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Jsme News

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Fluid Dynamical System as a Key Component of the Social System

To Develop JSME into a More Attractive Society for Engineers of Private Companies

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Introduction

The former president in the 84th period, Dr. Nobuhide Kasagi, provided us with very clear objectives as follows: 1) strengthen the competitiveness of JSME, 2) contribute to human resources development, and 3) establish the presence of JSME as a community of mechanical engineers. He also stated that the measures necessary to achieve these three objectives are open alliance and open innovation. We plan to pursue his objectives during this period of administrating JSME.

This fiscal year marks the 110th anniversary of the foundation of JSME, and a committee on commemorative events (chaired by Professor Akira Nagashima) has been organized to plan various events to commemorate this milestone. Also, events related to Machine Day and Machine Week, established in the previous fiscal year, are going to be held all over Japan. We should make sure Continued on page 2

Aero-Train Project

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Introduction

The Aero-Train project was proposed to answer the question of how to solve serious environmental problem from transport system. The concept of the new high speed ground transportation "Aero-Train" was created to establish a zero-emission high speed vehicle. At high speed cruise, largest drag force is coming from aerodynamic drag. Aero-Train is the ideal system to minimize the aerodynamic drag among other high speed vehicles. Wing-in-ground (WIG) effect is effectively introduced to suspend Aero-Train to contact-less high speed Continued on page 3

Aerial Robotics for Logistics

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Introduction

This research is a challenge for novel personal air transportation system. Transportation is indispensable not only for various industry sectors but also daily individual life. Transportation systems can be classified into two types, the public (cf. train, bus) and the personal (cf. automobile) one. The important point is the difference of the production scale between them. Market for the personal use has become larger than that for the public in history because the former matches massproduction. Progresse in transportation have been made Continued on page 4

Pathways to sustainable society with wind turbines

Chuichi Arakawa

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Introduction

1.Introduction

In the world there are now 70 GW of cumulative wind turbines as installed capacity, and the growth rate was around 30% for the last 10 years. The wind power is evaluated to be a leading energy for sustainable society among renewable ones and is predicted to increase in the similar growth rate. The total accumulation of wind turbines in Japan was 1.5GW in the end of last year and the target of 2010 year for Kyoto protocol is 3GW. Fig.1 shows one example Continued on page 5

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Continued from page 1 that these events will be successful.

The above-mentioned activities are related to objective 3) mentioned above. However, I recognize that JSME is struggling with objective 1), i.e., strengthening the competitiveness of JSME, which is of utmost importance for us. The problem is the continuous gradual decline in the number of Regular Members; fortunately, however, the number of Student Members has been increasing thanks to efforts made by Student Member Branch, which has resulted in a gradual increase in the total number of members. Here, we would like to explain matters related to this problem including what we have already figured out, what we have not yet clarified, and what we are planning to carry out in the future. We would like all leaders of JSME to understand and support us in order to improve the current situation.

