Papers on Environmental Science.pdf

Article · January 2021

CITATIONS
0

READS
7,816

1 author:

Abhijit Mitra
University of Calcutta
13,045 PUBLICATIONS **31,879** CITATIONS

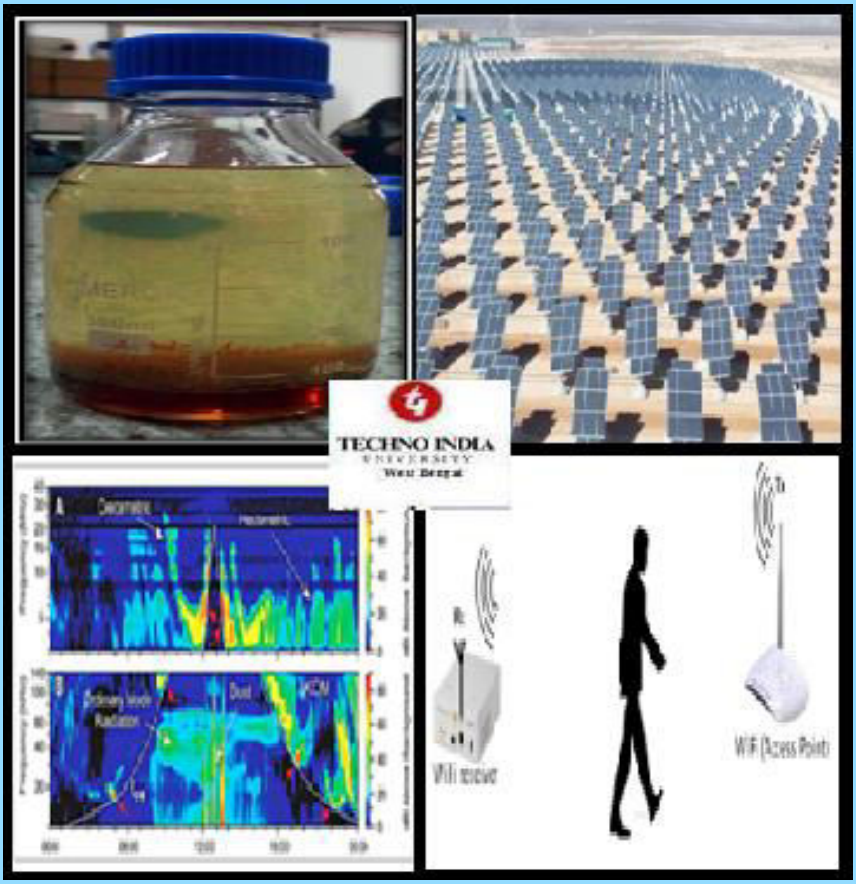
SEE PROFILE

ISSN: 2581-4257
VOLUME 2, ISSUE 5
SEPTEMBER – OCTOBER 2018

Techno International Journal of Health, Engineering, Management and Science (TIJHEMS)

Smooth, simple and timely publishing of Review and Research articles

A PEER REVIEWED REFEREED BIMONTHLY INTERNATIONAL JOURNAL



Published by
TECHNO INDIA UNIVERSITY, WEST BENGAL
Salt Lake, Sector V, Kolkata 700091

Contents

Physicochemical characterization of biodiesel from vegetable oil

Angshuman Chatterjee
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
badangshuman1@gmail.com

Dhrubajyoti Dutta
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
duttadhrubajyoti04@gmail.com

Pousam Ray
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
pousam.ray@gmail.com

Subhojit Dutta
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
subhojitdutta.1097@gmail.com

Ayan Das
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
ayand0243@gmail.com

Satarupa Roy
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
sata.roy91@gmail.com

Madhumita Roy
Department of Biotechnology,
Techno India University, West Bengal,
Kolkata-700091, India
biotech4job@gmail.com

SufiaZaman
Department of Oceanography,
Techno India University, West Bengal,
Kolkata-700091, India
zamansufia123@gmail.com

AbhijitMitra
Department of Marine Science,
University of Calcutta, 35,
Ballygunge Circular Road, Kolkata-19, India
abhijit_mitra@hotmail.com

***Abstract*- Biodiesel is a vegetable oil based fuel consisting of long-chain alkyl esters. It is typically made by chemically reacting lipid (e.g.: Vegetable oil) with an alcohol which produces a fatty acid ester. Biodiesel is made by reacting with an alcohol producing fatty acid ester, thus it causes very less pollution in the environment. The biodiesel reduces the emission of carbon monoxide and sulphates in the air and helps to control air pollution. The present work was directed towards producing biodiesel from vegetable oil and methanol. Physicochemical characterization of sample was analysed based on the standard method. Its characterization study reveals that vegetable oil based biodiesel is an alternative source of diesel.**

Keywords- Biodiesel; vegetable oil;methanol; acid value; moisture content

I. INTRODUCTION

Biodiesel is a vegetable oil based fuel consisting of long-chain alkyl esters and it is considered as possible fuel similar to conventional or 'fossil' diesel. Biodiesel can be generated from vegetable oil, soybean oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called trans-esterification. The main probable source of vegetable oil comes from oil crops such as rapeseed, palm or soybean. Oil straight from the agricultural industry represents the greatest potential source [1]. Chemically, Biodiesel refers to a vegetable oil or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl,

or propyl) esters. Extraction of biodiesel is done from chemically reacting lipids with an alcohol by producing fatty acid esters [2].

Diesel is produced by distilling crude oil at 200°C-350°C, thus it pollutes the environmentand hence it is not eco-friendly. But in case of Biodiesel, the production process includes reacting a lipid with an alcohol which produces a fatty acid ester, thus resulting in less pollution, hence it is an alternative fossil fuel. The use of Biodiesel reduces the emission of carbon monoxide and sulphates in the air and helps reduce the air pollution. Moreover, the lubricating property of Biodiesel may lengthen the lifetime of engines [3].

Vegetable oil based fuels were more expensive that petroleum fuels thus its market value was very less. Now these days, interest in vegetable oil fuels for diesel engines are gaining due to increase in petroleum prices and uncertainties concerning petroleum availability. But some problems with the performance of engine still exist. Trans-esterification process lowers the viscosity of the oil. The alternative diesel engine fuel can be soap pyrolysis products of vegetable oils. Trans-esterification process mainly affects the molar ratio of glycerides to alcohol, catalyst, reaction temperature and pressure, reaction time and the components of free fatty acids and water in oils [4].

The present work involves the production of biodiesel from vegetable oil and methanol. Physicochemical characterization of sample such as analysis of pH, moisture content, acid value, free fatty acid value and saponification value were determined based on the standard method.

II. MATERIALS AND METHODS

A. Preparation of biodiesel from vegetable oil

500ml vegetable oil was measured by measuring cylinder and poured into 1000ml conical flask. Then the oil was heated in hot plate at 60ºfor 2-3 minutes. A catalyst solution was prepared by adding 100ml of Methanol and 2.8gm of NAOH in a beaker. The oil and the catalyst solution were poured in a 1000ml conical flask and the flask was placed on a magnetic stirrer for 10-20 min at 70℃ to mix the oil properly. Then the oil was poured in a bottle and kept the bottle for 48 hours to settle down the oil.

B. Physico-chemical characterization of biodiesel

Physicochemical characterization of sample such as analysis of pH, moisture content, acid value, free fatty acid value and saponification value were determined based on the standard method.

