability that products that people do not consider as a necessity are emerging as a new necessity. Considering the primitive instincts of humans wanting to fly in the sky, drone is a representative product having these characteristics.

With regard to leisure, the use of drones such as art, drone show (2018 Winter Olympics in PyeongChang, South Korea), cultural performance, and sports (drone football) is so extensive. As the artificial intelligence society progresses, it will be evident that the drones are emerging as a necessity. More exactly, human driving cars were deemed necessary in the non-CPS era before the fourth industrial societies.

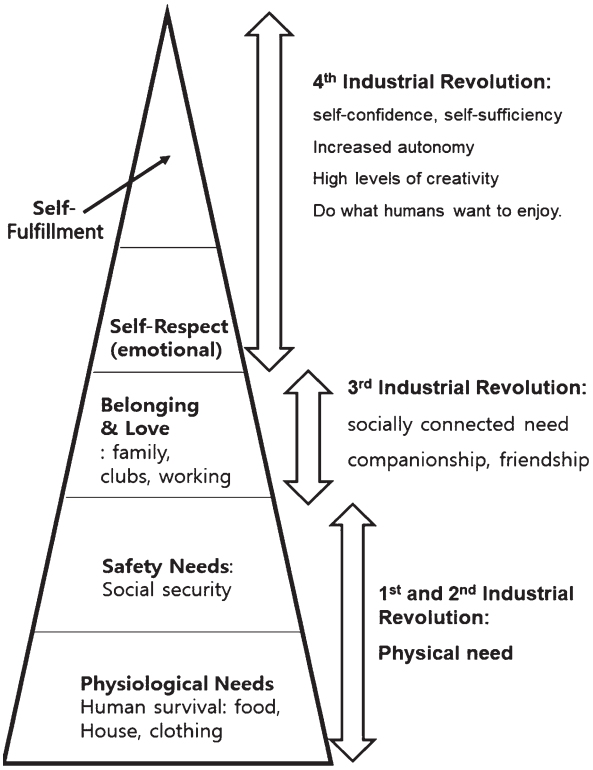

Fig. 8.1 Schematic diagram showing the hierarchal relationship between human needs and industrial revolution

Increasingly, human in the fourth industrial societies will be choosing from everything that is desirable to achieve reduced working hours. Advanced industrial society is in permanent mobilization toward this expanded leisure time. Desirable possibility such as self-driving flying car itself would be going to emerge as a new necessity.

8.3.3 Exponential Speed of Drone Cyber-Physical Bridging

8.3.3.1 Disruptive Power of Cyber Technology

Over the course of the last decade, cyber technologies have increased their potential to disrupt societies, cultures and politics, in positive and negative ways. The television, telephone, and computer have become the prototypical machines of the modern Information Age, although, computer technology is often identified as the central driving technology in the contemporary technological revolution [2]. The list below includes examples of these technologies directly or indirectly, influenced and supported industry change and innovation with the use of computers and information technology.

Visual information → paper map → tablet CNS (Car Navigation System)→ smartphone CNS
Public telephone → portable phone → feature phone, folder phone→ smart phone
mainframe → workstation → PC
video tape lending shop → online music download
typewriter → personal printer and computer
postal service, postal box → email
newspaper → portal, web
magnetic tape → video tape → CD → DVD → USB
floppy disk → CD → DVD → USB
film photography → digital photography
digital camera → smart phone
off-line market → on-line market
remote or wilderness space (such as unbridged glacial rivers and rough mountain) → connected space
constructed social spaces → on line community
slow business → real time business
traditional physical offices, office building → on line market

It is interesting to note how the pace of disruption has increased exponentially. While it took the telephone 75 years to reach 100 million users worldwide (starting in 1878), it took only 2 years and 4 months for Instagram to reach an audience of the same size. In July 2016 the location-enabled augmented reality game 'Pokémon Go' took a mere 25 days to be downloaded by 100 million users. We live in times when the adoption of new technology is occurring at an unprecedented pace [21]. Smartphones are the most visible interface of ubiquitous cyber infrastructures. The reason has not been new political or economic doctrines but cyber- innovations are providing novel ways to enable an "always on" the touchpoint for a wide array of products and services. Cyber technology linking mobile, social, and cloud technologies are being interwoven into the fabric of everyday life creating new value or offering new efficiencies.