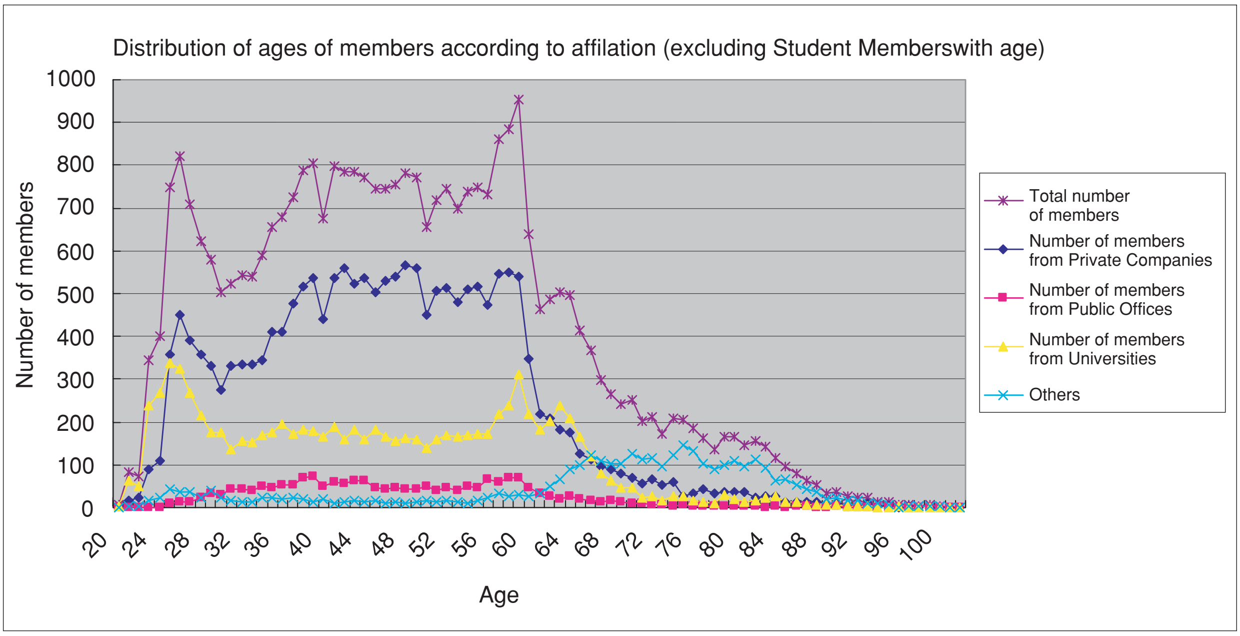
Clarification of the Problem

Please refer to the figure to see the current situation of the number of members of JSME. The figure shows the distribution of the number of the age; i.e., a breakdown by age of the total number of members of JSME, members from private companies, and members from public offices and universities. As is obvious from the figure, the reason for the decline in the number of total Regular Members in recent years can be explained As follows; many senior members resign from their membership, but this decrease cannot be compensated due to the decrease in the number of young members from private companies. Moreover, there are other problems as explained in the next section.

Problem Concerning Young Members from Private Companies

Why is the number of young members from private companies severely decreasing? Is this situation influenced by the public trends of the “lost decade” and the difficult times for college-graduate job seekers during the decade? We can easily fall back on such reasons. However, we believe that the actual situation is slightly different. We often hear opinions that JSME is not attractive to young members from private companies. We will investigate the wishes of members from private companies and the reasons behind the decrease with the help of the leadership of the Regular Member Branch. At the same time, we would like leaders from private companies to individually investigate the reasons behind these problems and the measures required to address them, and we look forward to hearing advice on these problems from them.

From another point of view, it may be possible that young engineers tend to not belong to any society. If young researchers tend to less effectively utilize opportunities for continuous brainstorming after their graduation from universities, we must say that it is a national loss, and that the future of our country, which depends on manufacturing, cannot be bright. At present, Japan leads other countries in the world in the field of engineering, and we believe that the importance of engineering should not be undermined. Activities in societies enable researchers to form a network of their own and also construct a “small world” to tackle various problems. We expect senior members to invite young engineers to join JSME in order to increase the number of young members and to further



revitalize our society.

We also hear opinions that a society is useful for private companies when industrial standards for a research achievement are determined. Because this is a matter that greatly affects the finances of the society, we plan to consult with persons concerned and make decisions carefully.

Problems Concerning Student Members and Senior Members

The numbers of Associate Members and Student Members are currently increasing thanks to the efforts of the Student Member Branch; however, many such members withdraw from membership upon graduation, which suggests that additional follow-up measures for Student Members are insufficient. We will develop measures so that such members as long as possible, and we will carry out such measures in coordination with Executive Board Members, Divisions, Regular Member Branch, and Student Member Branch. Your cooperation on this matter is greatly appreciated.