C. Determination of Free Fatty Acid Value by Titration

A beaker was taken and 2g of oil was measured and poured in it. A mixture of ethanol and petroleum ether (a neutral solvent) was made. The beaker with the oil sample was taken and 50ml of neutral solvent was poured in it. It was stirred vigorously for 30 minutes. Another beaker was taken and 0.56g Potassium Hydroxide pellet was measured and kept in it. A 0.1M solution was prepared with it. Few drops of Phenolphthalein/Phenol Red was added in the sample and it was titrated against 0.1M KOH until the colour turned pink and stayed for 15 minutes.

$$AV = \frac{56.1 \times A \times N}{WOil}$$

Where; V= volume of standard alkali used;
N= normality of standard alkali used;
Woil = weight of oil used

D. Saponification Value Determination

KOH pellets was dissolved in ethanol and alcoholic KOH was prepared. A conical flask was taken and 2g oil was poured in it. 25ml freshly prepared alcoholic KOH was taken and added to the oil. The mixture was then covered and put in a steam water bath. It was shaken periodically. 1ml Phenolphthalein/Phenol Red was added to it continuously and it was titrated against 0.5M HCl until the end point.

E. Determination of moisture content

48.15g of oil was weighted in a moisture pan and after taking weight of the pan and oil it was kept inside an oven at a temperature of 450 °C for 3 hours. The dried sample was taken outside and kept to cool down for 1 hour. The weight of the pan with dried sample was taken.

Calculation*:*

Moisture (%) = (W1-W2) ×100

Where,

W1-(g) sample before drying

W2-(g) sample after drying

III. RESULTS AND DISCUSSIONS

Biodiesel was prepared with vegetable oil, methanol and NaOH. Washing and drying are necessary for untreated biodiesel containing impurities like free glycerol, free fatty acid, soap, catalysts, methanol, glycerides and metals. The biodiesel containing unreacted methanol can corrode engine components which has risks for the protection. NaOH, which is used as residual catalyst, can damage engine components and fuel lubricity can be reduced by using soap. It creates injector coking and other deposits.

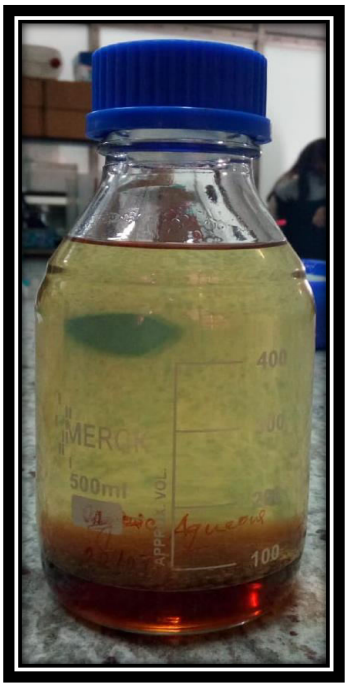


Fig. 1. Biodiesel prepared from vegetable oil

After adding phenolphthalein, colour changed from yellow to pink and stayed for 15 minutes which confirmed the presence of free fatty acid.

Where,

V = Volume of standard alkali used = 0.168 g
N = Normality of standard alkali used = 5.6
Woil = Weight of oil used = 2ml

So, the FFA present in the fuel was 13.2

Free fatty acid value was determined according to the calculation.

Effective process to remove most impurities is traditional water wash which has been extensively used. However, there are several drawback: production cost is higher due to treatment of waste water; when biodiesel is treating from waste cooking oil, emulsion forms due to soap formation [5, 6]; Methyl esters remove due to retention in the water phase. The use dry washes resin like magnesol, which is iron exchange, can cure all these disadvantages. However, Berros et al. [7] reported only water wash can purify biodiesel directly from glycerol separation to the requirements of EN 14214 Standard. Therefore, in this study, both water and magnesol washes were applied [8]. First two 20% (v/v, based on methyl ester layer) water wash was used followed by 0.5% (wt/wt, based on methyl ester layer) magnesol wash.

Reference

[1] ShirudeAA. (2011). Phytochemical and pharmacological screening of Wheatgrass (Triticumaestivum L.) . International Journal of

Pharmaceutical Sciences Review and Research. 9 (1), pp159-164.

[2] Issariyakul, T. and Dalai A. K. (2014). Biodiesel from vegetable oils. Renewable and Sustainable Energy Reviews. 31, pp446-471.

[3] Demirbaş A. (2002). Biodiesel from vegetable oils via transesterification in supercritical methanol. Energy conversion and management. 43(17), pp2349-2356.

[4] Demirbas A. (2011). Biodiesel from oilgae, biofixation of carbon dioxide by microalgae: a solution to pollution problems. Applied Energy. pp. 88(10), 3541-3547.

[5] Demirbaş A. (2003). Biodiesel fuels from vegetable oils via catalytic and non-catalytic supercritical alcohol transesterifications and other methods: a survey. Energy conversion and Management. 44(13),pp 2093-2109.

[6] Indhumathi P. PS S. S. and Shoba U. S. (2014). A Method for production and characterization of biodiesel from green micro algae. International Journal of Bio-Science and Bio-Technology. 6(5),pp 111-122.

[7] Sathasivam S. and Manickam A. (1996). "Biochemical Methods", revised 2nd edition, new age international Pvt Ltd. pp. 23-25.

[8] El-Sabagh S. M. Keera S.T. and Tama A.R. (2011). Energy Source. 33, pp. 401-409.

Design of a Low Cost Home Automation System using Arduino WIFI Module

Pritha Mitra
Department of Electronics & Communication Engineering
Techno India University, West Bengal,
Kolkata- 700091, India
prithamitra.niles@gmail.com

Kaustav Madhab Chatterjee
Ardent Computech Private Limited
Kolkata- 700091, West Bengal, India
kaustav@ardentcollaborations.com

Asit B. Bhattacharya
Department of Electronics and Communication Engineering
Techno India University, West Bengal,
Kolkata-700091, India
bhattacharyaasitbaran@gmail.com

***Abstract*— The paper presents the design and technology of a low cost and flexible home control and environmental monitoring system. It employs an embedded micro web server in Arduino Mega 328PU microcontroller, with IP connectivity for accessing and controlling devices and appliances remotely. The devices can be controlled through a web application or via Android based Smart phone app. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. To express the practicability and effectiveness of this system, devices such as light switches, power plug, temperature sensor, gas sensor and motion sensors have been integrated with the proposed home control system.**

Keywords—micro web server; microcontroller; arduino; wi-fi module; relay; home automation;

I. INTRODUCTION

Both our personal and professional life is largely dependent on modern technology developed in recent years. Technology has developed with time and it has transformed the way we purchase products, the today's way of living, the way we communicate, the way we travel, the way we learn and so many other changes have been brought about by the continuous technological advancements. As people's demands and life style are rapidly changing, the demand for advancing the type of technology is obvious [1]. Almost everything we use today has been innovated to better standards so that we can keep up to the ever-progressing times. In the twenty-first century, wireless communication is growing faster than other technological advancements because of its ease of usage and cheaper costs. From WIFI based electronic devices to wireless home automation, people have got advantages in many ways for making their lives easier with lesser stress [2]. This paper proposes a low cost, simple and efficient technology about how to control the home appliances. Based on the Wi-Fi and Arduino the instrument and technique suggested will show how to improve the standard of living with less stress in daily life, particularly efficient for the handicapped persons who have little option to get support from other family members. The security system, in the suggested technology, is also highly effective as well as safer.