The first Android smartphone, the HTC Dream (or T-Mobile G1), had been released in 2008. Smartphones have currently attained the most important position in the daily life of ordinary people since there is almost no limit to what you can do with a smartphone these days [22]. All of our everyday needs were replaced by smartphone, for instance, one-stop-shop, cameras, calculators, diaries, satellite navigation and even on-line class such as torches [23]. Some have the ability to talk to you, answer questions, turn off your lights when you are not there, open doors, and even watch movies. We are not only reliant on our digital devices for quick communication, but that we also seek the same comfort and stability from our phone as we do from family and friends [24]. The shocking reality is that smartphones transformed ordinary people's life and business pattern and changed the world within 10 years. Further smartphones are advancing at a very quick pace. As a result, the potential of cyber-physical bridging has evolved over the last decade to accommodate disruptive power of this computers and connection technology.

8.3.3.2 Cyber-Physical Bridging Explosions

Cyber-physical bridging technologies are those which are unexpected but which have the power to change industries (not always for the good of established players). The world will be changed far more in a few decades than in any previous century due to cyber-physical bridging technologies. Cyber-physical bridging has implications for how people contextualize various aspects of life, their sense of space, culture and social relations. The connections as the greatest invention of the CPS era would colonize every aspect of the human life, since great many mobile users generally tend to stay in touch with internet if space has ensured connectivity. Unseen networks of connected devices and sensors would realize the full ubiquity of media and markets. Embedded microprocessors extend connectivity to virtually all ordinary objects – clothes, appliances, product packaging – in what is being called the Internet of Things, or, more ambitiously, the Internet of Everything (IoE). As a result, cyber-physical bridging can be expanded universally [25].

CPS explosions such as the smart city or smart factory over the next decade will also necessitate a CPS related infrastructure boom. For instance, current roads are not built on the premise that artificial intelligence (AI) drives. In order for an autonomous vehicle to travel, it must be re-constructed so that various objects on the road can be recognized by the sensor. We will see enormous global investment on replacing infrastructure in older, developed countries and the first-generation infrastructure being built in emerging nations. Drone will increasingly be able to act as sensors and create and update maps and related information spaces whilst smartphone expands their users and diverse applications linking with CPS. Examples might include augmented reality games as digital twin where the reality of the outdoors digitized by drone imagery is combined with the virtual reality magic of the computer world. The magic could involve increasingly in touching the lives of citizens since the three dimensional (3D) or 4D (time-sequential) drone imagery could play a key role in delivering various forms of CPS reality such as smart home, smart city. Clearly, new mobile devices like the Samsung Galaxy or Apple iPhone could be very important once augmented reality imagery captured by drone is bundled in.

Satisfactory data collection from a reliable sensor network is one of the most important concerns of the typical CPS project. Although in many previous applications, drone has been used successfully by utilizing stand-alone sensing, many applications could be improved, in terms of information collection by adopting a CPS approach. Until now drone cloud sensing in an area-wide CPS environment has just been at the exploratory stage. Many of the limitations inherent in the current practice of stand-alone drone could be reduced or overcome by fuller use of near future technology since, nowadays, most ‘cutting-edge’ equipment is based on the AI and IOT approach. It is difficult to predict even 2 or 3 years ahead, considering the rapid changes which have recently occurred in IOT and AI technologies. Concerning the computing side, it is difficult to see how fast or far AI computing (which identifies motion pictures and the necessary required computing power) will progress. The AI drone and super connected IOT will soon make present stand-alone drone sensing obsolete, by making it possible to acquire data sets with a

hyper-spectral or spatial real-time imagery, depending on the capability of the sensor in terms of memory and extended storage.