In addition, the problems concerning the baby-boom generation and mandatory retirement must be discussed. We consider that it is a waste of human resources for engineers who are active and have acquired advanced techniques and experience to prematurely withdraw from our society. According to a preliminary survey, approximately 10% of the members approaching retirement age indicated that they want to continue working but no reemployment system is available. We must consider measures for them, and carry out what we can as a first step.

The problems that have been mentioned here cannot be handled only by the current Executive Board Members. Your cooperation is greatly needed. We sincerely hope for your kind consideration on these matters.

Aero-Train Project

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Continued from page 1 cruise with astonishingly high energy efficiency. As a result, this system can practically operated using only natural energy resources, like solar, wind or others, which are considered presently not usable for their low ***energy density*** and ***unreliable*** nature, will become usable. Virtually, Zero-emission high speed ground transport system will become into reality.

Figure 1 shows a conceptual sketch of the Aero-Train system. As shown in the conceptual sketch, this system has solar panels over the guideway roof and wind mills at the side of the guideway where wind energy is available.

If the development of this system succeeds, then Zero-Emission High Speed Vehicle will become a reality. If the most difficult system like present proposed system (Ground transportation system with 500km/h) is successfully developed and put into in service, then other less difficult systems can be more easily realized in the society. As a result, all systems can become ***nature friendly***, and eventually, we could create a pollution-free, clean life style. Therefore, the development of the "Aero-Train" system is very critical. Namely, Aero-Train is a ***symbol of the future environment friendly life style.***

In 2003 March, using 2km guide way of Hyuga City, we have succeeded unmanned, 120km ～150km/h cruise, with zero emission by our second phase moder, ART002 shown in **Figure 2.**

Figure1 Conceptual design of the Aero-Train.
(500km/h cruise with 350 passenger by 3 coaches. Length:85m, Width:12m, Height:5m. Engine: 4 motor driven ducted fans. Electricity is from both side cable through special pantographs to motors)

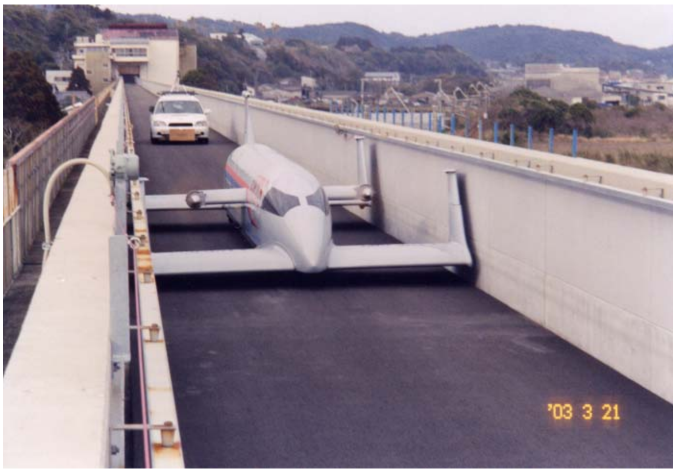

Figure 2. ART002 model cruise at 120km/h
(Unmanned, 150km/h with zero-emission. Length:8.5m, Width:3.3m, Height: 1.7m, Weight:420kg, Engine: 5kW motor driven propeller x 2)

Aerial Robotics for Logistics

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Continued from page 1 Continued from page 1 from the hub spoke style to point-to-point traffics. However, in the air, we do not obtain the personal one yet. This is why we are trying to develop the 3-dimentional-transport robot (3DTR). Aerial Robot for Logistics (ARL) is one of applications of 3DTR.

Fig.1 shows a final image of 3DTR system. This system consists of slow speed 3DTR and high-speed ground-based manipulation robots that are able to catch and launch 3DTR. Technological realization of slow speed 3DTR and high-speed manipulations of ground based take-off & landing aid robots makes this system enable. This kind of large ground based manipulation robot is commercially available by a Japanese foremost machine builder (Fig.2). This machine can swing its arm tip up to 40km/h. Its speed is high enough to catch a 3DTR at a flight speed of 30km/h. So, the first objectives of this research are to make 3DTR fly at this slow speed safely.