II. WIFI BASED HOME AUTOMATION SYSTEM

People who are disabled or handicapped cannot operate the appliances in the home or they cannot reach comfortably close to those things many times. That is why home automation cannot be done in a very efficient way for them. In fact, for most of the time it becomes difficult and not secured for all practical purposes. In order to minimize these problems, a simple home automation system we have designed with the module of Wi-Fi interface. The device will enable its users to operate the electrical systems of their homes from anywhere in the world with the help of wireless communication or specifically by taking support of WIFI [3]. The block diagram of the proposed Wi-Fi based system is shown in Figure 1.

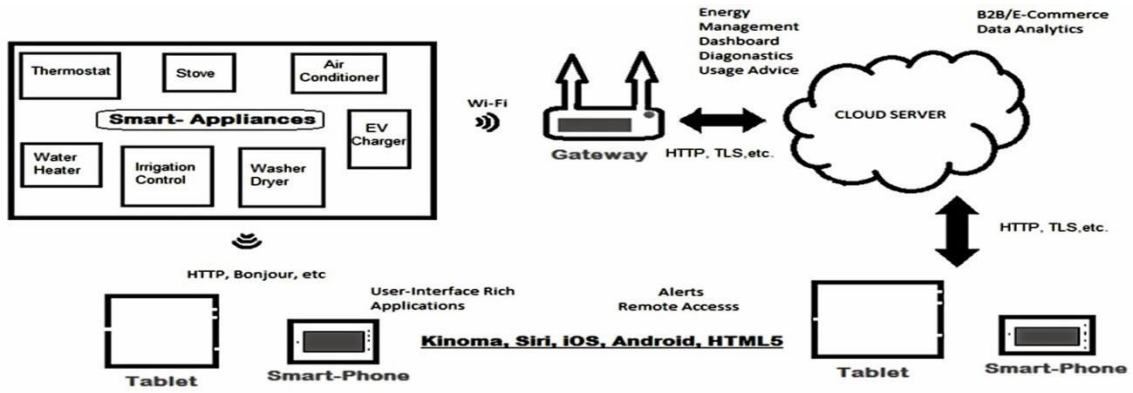


Fig. 1 Block diagram of Wi-Fi based system

III. METHODOLOGY

Figure 2 shows the module of Wi-Fi based system diagram. It is important to note that the Arduino is the main control unit in the system. All the home applications will be suitably controlled by the Arduino link to different available facilities. In practice, various sensors like temperature, IR sensors and others are to be controlled by Arduino while in the system LCD will be used to display the entered password [4]**.**

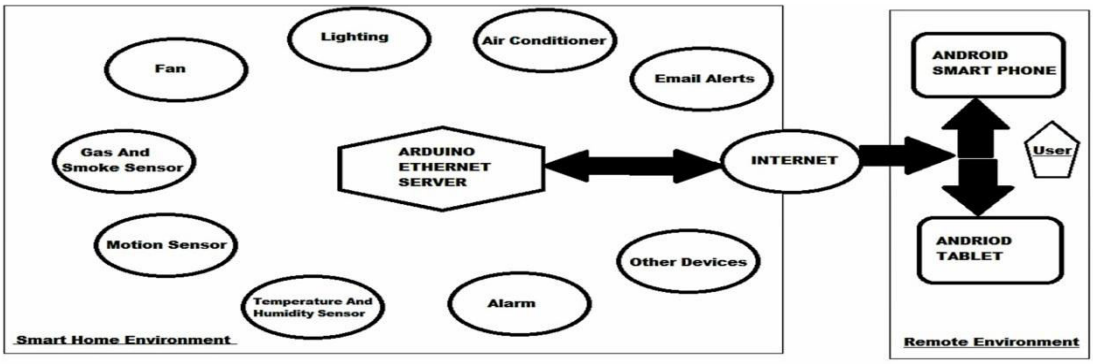


Fig. 2 Module of Wi-Fi based system

Fig. 6 Arduino IDE Software

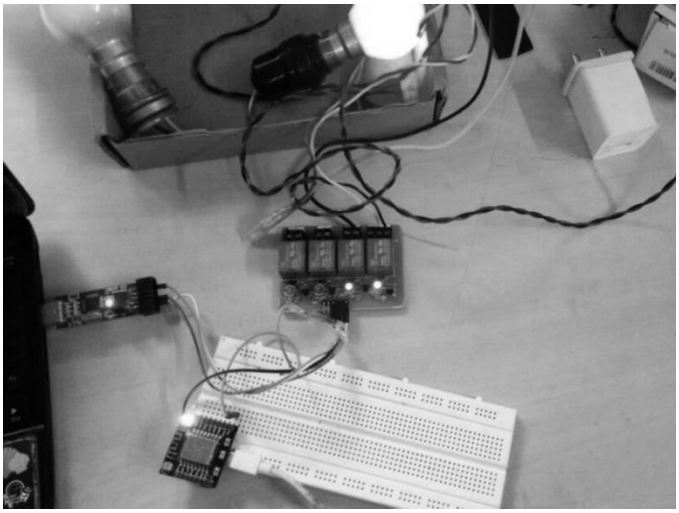


Fig. 5 The AI-Thinker Prototype

IV. Design And Implementation

A low cost and efficient smart home system that we have designed is shown in Figure 4. A circuit diagram of the system is shown in Figure 5. It has two main modules: (i) the hardware interface module and (ii) the software communication module. At the heart of the whole system, there is the Arduino Mega 328 PU which is capable of functioning as a micro web server and the interface for all the hardware modules. But in the present system we can conveniently use ESP 8266 Module AI-Thinker instead of ESP 8266 normal. The AI used in this system is generic. The module is itself a microcontroller which control all the tubes and fans using relay in home-automation system [5]. The modified program is burned into the AI-Thinker module by the use of Arduino IDE software (as shown in figure 6).

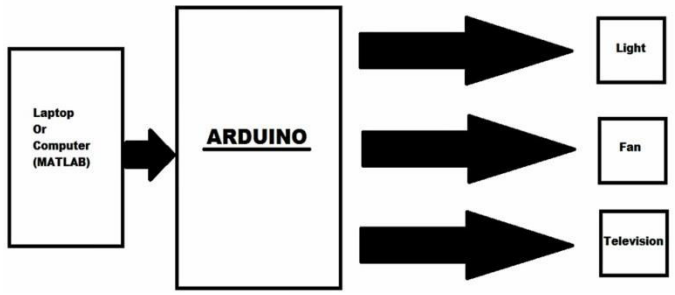


Fig. 4 Procedural Diagram of Wi-Fi based system

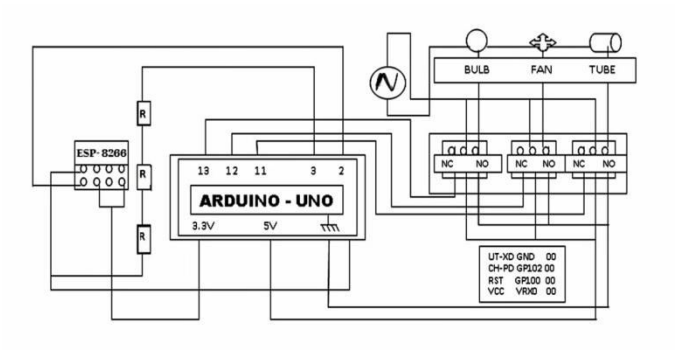


Fig. 5 Circuit diagram of Arduino based system

The main advantage of this system is that it is a low cost but very efficient device for the purpose. If we use Arduino UNO and ESP 8266, then the cost of the system becomes very high in comparison to the proposed model. In this system the use of the AI-Thinker makes the circuit easier to handle with much reduction of the cost. Figure 3 shows the AI-Thinker used.