An article published in The Economist titled, "Welcome to the Drone Age: Miniature Pilotless Aircraft are on the Border of Becoming Commonplace [26]," parallels the increasing popularity of drones to the rise of personal computers in the 1980s. For a relatively low cost, drones with photography and videography capabilities, the ability to fly more than 100 m above the ground are being purchased by individuals who may not have had previous interest or experience in aeronautics [27]. With the declining cost of the drone, these types of system will be available to broader markets, including video enthusiasts and home users in the not-so-distant future. As more people would have instruments for making high-resolution imagery and share it with the community, there would be closely connected interaction between off-the-shelf drone owner and mapping company to implement crowd-sourced mapping and to assist the time-dependent user.

In this regard, it may not seem a premature to think of introducing drone CPS mapping for routine applications. As the artificial intelligence society flourishes, the demand for various tools to teach artificial intelligence will increase rapidly. A real-time high-precision map is a typical example. It is designed to teach the artificial intelligence mounted on autonomous vehicles. As artificial intelligence begins to be applied to various fields such as smart home, smart building, smart factory, and smart city, the demand of 2D, 3D and 4D drone imageries as teaching tool for AI will surge. A platform for sharing drone imageries for various applications will be an important future industry. In fact, since drone images are a key tool for teaching artificial intelligence, drones will serve as a key tool for the proliferation of the fourth industrial revolution based on artificial intelligence. On-line platform such as youtube will continue to develop as the drone imageries are spreading widely for deep learning of AI. User uploaded drone imagery will play a key role in advancements in "deep learning" of artificial intelligence.

8.3.4 Drones as an AI Instrument to Speed Up Anywhere CPS Economy

8.3.4.1 Drone as AI Instrument

The super-intelligent drone armed with AI will thoroughly change the real world by adding hyper-connectivity to the entire existing system such as building, factory, road and car etc. Drones equipped with a growing array of fixed environmental sensors and interactive deep learning online platforms will infiltrate all aspects of our lives and the possible applications of drones suddenly appear limitless. Drone as AI instrument will cause radical changes to traditional forms of information collection, storage and analysis processes. We will experience a shift from targeted, purposeful and discrete forms of information collection to always-on, ubiquitous, ever-expanding and non-specific forms of data generation and acquisition. The increased

use of drone therefore marks important changes to our understandings of surveillance, information processing, and privacy [28]. As intelligent things proliferate, we expect a shift from stand-alone intelligent things to a swarm of collaborative intelligent things. In this model, multiple devices will work together, either independently of people or with human input through autonomic sensing and autonomic control [29].

For example, during the 2018 Winter Olympics in PyeongChang (South Korea), Intel's Shooting Star has performed "drone show" as alternative to the traditional fireworks by operating 1218 drones in the sky simultaneously, breaking the Guinness World Records. Intel's Shooting Star drones created various colorful illustrations in the sky, including the Olympics mascot, the white tiger who comes running above the stadium and a heart drawn in the sky to show the love and appreciation for all the Olympic athletes and fans from around the world. Each drone is able to emit more than 4 billion color combinations and they are custom-built for entertainment purposes. All the drones in the air during the shows are flown by only one ground pilot [30]. The age of autonomic drone shipping corps is approaching, in which dozens and hundreds of drones communicate with each other to accommodate the orders of the customers while the drone located closest to the customers are delivering the ordered goods by themselves (Fig. 8.2). It is anticipated that artificial superintelligent drones will communicate directly and fluently with human brains in the not too distant future, changing the way we work.