Stability in slow flight is indispensable for 3DTR, and at the same time gust alleviation features are required. Fig.3 shows the structure and the pendulum attitude stability method of 3DTR, which enable to absorb both rotational and translation shocks by gusts. The wing weight of 3DTR must be small in order to position the center of gravity (CG) lower to acquire pendulum effects. A fabric wing is suitable for the wing of 3DTR. It is made of CFRP or Duralumin frames and synthetic fiber textile, and it can be folded easily during parking on the ground as shown in Fig.4. The lightweight flexible wing is connected to the hull only at one point near the center of MAC (mean aerodynamic chord) with actuator-controlled joint. Lowering stall velocity and attitude controllability at slow speed could be respectively attained by small wing loading and the CG control method. The actuator-controlled joint driven by roll- and pitch-axis servomotors can shift CG and keep maneuverability. This 3DTR structure that the wing and the hull are connected with only one point makes its design easy and simple. Only by measuring L/D (lift/drag) ratios of the wing and drag of the hull, the required thrust of 3DTR could be calculated.

Thrust generation system using propeller blades is not suitable for this kind of robots because of its hazardous large diameter estimated as about 1350mm. Safety is one of the most significant features of the personal robot. So, we have chosen turbo jet engines as thrust sources of 3DTR. A jet engine has advantages as the following; protection against possible injury, space saving, lightweight due to high power weight ratio and reliability. Recent

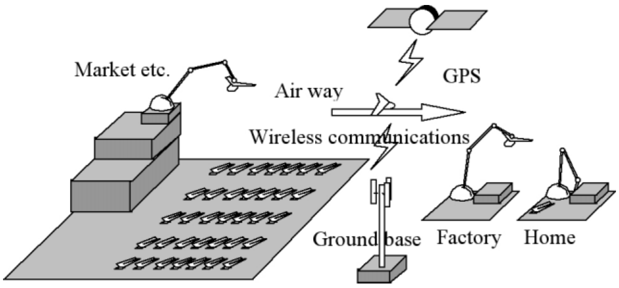

Fig. 1. Concept of Personal Air Transportation System

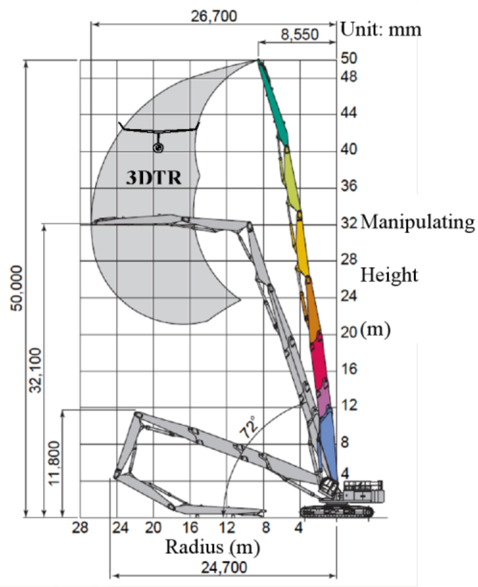

Fig. 2. A high-speed ground-based manipulation robot.

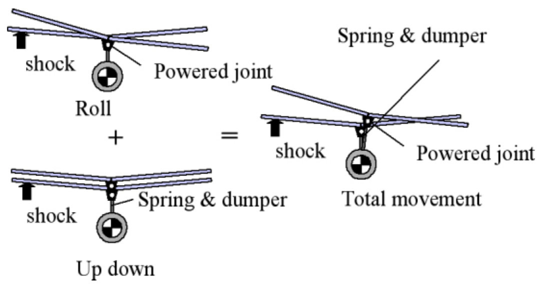

Fig. 3. The basic structure of 3DTR.