The associated Algorithm showing the different steps to be followed for operation is given below:

Step-1: START

Step-2: Define Arduino and WIFI-module header file

Step-3: Web server client header declaration

Step-4: Define all the integers for different components like fan, tube lights or bulbs

Step-5: Declare output modes for components

Step-6: Setup the WIFI-module router as per the username and password provided

Step-7: Define web link switches as per the fans, tube lights or bulbs will be controlled

Step-8: END

V. Web Application And Other Advantages

Internet of Things (IOT) is a new revolution of the internet in today's world. A world where the real, digital and the virtual are converging to create smart environments that can cover many areas more intelligently [6, 7]. In recent years, there are many Android and server based applications. In the proposed system, value of the web server through wireless communication and device will be able to show on GUI (Graphical User Interface) or web server through wireless communication and the device will be controlled automatically as well as it will be operated on WIFI. In my system ESP 8266 AI-Thinker should be connected to the WIFI device, like a mobile phone or a home router, through hotspot [8]. When this WIFI system will be connected with a mobile phone or router then by the use of web server, opening a particular website, we can control all the home applications like tube lights or fans, simply by changing the radio buttons already present in the website of the web server [8].

This is helpful for saving the energy by auto on and off in houses. At night times in major city office buildings as well as in the educational institutes after 6 pm for the door lock password based system it can be used as the key technology of security. Further it can be suitably used to control the speed of the fans. The security system includes a motion sensor which detects the unauthorized movements which will be detected by this system and will alert the user.

VI. CONCLUSIONS

The proposed home automation system using Arduino with WIFI module is versatile, affordable and very convenient. People, particularly adults, face a lot of difficulties to handle home appliances such as switching off lights or fans or turning of air conditioner or even locking car or other electronic devices. The proposed technology will be able to solve those regular problems. It is an energy efficient, labour efficient, cost efficient and time saving smart city project which can definitely improve a person's lifestyle. Moreover, the proposed system will largely assist to handicapped, disabled and aged people. The simple prototype home automation system in future may expand in many areas.

Acknowledgment

We are thankful to Techno India University, West Bengal, Salt Lake, Kolkata 700091, India, for constant encouragement and Ardent Computech Pvt. Ltd. for their technical supports.

References

[1] Kumar, P. P., Vasu, G. T., (2015) "Home Automation System and Security System using Arduino", International Journal of Emerging Trends in Engineering Research. 3, 190-194.

[2] Choudhary, V., Parab, A., Bhapkar. S., Jha, N., Kulkarni, M., (2016) "Design and Implementation of Wi-Fi based Smart Home System", International Journal of Engineering and Computer Science, 5, 15852-15855.

[3] Gurek, A., Gur, C., Guraki, C., Akdeniz, M., Kumova, S., Korkmaz, M., (2013) "An android based home automation system, High Capacity Optical Networks and Enabling Technologies (HONET-CNS)," 10th International Conference on IEEE, 121-125.

[4] Mattia, G., Gonella, A., Palazzi, E.C., (2015) "Design issues and solutions in a modern home automation system, Computing, Networking and Communications," International Conference on. IEEE.

[5] Kelly, S.D.T., Suryadevara, N.K., Mukhopadhyay, S.C., (2013) "Towards the Implementation of IOT for Environmental Condition Monitoring in Homes," IEEE, 13, 3846-3853.

[6] Godha, R., Prateek, S., Kataria, N., (2014) "Home Automation: Access Control for IoT Devices", International Journal of Scientific and Research Publications, 4, 1.

[7] Patil, P.B., Patil, R.R., Patil, S.V., Telepatil, A.R., (2016) "Home Automation System Using Android and Arduino Board", International Journal of Innovative Research in Science, Engineering and Technology, 5, Issue 4, ISSN 2319-8753 (Online),.

[8] IOT Based Home Automation System Using Arduino Board, Harsh Mehta, Kunal Jadhav, Avinash Mishra , Prof. Anushree Deshmukh , International Research Journal of Engineering and Technology (IRJET), 4, Issue-01 | Jan -2017, e-ISSN: 2395 -0056, p-ISSN: 2395-0072.

Can Condition Factor of Fish Serve as Proxy to Salinity Alteration?

Pavel Biswas
Department of Oceanography
Techno India University, West Bengal
Kolkata 700091, India
babanpavel@gmail.com

Sujoy Biswas
Department of Civil Engineering,
Techno India University, West Bengal,
Saltlake, Kolkata 700091, India
skbuniverse@gmail.com

Sufia Zaman
Department of Oceanography
Techno India University, West Bengal
Kolkata 700091, India
zamansufia123@gmail.com

Abhijit Mitra
Department of Marine Science
University of Calcutta
Kolkata700019, India
abhijit_mitra@hotmail.com

***Abstract* – The condition index of dominant commercially important fishes were monitored with respect to ambient aquatic salinity during June 2017 from two major estuaries of Indian Sundarbans. The Hugli estuary in the western sector is relatively low saline compared to the Matla estuary in the central sector on account of receiving the fresh water discharge from the Farakka barrage. The central sector is hyper saline due to siltation of the Bidyadhari River since the late 15th century. The present study evaluates the condition factor of fourteen commercially important fin fish species collected from the Hugli and Matla estuaries in the western and central sectors of the lower Gangetic delta respectively. Relatively higher values of condition factors of all the species collected from the Hugli estuary (compared to those collected from the Matla estuary) signifies the adverse effect of hyper salinity on the growth and condition factor of the species.**

Keywords – condition index, salinity, fin fish, marine species.

I. INTRODUCTION

There is a consensus of scientific opinion that salinity fluctuation plays a regulatory role on the metabolism and growth of fin fishes. This is reflected through condition factor of the fin fish species, which is a function of the weight and total length of the selected species. The lower Gangetic delta encompassing the mangrove ecosystem of Indian Sundarbans is the breeding and residential ground of a large variety of fin fishes.

The fish fauna of the present study area may be classified into residents and transients (migrants). The species whose individuals of different sizes are present during all the months of the year in any zone of the estuary are referred to as resident species. The important resident fin fish species are *Mugil parsia, Mugil tade, Polynemus paradiseus, Polydactylus indicus, Otolithoides biauritus, Lates calcarifer, Hilsa toli, Arius jella, Harpodon nehereus, Setipinna taty, Ilisha elongata, Setipinna phasa, Coilia ramcarati, Pama pama and Sillaginopsis panijus*. The transient or migratory fishes enter and stay in the Bay of Bengal associated estuaries for a short period. Depending on their migratory pattern and direction, the migrants are divided into three categories[1,2].