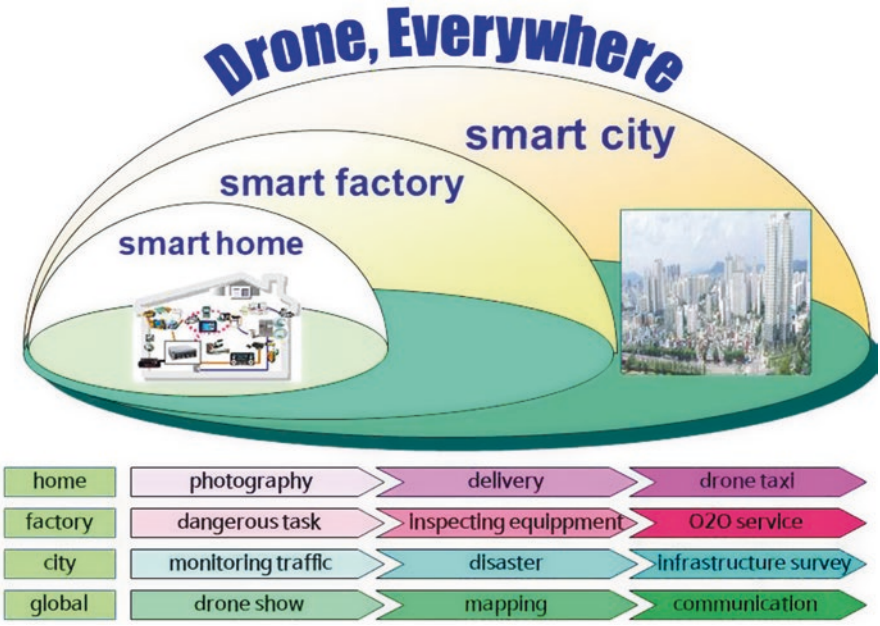

Fig. 8.2 Schematic diagram showing future prospect of drone toward anywhere CPS economy

The recent spurt in AI technology, combined with advanced design, mapping, and visualization techniques, makes possible today something that was unimaginable even a few years ago – a virtual or augmented reality and mobile eye in the sky [31]. The limitation of the movement to the real world can go beyond imagination through the drone imagery. It will provide AR (Augmented Reality) service that allows you to experience a space that is similar to the real physical system, offering touching, stirring and heartbreaking spatial and time elements. For instance, screen golf lets you enjoy the feeling of a real golf course without going directly to the field. There will be a variety of tangible services through 360 degree virtual reality (VR) functions to reflect customer needs such as on-site experience before purchasing real estate, real-time field experience for the construction site, and preliminary exploration of travel destinations.

8.3.4.2 Anywhere CPS Economy

Historically, workers have always lived in the vicinity of the place where they work. The farmer lived in the vicinity of the farmland. Factory workers resided around the factory and relocated nearer to manufacturing centers. However, the past models of such occupations and places of residence will not appropriate in CPS era. Even if the office does not exist, you can do any business if the Internet is connected. No matter what occupation, location would not be important, but information and connectivity will be emerging as the most important factor. Business will operate where and when it wishes, and enterprise will become size-neutral. Cyber-physical bridging tools will make people powerful because they will make them geographically independent of homes and offices. With the right cyber-physical bridging business model, companies can sell their products to global customers using mobile connectivity technologies while still creating and maintaining sticky relationships with customers in a customer-centric way. Cyber-physical bridging technology flexible from staff and clients could bring about the end of traditional offices. Conducting business in a well-connected cyber and physical world means that geography and size will no longer rule. While the world is still exploring and discovering additional opportunities that cyber-physical bridging technologies may offer, it's clear that we are on our way to an anytime, anywhere CPS economy.

With the deployment of drones, different new business models will emerge such as sensing and services applications. These businesses will utilize these flying vehicles as a platform that works in parallel to the ground Internet or to complement the coverage of 5G. For instance, drones can operate as high altitude communications relay platform that can deliver mobile, persistent connectivity over different regions [32]. For example, Google tests multiple prototypes of solar-powered Internet drones to ensure security for delivering Internet from the sky. Google SkyBender uses the drones to deliver next generation 5G wireless Internet, up to 40 times faster than 4G systems [33]. Moreover, drones are foreseen as an important component of an advanced cyber-physical Internet of Things (IoT) ecosystem [33]. IoT aims at enabling things to be connected anytime, anywhere ideally using any network and

providing any service. The IoT concept allows drones to become an integral part of anywhere CPS Economy and infrastructure. This is due to the fact that drones possess unique characteristics in being dynamic, easy-to-deploy, easy-to-reprogram during run-time, capable of measuring anything anywhere, and capable of flying anywhere with a high degree of autonomy [34].