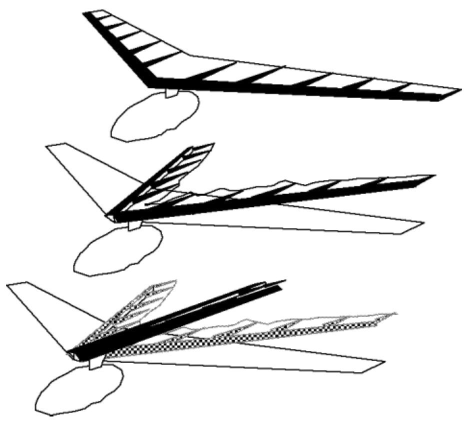

Fig. 4. Foldable flexible wing of 3DTR.

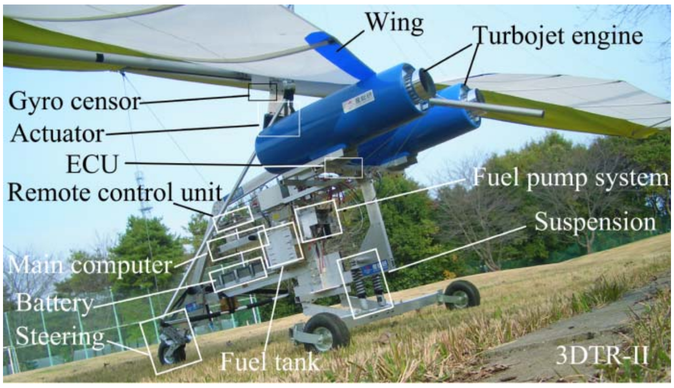

Fig. 5. Right rear view of 3DTR-II.

innovation of turbo jet engines has achieved high power weight ratio of up to 6 and is able to reduce an engine weight of 3DTR below to 8kg at maximum thrust of 47kg. However, a turbojet engine has a serious problem of painful laud acoustic emission. We measured a purchased turbo jet engine noise and obtained an unbearable noise level of 110dB. It is impossible to handle the engine close to people. So, we have improved and made it quiet for 3DTR. The quiet turbojet engine has both high efficient noise reduction of 20dB and air-cooling system, and then the engine can be operated without ear protectors even when the engine is in operation close to ears. The quiet jet engines are also safe for human due to its low temperature surface by the air-cooling system.

Fig.5 shows a left-rear view of 3DTR-II. Two quiet turbojet engines are positioned between the center of gravity and the actuation joint. In order to make CG lower, four lead-acid batteries are positioned on the bottom frame of 3DTR-II. Landing gears are quite important to reduce touchdown shocks. It has twin coils and dumpers. Damping rate is variable in order to be adjusted by runway conditions. Steering is necessary to keep the rolling direction just before take off. Main computer receives commands from an operator through radio signal receiver. 3DTR-II controlled its attitude automatically by sensor feedback systems. Flight tests were conducted in order to check thrust power, ground run stability, take-off speeds and cruising speeds. On November 22, 2005, 3DTR-II succeeded in its maiden flight. Fig.6 shows a recent test to minimize ground-run-distance for take-off. We have succeeded in the distance reduction up to 36m in 2006. The wing attack angle is important to maximize STOL (short take-off and landing) characteristics and 16 degrees has to be kept during ground-run and after the take-off. 3DTR-II could accomplish the shortest ground-run distance for take-off. The take-off speed was about 32.4km/h (9.0m/s). This angle should be kept by active control because it varies according to turbojet thrust, location of CG and airspeed of 3DTR-II. Farther development has been going on now.

Fig. 6. Flight test of 3DTR-II.

Pathways to sustainable society with wind turbines

Chuichi Arakawa

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Continued from page 1 of beautiful wind turbine in Tokyo. We are carrying out several projects to advance the penetration such as the development of big size of battery and the precise forecasting system of electricity with wind in order for electric companies to accept them. Furthermore the Japanese standard for wind turbines is now required because the weather is different from European area such as the strong wind of typhoon, turbulent flows in complex terrain and strong lightning in the winter. In Japan the new target will be discussed after 2010 and the offshore wind farm will be a key technology for continuous development of wind power. These topics will be described in the following for focusing on Japanese technology and environment.