(1) Marine forms that migrate upstream and spawn in freshwater areas of the estuary *like Tenualosa ilisha, Polynemus paradiseus, Sillaginopsis panijus and Pama pama,*

(2) Freshwater species, which spawn in saline area of the estuary *like Pangasius pangasius*, and (3) Marine species, that spawn in less saline water of the estuary like *Arius jella, Osteogeneious militaris and Polydactylus indicus.*

In the present study, we have used condition factor as the proxy of stress posed by salinity of the aquatic phase. Our main aim is to determine the impact of salinity fluctuation on the condition factor of the selected 14 commercially important fin fish species as the price of the fish mostly depends on their growth (in terms of length and weight).

II. MATERIALS AND METHOD

The entire network of the present study consists of the collection of 50 individuals of the selected species (*Tenualosa ilisha, Pama pama, Pampus spp., Ilisha elongate, Lates calcarifer, Pangasius pangasius, Liza parsia, Liza tade, Tenualosa toli, Polynemus paradiseus, Otolithoides biauritus, Tachysurus jella, Sciaena biauritus and*

Eleutheronema tetradactylum) from the two major estuaries in the study area namely Hugli (in the western sector) and Matla (in the central sector). Individual length and weight of the selected species were measured to evaluate the condition factor as per the following expression:

$$K = \frac{\bar{w}}{(\overline{TL})^3} \times 10^3$$

Where K is the condition factor, is the average weight (g) and is the average total length (cm). The secondary data of surface water salinity were obtained from the existing data bank for the area 2, 4-8.

III. RESULT & DISCUSSION

It is evident from the data set that condition factor is relatively higher for the fin fish species collected from the Hugli estuary compared to those collected from the Matla estuarine water (Table 1). This may be attributed to variation in aquatic salinity as evidenced from the secondary data bank. The Hugli estuarine water is relatively hypo saline as compared to the water of Matla estuary in the central sector of the study area [2, 8]

TABLE 1: Condition factors of the selected fin fish species in the western and central sectors of the study area.

S. No.	Commercially important fin fish	Western sector (Hugli estuary)	Central sector (Matla estuary)
1.	*Tenualosa ilisha* (Family: Clupeidae)	**0.886**	**0**
2.	*Pama pama* (Family: Sciaenidae)	**1.113**	**0.621**
3.	*Pampus* spp. (Family: Stromateidae)	**1.431**	**0**
4.	*Ilisha elongata* (Family: Pristigasteridae)	**0.838**	**0**
5.	*Lates calcarifer* (Family: Centropomidae)	**1.299**	**0.491**
6.	*Pangasius pangasius* (Family: Pangasiidae)	**0.908**	**0.438**
7.	*Liza parsia* (Family: Mugilidae)	**1.098**	**0.665**
8.	*Liza tade* (Family: Mugilidae)	**0.869**	**0.677**
9.	*Tenualosa toli* (Family: Clupeidae)	**0.998**	**0.459**
10.	*Polynemus paradiseus* (Family: Polynemidae)	**0.904**	**0.593**
11.	*Otolithoides biauritus* (Family: Sciaenidae)	**1.105**	**0.880**
12.	*Tachysurus jella* (Family: Ariidae)	**1.025**	**0.693**
13.	*Sciaena biauritus* (Family: Sciaenidae)	**1.098**	**0.895**
14.	*Eleutheronema tetradactylum* (Family: Polynemidae)	**0.984**	**0.688**

Note: The value 0 (zero) represents the non availability of the species in the estuarine water.

Condition factor is an indication of the well being of an organism and is based on the hypothesis that heavier fish of a given length are in a better condition [9, 10] than light weighed fish of the same species. It has been used as an index of growth and feeding intensity [11, 12], decreases with increase in length [11, 13, 14] and also influences the reproductive cycle in fish. On this background we have used this parameter as proxy to detect the impact of salinity in the present study area.

Aquatic salinity has both direct and indirect impacts on fish stocks which are exploited commercially preferably for the livelihood. Direct effects act on physiology and behavior of fishes

and alter their growth, reproduction, mortality and distribution. Indirect effects encompass events like alteration of aquatic productivity, biotic community structure and composition of the marine and estuarine ecosystems on which fishes depend for food and survival. Changes in primary and secondary production will obviously have a major effect on fisheries production, but it is not possible in the current state of knowledge to make accurate quantitative predictions of changes in global marine primary production solely due to climate change induced salinity fluctuation [2].

Our first order analysis clearly reflects a pronounced variation in condition factor of the selected species between the two sectors. Significantly higher condition factor of commercially important fin fish was observed in the species collected from the Hugli estuary, where the aquatic phase is congenial in terms of salinity. This hyposaline environment may be attributed to discharge from Farakka barrage that is situated in the upstream region of Ganga- Bhagirathi - Hooghly river system. 10-year surveys (1999 to 2008) on water discharge from Farakka dam revealed an average discharge of $(3.7 \pm 1.15) \times 10^3$ m^3s^{-1}. Higher discharge values were observed during the monsoon with an average of $(3.81 \pm 1.23) \times 10^3$ m^3s^{-1}, and the maximum of the order 4524 m^3s^{-1} during freshet (September). Considerably lower discharge values were recorded during premonsoon with an average of $(1.18 \pm 0.08) \times 10^3$ m^3s^{-1}, and the minimum of the order 846 m^3s^{-1} during May. During postmonsoon discharge, values were moderate with an average of $(1.98 \pm 0.97) \times 10^3$ m^3s^{-1} as recorded by earlier workers [2]. This hyposaline condition supports migration of *Tenualosa ilisha* for breeding in the upstream region of Gangetic delta and also acts as the nursery ground of several species of commercially important fin fish (Table 1).

In the Matla estuary, the ingression of seawater and resultant salinity increase has completely reversed the picture with less value of condition factor in the fin fish species (Table 1). The unavailability of fresh water in this estuary of lower Gangetic delta due siltation and blockage of Bidyadhari River since the late 15th century 2, 7, 8 may be the primary cause of

(i) adverse impact on fish metabolism in the hypersaline environment

(ii) Loss of primary food supply (mainly plankton) due to adverse impact of salinity tolerance for that organism (plankton) and

(iii) Direct mortality due to extreme saline condition [2].

A long-term study of some fifty years is, however, prescribed to pinpoint the adverse impact of hyper salinity on the growth and health of commercially important fin fish species in the lower Gangetic delta.

References

[1] Jhingran, V.G. (1982). Fish and Fisheries of India. Hindusthan Publishing Corporation (India), Delhi.

[2] Mitra, A. (2013). Sensitivity of Mangrove ecosystem to changing Climate. Springer DOI: 10.1007/978-81-322-1509-7, pp. 323.

[3] Chow, S. & Sandifer, P.A. (1991, 92). Differences in growth, morphometric traits and male sexual maturity among Pacific white shrimp, *Penaeus vannamei*, from different commercial hatcheries. Aquaculture, 165–178.

[4] Ray Chaudhuri, T., Fazli, P. Zaman, S., Pramanick, P. Bose, R. & Mitra, A. (2014). Impact of acidification on heavy metals in Hooghly Estuary. Journal of Harmonized Research in Applied Science, 2(2), 91-97.

[5] Chakraborty, S., Zaman, S., Pramanick, P., Raha, A.K. , Mukhopadhyay, N., Chakravartty, D. and Mitra, A. (2013). Acidifications of Sundarbans mangrove estuarine system. Discovery Nature, 6(14), 14-20.