Drones have seen an increasing amount of attention as an evolving industry. Up until recently, drones were mostly used for media and mapping. The game has changed now with leisure drones already selling in the millions. Today's drone technology and market development includes both familiar and new faces to the world of aviation. Leading aerospace and defence players are investing into military-grade systems and related services that are also transferrable for civil uses by government authorities and, at a later stage, to commercial aviation. At the same time, new players emerging from start-up and academic settings are driving growth in leisure drones and many early forms of commercial missions [35]. These start-ups are joined by a variety of other established companies that are investing in drone related capabilities. All over the globe, start-ups and established companies are developing and providing capabilities ranging from drone development and production to drone operations and/or the development of data analytics and user platforms that act as entire area of services [35].

There will be an era in the near future where many moving bodies, including drones, can be combined through internet of things systems. In this case, the flying machine could be merged with other machines and suddenly enter the water or run on the road. For example, when a car meets traffic jam during driving, it could fly to the sky. Drones are commonly used as generic term for moving bodies that are remotely controlled or moving autonomously. It can include bodies moving on the surface of the water or submerging under the water. It can include a robot that imitates animal movements or a robot follows the behavior of insects. Drones' maneuverability, small size, and ability to operate without a human onboard create a vast array of potential uses such as nano-drones, biomimetic drone, underwater drone, and diving drone. There are many similarities in core technologies such as navigation, task assignment, coordination, and communication, and very high synergy is expected when developing as configured common distributed/collaborative physical systems (DCPS). It can carry out the variety of attracting mission being discussed from globally different markets with adaptive integrated operating system for different models and devices.

8.4 Conclusion

Young people of the present age have grown by experiencing changes of various technologies ranging from wired phone, folder phones, touch phones to smart phones. It is the role of education to induce the experience of this technological development in the positive direction as much as possible. This book has sought to clarify the drone could provide potential of new pedagogies to find core elements of

cyber-physical bridging. The data collection could be done without the complicated logistics required to acquire aerial photography. As a result, it is possible that drone could completely replace existing remote sensing systems toward 'Anywhere CPS Economy'. The AI drone will resolve significantly many of the difficulties (obstacle avoidance during autonomous flight and distributed/collaborative physical systems (DCPS) in the long duration mission. The 'CPS Revolution' will radically change the means of drone bigdata acquisition, which affects virtually every aspect of Anywhere CPS economy. The improved obstacle avoidance performance will ultimately lead to the practicality of a drone bigdata toward 'Anywhere CPS Economy'.

It can be confidently asserted that there are no insurmountable obstacles in the way of implementing a 'drone big-data acquisition system' for a 'Anywhere CPS Economy'. Drone has a potential to transform our world more in the next decade than any other single factor. Technology can, in turn, affect science as more complex and powerful drone are developed for observing and investigating nature (e.g. the AI drone, the hyper-spectral sensor drone, and solar power drone). Our scientific knowledge will grow through new observations and experimental results as new finding from drone investigation often redefine our traditional values. As a result, the book has opened new possibilities for implementing drone as 'new pedagogies to find core elements of cyber-physical bridging', proposed as an initial aim of this book. However, many of the basic issues in 'cyber-physical bridging', newly suggested in this book, are still at the investigation stage. Many of the issues untouched in this book could be improved by advanced equipment at present and in the future. In particular, the emergence of high resolution sensor and improvement of deep learning power will greatly contribute to automating the drone bigdata collection process. Additionally, regulation and societal concerns related to privacy and safety remain constraints for some applications already feasible from a technical perspective.

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