Fig. 1. Lighting wind turbines in Tokyo area (photo by J-Power)

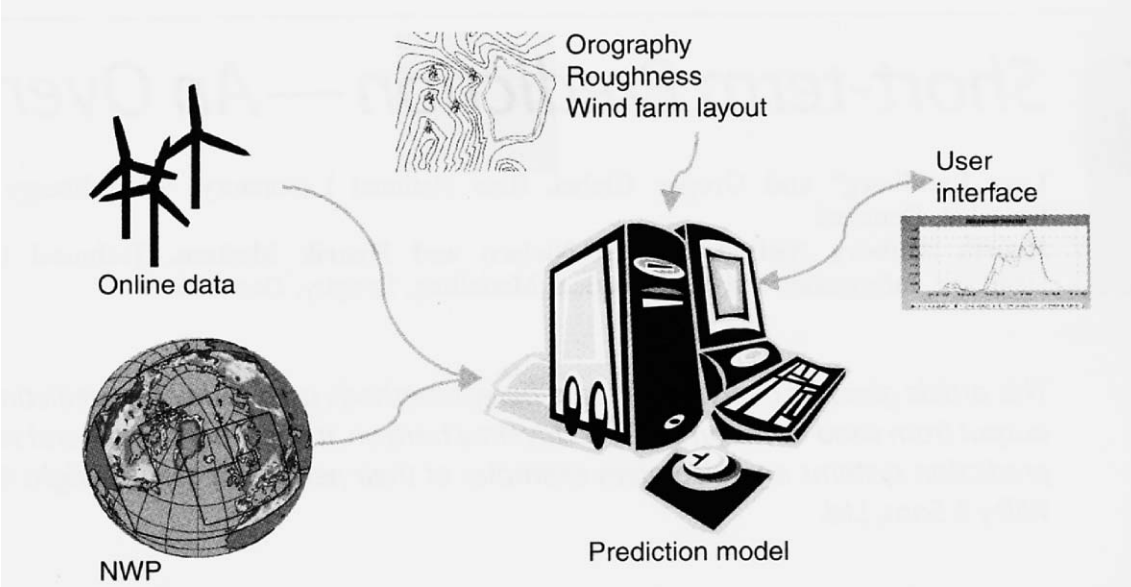

Fig. 2. Schematic diagram for forecasting system of wind generating power

Fig. 3. Destroyed wind turbine by typhoon in Miyako-jima isaland, Okinawa

2. Accurate Forecasting of Wind Power Generation

The electric companies strongly demand the good quality of electricity and keep their own grids independently while there are ten companies in Japan. General speaking, each company has the upper limit of about 5% for wind power against total capacities of electric generation. In order for them to accept more wind energy in each area, the government supports two big national projects. The first one is to develop big size of electric battery for removing the fluctuation of power output although the battery is as expensive as the wind turbine for the time being. The second one is to prepare the accurate system of forecasting wind power generation one day ahead. The electric company will easily be able to plan the preparation of another power plants to compensate for wind power with this system. The author is a leader in this project, and more detailed plan is reported here.

The forecasting system is also popular in Europe, but the system there is not available for Japanese weather because most of Japanese wind farms are located on complex terrain or steep coastal cliffs and the prediction of wind variation is difficult and may have large error. Our study team, formed with five organizations, aims to develop practical power prediction system using CFD based meteorological forecasting models and to contribute to wind power stabilization. As shown in Fig.2, simultaneous observation of wind, turbulence, power and other information of wind turbines are planned at nine wind farms in northern Japan. Analyses on those data will be utilized mainly to optimize the data assimilation method in the development phase of models. Actual power curve and wake effect will be also considered through those analyses. Model performance on the meteolorogical characteritics of Japan, especially due to mountaneous topography and the effects of typhoon will be carefully checked through on-line validation for one year. Furthermore we have new prediction system not only for one wind farm but also one electric company area with the up-scaling model. By the end of this fiscal year we will reach the good reliability condition within 20% error for one day ahead and 15% for today. This system will surely support the electric companies to accept wind power much more than the previous days.