[6] Sengupta, K.., Roy Chowdhury, M., Bhattacharyya, S.B, Raha, A., Zaman, S. and Mitra, A. (2013). Spatial variation of stored carbon in *Avicennia alba* of Indian Sundarbans. Discovery Nature, (ISSN: 2319-5703), 3(8), 19 -24.

[7] Mitra, A. & Zaman, S. (2014). Carbon Sequestration by Coastal Floral Community; published by The Energy and Resources Institute (TERI) TERI Press, India; Copyright The Energy and Resources Institute; ISBN- 978-81-7993-551-4.

[8] Mitra, A. & Zaman, S. (2015). Blue Carbon Reservoir of the Blue Planet. Published by Springer; ISBN 978-81-322-2106-7 (Springer DOI 10.1007/978-81-322-2107-4).

[9] Bagenal, T.B. & Tesch, A.T. (1978). Conditions and Growth Patterns in Freshwater Habitats. Blackwell Scientific Publications, Oxford, pp: 75 -89.

[10] Abowei, J.F.N & George, A.D.I (2009). A study of the length - weight relationship and condition factor of *Callinectes*

amicola (De Rochebrune, 1883) from Okpoka Creek, Niger Delta, Nigeria. International Journal of Animal and Veterinary Advances, 1(2), 66-72.

[11] Fagade, S.O (1979). Observations on the Biology of two species of Tilapia from Lagos Lagoon, Nigeria. Bulletin d'Institut Français d'Afrique Noire, 41, 627–653.

[12] Abowei, J.F.N., Davies, O.A. & Eli, E.E (2009). Study of the length - weight relationship and condition factor of five fish species from Nkoro river, Niger Delta, Nigeria. Current Research Journal of Biological Sciences, 1(3), 94-98.

[13] Bakare, O. (1970). Bottom Deposits as Food of Inland Freshwater Fish. In: A Nigerian Man Made Lake. Kainji Lake Studies, 1, (Visser, S.A. and Lake, K., Eds.), Ecology, NISER, Ibadan, Nigeria.

[14] Abowei, J.F.N. (2009). The abundance, condition factor and length - weight relationship of *Cynoglossus senegalensis* (Kaup, 1858) from Nkoro River Niger Delta, Nigeria. Advanced Journal of Food Science and Technology, 1(1), 56-61.

Effects of supplementation of amino acids in plant protein based low cost aqua feed using seaweed extract on the performances of shrimp-mullets polyculture

Deepta Chakravartty
Department of Oceanography, Techno India University, West Bengal, Salt Lake, Kolkata, India
Email: dechavy@gmail.com

Asish Mondal
Department of Oceanography, Techno India University, West Bengal, Salt Lake, Kolkata, India
Email: asish177@gmail.com

Abstract - **Effects of supplementation of low cost plant protein based aqua-feed at varied inclusion levels with commercially available extract of brown sea weed, *Ascophyllum nodosum*, rich in all essential amino acids, antioxidants and immune stimulants were tested in tiger shrimp–mulletspolyculture. Tiger shrimp (*Penaeus monodon* Fabricius 1798) juveniles (0.63±0.04 g) and fingerlings of Goldspot mullet (*Liza parsia*Hamilton 1822, 5.14±0.31 g), Tade mullet (*Liza tade* Forsskål 1775,5.09±0.33 g) and Grey mullet (*Mugilcephalus* Linnaeus 1758,4.97±0.43 g) were rearedfor 180 days in brackishwater ponds (2 ha) at respective stocking density of 40000, 20000, 10000 and 5000 numbers ha^{-1}. Sea weed extract was coated on the feed pellets at the rate of 5.0 (T3) and 2.5 (T2) ml Kg^{-1} and fed in triplicate ponds at the rate starting with 10% and ending with 1 % of fish biomass while non-supplemented (T1) feed was applied in other three ponds. At harvest, highest average body weight of Tiger shrimp (31.01±2.16 g), Goldspot mullet (56.50±2.05 g), Tade mullet (60.10±2.04 g) and Grey mullet (146.19±3.72 g) were attained in T3. Highest total production was achieved in T3 (3254 Kg ha-1) followed by T2 (2384 Kg ha-1) and T1 (1900 Kg ha-1). Water quality parameters were within optimum ranges. Amino acids supplementation using sea weed extract might have facilitated better utilization of plant protein based feed. Supplementation of *A. nodosum* extract at the rate of 5 ml Kg^{-1} in plant protein based low cost aqua-feed wasfound to be a viable option for better production in shrimp-mulletspolyculture.**

Keywords - polyculture; aqua-feed; plant protein; amino acid; supplementation; seaweed extract

I. INTRODUCTION

World aquaculture production exceeded 66 million tonnes in 2012 where India contributed over 4.2 million tonnes which accounted for about 6.3% of global production [1]. This ranks India the world's second largest aquaculture producer, next to China. With fast disappearing fresh water areas, aquaculture development gradually found its way into marine and brackishwater systems [2]. Intensive monoculture caused disaster to coastal ecosystems by way of deteriorating the water quality, mangrove deforestation etc [3, 4, 5]. Intensive stocking results in stress and disease related loss. White spot syndrome is a relevant example in this context [6, 7]. Conversely, improved polyculture is a sustainable option combining diverse feeding habits together so that the reared organisms consume the natural food available in all trophic levels and supplementary formulated feed administration with optimal levels of nutrition for achieving a superior yield [8, 9, 10, 11].

Aquaculture has essentially been a traditional practice in the state of West Bengal [12, 13]. In brackish-water areas, low lying lands near the banks of rivers and creeks are encircled by peripheral dyke and tidal water is allowed to enter in the impoundment along with natural seeds of various species of shrimps, crabs and fishes. Water is retained with periodical exchanges during lunar cycles and the trapped animals grow utilizing natural food. Partial harvests are carried out 3-4 months onwards during lunar cycles and the impoundments are dewatered for final harvest at 9-11 months. These fisheries are popularly known as '*bheries'* in West Bengal. Productivity of this system ranges between 500-900 kg/ha/yr. Modification of this system of aquaculture with selective stocking, feeding and

application of better management practices is yielding much better production. Improved poly-farming of non-carnivorous fishes (e.g., mullets) with tiger shrimp has been proved to be a viable alternative to mono-shrimp farming as a low cost-low risk and high profit venture [12, 14].

Feed is of prime importance in modern aquaculture and accounts for a major share of total operational cost. Fish meal has historically been the protein source of choice in aquatic feeds, but global supplies have reached a plateau making it less available and more expensive [15]. As a consequence, the use of cheaper plant proteins and byproducts from agriculture has flourished within the aquaculture feed industry [8, 15] to reduce the cost. Although these alternate cheaper ingredients may contain crude protein content comparable to fish meal, they may be less digestible and deficient in one or more of the ten essential amino acids which in turn increase the nitrogen content of the pond water [16, 17].

In this context, sea weed have a big role to play in aqua-feed technology. The importance of sea weeds as functional food is primarily because of their rich source of amino acids, bioactive polysaccharides and antioxidants. Apart from their use as alginate in various food grade and laboratory materials, sea vegetables are able to accelerate the growth of oysters, tilapia, salmon, trout, etc [18]. Commercially available extracts of sea weeds can be considered as a potential source to make up the deficiency of amino acids in plant protein based low cost aqua-feed. Additionally, presence of bioactive polysaccharides and antioxidants in sea weed extract may improve immunity of farmed organisms against stress and diseases.