3. Guidelines for Japanese Wind Power

All wind turbines were destroyed in Miyako-jima island in Okinawa area in September, 2003 because the typhoon stayed for one day and the maximum wind speed exceeded the designed one of 70 m/s for the world IEC standard. Fig.3 shows one example of destroyed turbine. Some wind turbines were fired after the lightning attacked them in the winter in Japanese sea area because the strength of lightning is about ten times as large as the standard one in the summer or other countries. Furthermore the strong turbulence of wind in the complex terrain may induce the trouble of control system and the fatigue of material in the future. The government supports the project group to establish the guidelines for Japanese type of wind power.

Fig. 4. New technology of carbon-reinforced material in small wind turbine of Airdolphin by Zepher

They are focusing on drawing the area map where the extreme velocity will be accurately predicted with the simulation and the observation. The simple design methods for strong wind, large turbulence and big lightning will be listed for Japanese type of wind turbines which will be also available for other Asian area of monsoon weather.

4. New Road Map of Wind Turbines and Offshore Wind Farms

The target of the government for wind power is only 3GW by 2010 although other countries have big target such as 180GW by 2020 of EU. Certainly the area of the land is limited for wind power in Japan, but we have large area in the offshore because our island is surrounded with the Pacific Ocean and Japan Sea. General speaking the wind is stronger in 20% in the offshore than in the onshore, which means that the high potential exists for offshore wind farms even if it will be a little expensive. The author proposes 30GW of wind power by 2030 in the frame that the renewable energy should cover 1/4 of all energy and wind power will share its 1/4 of renewable ones. The simulation of wind and some observation data in the sea-shore supports the target of 30GW.

Now the new technology for offshore wind farms are required such as huge size of wind turbines and some specified marine engineering for supporting system. Fortunately key technology has existed in Japan. For example, carbon-fiber reinforced plastics has already been used for small size of wind turbine in Fig.4 and this material will be applied for giant turbine with small weight of aerofoil. Because superconducting motors are also available for marine propeller, the generator will be developed in near future for off-shore wind turbines. The combination of carbon-fiber plastics for blades and superconducting generators will make it possible to produce the next generation of wind turbines with small weight and high efficiency. The floating type of offshore wind farms shown in Fig.5 will be also an important technology for deep water.

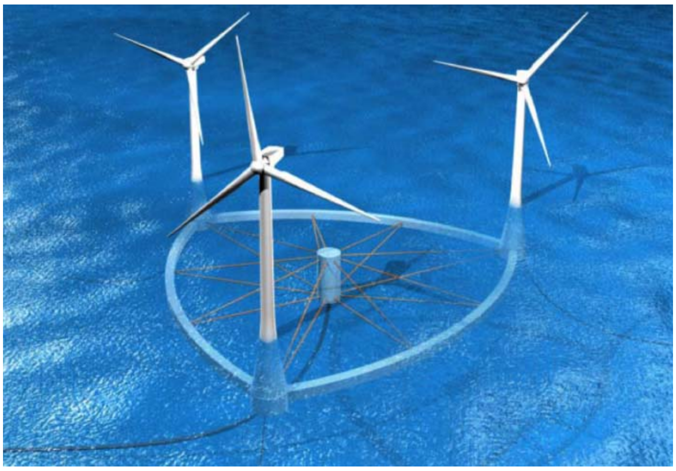

Fig. 5. 5 Idea of offshore wind farms in the floating type (Cooperative research with the University of Tokyo and Tokyo electric company)

4. Conclusions

G8 summit has concluded in Heiligendamm, Germany that they will decrease more than 50% of global emission by 2050. The wind power must play the most important role to realize this declaration among the renewable ones. The Japanese system for wind turbines described will be available for other Asian countries of China and India which are the key country for climate change. The author strongly hopes that the new technology will support the sustainable society and beautiful globe through the development of wind turbines.

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