Effects of the supplementation of low cost feed containing mostly second class protein with commercially available extract of brown sea weed, *Ascophyllumnodosum*were tested in tiger shrimp–mulletspolyculture.

II. MATERIALS AND METHODS

The experimental farming was conducted at Chotomollahali Island (88°54'26.71" N, 22°10'40.00'' E), Gosaba block, South 24 Parganas, West Bengal, India for 180 days during February to August, 2016 in 9 brackishwater ponds (2 ha) locally known as 'Bhery'. Appropriate pond preparation involving bleaching, liming and fertilization was done. Juveniles of Tiger shrimp (*Penaeusmonodon*Fabricius 1798, 0.63±0.04 g) and fingerlings of Goldspot mullet (*Liza parsia* Hamilton 1822, 5.14±0.31 g), Tade mullet (*Liza tade*Forsskål 1775, 5.09±0.33 g) and Grey mullet (*Mugilcephalus*Linnaeus 1758, 4.97±0.43 g) were reared at respective stocking density of 40000, 20000, 10000 and 5000 numbers ha^{-1} following common practice derived from an interview based survey. Reared animals were fed with commercially available low cost floating feed pellets at the rate starting with 10 % and ending with 1 % of mullet biomass determined through monthly samplings. No sinking feed for tiger shrimp was applied. Extract of brown sea weed *Ascophyllumnodosum*produced in India by 'NatureNerve' containing all essential amino acids (Table 1) were coated on the feed pellets at the rate of 2.5 (T2) and 5.0 (T3) ml $Kg^{-1}$and fed in triplicate ponds while non-supplemented (T1) feed was applied in other three ponds. Lime stone powder was applied @ 100 Kg ha^{-1} at fortnightly intervals to maintain optimum water quality. Shrimp, fish and water samples were collected monthly during morning in between 07.00 to 09.00 hours and carried to laboratory in ice boxes for subsequent analysis.

Water quality parameters were measured following standard methods [19]. Water temperature and pH was determined using a digital multi-meter (model: deluxe 191E). Salinity was recorded using a refractometer (ATAGO, Japan). Dissolved oxygen (DO) was analyzed using modified Winkler's method and total alkalinity was determined through titration.

Body weight (W, g) of tiger shrimp and fishes was recorded with a digital electronic balance. Daily weight gain (DWG) was estimated using the following conventional equation:

$$DWG = \frac{W_f - W_i}{t}$$

Where W_f and W_i are the average final and initial weight in time *t*.

Specific growth rate (SGR) was calculated using the following equation [20]:

$$SGR = \frac{\ln w_f - \ln w_i}{t} \times 100$$

Where W_f and W_i are the average final and initial weight in time *t*.

Production parameters like final weights (g) of individual species, survival (%), productivity (kg ha^{-1}) and feed conversion ratio (FCR) were estimated after harvest by drag netting and dewatering the pond finally. Comparative accounts of economic parameters were carried out after sale of the product.

III. RESULTS AND DISCUSSION

Water quality parameters of the studied ponds are presented in table 1. Minimum temperature was

recorded during February (18.5°C) and maximum during June (33.65°C) with insignificant ($p>0.05$) difference among treatments. Salinity fluctuation showed wide range and was maximum (14.90 ppt) during May and minimum (4.50 ppt) during August with insignificant difference ($p>0.05$) among treatments. Mean pH differed significantly ($p<0.05$) among treatments with highest (8.10±0.31) and lowest (7.82±0.27) in T3 and T1, respectively. Total alkalinity showed similar trend. Dissolved oxygen (DO) varied between 5.20 to 7.85 mg L^{-1} with highest in T3 and lowest in T1 and differed significantly ($p<0.05$) among treatments.

Water quality parameters were within the optimum ranges for brackish-water shrimp and finfish farming [21, 22]. Periodical application of lime and appropriate feed management might have contributed to optimum water quality parameters in all treatments. Better feed utilization in T3 might have contributed to better water quality among treatments.

Table 2: Water quality parameters in tiger shrimp-mullets polyculture fed with plant protein based feed (T1), plant protein based feed supplemented with 2.5 (T2) and 5

(T3) ml Kg^{-1} sea weed extract

Parameters	T1	T2	T3
Temperature (ºC)	28.4±1.6	28.5±1.9	28.6±1.7
Salinity (ppt)	9.88±2.26	10.19±2.18	9.72±2.33
pH	7.82±0.27 b	8.10±0.31 a	8.09±0.25 a
Total alkalinity (mg L^{-1})	129±6[b]	137±9[a]	135±7[a]
Dissolved Oxygen (mg L^{-1})	5.65±0.63 c	5.73±0.52 b	6.14±0.51 a

Values are expressed as mean ± SE of three replicate ponds. Different superscripts in a row indicates significant ($p < 0.05$) difference

Comparative account of growth parameters of the candidates in co-culture are depicted in table 2. At harvest, significantly ($p < 0.05$) highermean body weights of Tiger shrimp (31.01±2.16 g), Goldspot mullet (56.50±2.05 g), Tade mullet (60.10±2.04 g), and Grey mullet (146.19±3.72 g) were attained in T3 with respective significant ($p<0.05$) higher daily weight gains (DWG) of 0.17±0.01, 0.30±0.02, 0.30±0.01 and 0.78±0.01 g day^{-1}compared to other treatments. Similarly, specific growth rate (SGR) recorded for Tiger shrimp (1.92±1.08 % day^{-1}), Goldspot mullet (2.23±1.28 % day^{-1}), Tade mullet (2.25±1.16 % day^{-1}), and Grey mullet (2.76±1.40 % day^{-1}) were significantly ($p < 0.05$) higher in T3 than other treatments.Different ranges of growth at different stocking density, farming systems and salinity [23, 24, 25] have been reported to support commercially acceptable production of Tiger shrimp in mono-culture. Reports on shrimp growth in polyculture in similar environment are limited. However, Tiger shrimp harvest weights of 18.00 ± 0.64 and 17.01 ± 0.72 g in polyculture with mullets and milkfish (*Chanoschanos*), respectively at stocking density of 20000 ha^{-1}in 6 months of rearing have been reported from Sundarbans [11]. Tiger shrimp harvest weight of 12.8–17.8 g after 6 months of culture with milkfish have also been reported from different location in India [26]. Reported [11] harvest weights of Goldspot mullet (54.02 ± 2.11 g), Tade mullet (80.40 ± 4.02 g) and Grey mullet (92.29 ± 4.36 g) at respective stocking density of 2000, 1500 and 4500 numbers ha^{-1} in similar duration of rearing can be compared with the present study. Although reared at higher stocking density in the present study, similar growth of Goldspot mullet, have been observed in T3. Lower growth of Tade mullet in the same treatment in the present study can be attributed to rearing at much higher stocking density. Although reared at similar stocking density, much higher growth of Grey mullet has been found in all treatments in the present study. Better shrimp and fish growth performances in the present study are indicative of better feed utilization when supplemented with sea weed extract.

Table 3: Growth parameters of Tiger shrimp and mullets in brackishwaterpolyculturefed with plant protein based feed (T1), plant protein based feed supplemented with 2.5 (T2) and 5 (T3) ml Kg^{-1} sea weed extract

Species		SD (nos ha^{-1})	Body weight (g)		DWG (g day^{-1})	SGR (% day^{-1})
			Initial	Final		
Tiger shrimp	T1	40000	0.63± 0.04	24.40± 1.50	0.13± 0.01	1.79± 1.02
	T2		0.62± 0.03	28.08± 1.56	0.15± 0.01	1.86± 0.88
	T3		0.63± 0.06	31.10± 2.16	0.17± 0.01	1.92± 1.08
Tade mullet	T1	10000	5.22± 0.41	30.02± 1.52	0.14± 0.01	1.86± 0.91
	T2		5.16± 0.28	42.9± 1.86	0.21± 0.01	2.07± 1.14
	T3		4.88± 0.30	60.10± 2.04	0.30± 0.01	2.25± 1.16
Goldspot mullet	T1	20000	4.93± 0.26	42.80± 1.51	0.21± 0.01	2.07± 0.95
	T2		5.38± 0.22	44.10± 1.85	0.22± 0.01	2.08± 1.12
	T3		5.10± 0.46	56.50± 2.05	0.30± 0.02	2.23± 1.28
Grey mullet	T1	5000	5.22± 0.31	108.02 ±3.51	0.57± 0.03	2.59± 1.28
	T2		4.64± 0.53	121.01 ±4.11	0.65± 0.02	2.66± 1.30
	T3		5.10± 0.46	146.19 ±3.72	0.78± 0.01	2.76± 1.40

Different superscripts in columns for a species indicate significant ($p < 0.05$) differences. Values are expressed as mean ± SE of three replicate ponds. SD=Stocking density, DWG=Daily weight gain, SGR=Specific growth rate

Production parameters are presented in table 3. Tiger shrimp survival was highest in T3 (65.3±3.6%). Goldspot mullet (99.3±5.9%), Tademullet (98.4±5.1%) and Grey mullet (99.8±5.9%) also survived best in T3. Conversely, T1 displayed lowest survival of Tiger shrimp (42.2±2.3%), Goldspot mullet (85.8±5.7%), Tademullet (87.2±3.7%) and Grey mullet (91.2±4.9%) while moderate survivals were observed in T2.Owing to higher harvest weights and survivals, higher productivity of Tiger shrimp (810 Kg ha^{-1}), Goldspot mullet (1122 Kg ha^{-1}), Tade mullet (591 Kg ha^{-1}) and Grey mullet (731 Kg ha^{-1}) were achieved in T3. Significantly ($p < 0.05$) highertotal production was observed in T3 (3254 Kg ha^{-1}) followed by T2 (2384 Kg ha^{-1}) and T1 (1900 Kg

ha^{-1}). FCR was lowest in T3 (1.63), followed by T2 (1.78) and T1 (1.90).

Table 4: Production parameters of Tiger shrimp-mullets polyculturefed with plant protein based feed (T1), plant protein based feed supplemented with 2.5 (T2) and 5 (T3) ml Kg^{-1} sea weed extract

	Species	Survival %	Production (Kg ha^{-1})		FCR
			Individual	Total	
T1	Tiger shrimp	42.2±2.3	412	1900	1.90
	Tade mullet	87.2±3.7	262		
	Goldspot mullet	85.8±5.7	735		
	Grey mullet	91.2±4.9	493		
T2	Tiger shrimp	55.0±2.1	616	2384	1.78
	Tade mullet	91.3±4.9	392		
	Goldspot mullet	90.6±4.9	799		
	Grey mullet	95.4±5.1	577		
T3	Tiger shrimp	65.3±3.6	810	3254	1.63
	Tade mullet	98.4±5.1	591		
	Goldspot mullet	99.3±5.9	1122		
	Grey mullet	99.8±5.9	731		

Values are expressed as mean ± SE of three replicate ponds

Better utilization of feed directly affects profitability and environmental sustainability [27]. Targeted formulated feed is a prime requirement for this vast expanding sector keeping in mind limited environmental impacts. This has required the adoption of more modern formulation approaches which take into account nutrient availability, especially with regards to amino acids [10, 28]. The effectiveness of amino acids has been established for a number of species of fin-fish and shrimp [29]. Lower pH, alkalinity and dissolved oxygen in treatment fed with non-supplemented feed indicated inefficient feed utilization and deterioration of water quality. Formulating for amino acids by increasing

the dietary inclusion levels of ingredients that contain intact sources of the targeted essential amino acids can lead to over formulated mixture with excessive levels of crude protein and other nutrients [16, 17]. Supplementation of the diet with amino acids as a more rational approach might have provided better water quality and fish performances in the present study.

Modern sustainable nutrition based therapy is widely used to improve immunity and help counter diseases [30, 31]. Sulfated polysaccharides retard growth of pathogenic bacteria and possess prebiotic properties. Studies conducted by Prabu et al [32] showed disease resistance against strong pathogens like *Aeromonashydrophila* in *Pangasianodon* sp. The most celebrated of these are alginates, fucoidan, laminarin and galactans. These polysaccharides compose the cell wall and inter cellular matrix of seaweeds. Fucoidan is sourced from brown seaweed and possess antiviral, anti-tumour, anti-inflammatory and antioxidant properties. Chotigeat et al [33] demonstrated increased survival rate of white spot syndrome virus affected tiger prawns by administering fucoidan extracts from brown or green seaweed. Laminarin is also present in brown seaweed had acts as a prebiotic, apart from containing antiviral and antibiotic properties. Nearly 47% of brown seaweed biomass is comprised of alginate and acts as a potent antibiotic and anti-inflammatory. Galactans have anti tumour and antiviral activities [34, 35]. Antioxidants present in seaweed are in the form of carotenoids, phycobiliproteins and polyphenols. Both of these are strong free radical scavengers with phycobiliproteins possessing additional antiviral and anti-inflammatory values. Pholorotannins are a form of polyphenols which has both antioxidant and antibacterial values [34, 35, 36].

Amino acids, antioxidants and immuno-stimulants supplementation using sea weed extract might have facilitated better utilization of plant ingredient based feed and reduced stress to the reared organisms. It may be inferred that amino acid supplementation using sea weed extract is a sustainable option for production and profitability increment in low saline polyculture. More research is necessary with sustainable feed additives and fish species combinations to evaluate a sustainable model for farming. Other types of supplementation of herbal properties need also to be investigated by the aquatic industry to keep productivity both sustainable and economical.

Reference

[1] FAO Fisheries and Aquaculture Department (2014). Global Aquaculture Production Statistics for the year 2012. ftp://ftp.fao.org/FI/STAT/Overviews/AquacultureStatistics2012.pdf

[2] Troell, M. (2009). Integrated marine and brackishwater aquaculture in tropical regions: research, implementation and prospects. In D. Soto (ed.). Integrated mariculture: a global review. FAO Fisheries and Aquaculture Technical Paper. Rome, FAO 529, pp 47–131.

[3] Primavera, J. H. (2006). Overcoming the impacts of aquaculture on the coastal zone. Ocean & Coastal Management 49, pp 531–545.

[4] Valiela, I., Bowen, J. L. and York, J. K. (2001). Mangrove Forests: One of the world's threatened major tropical environments. BioScience 51(10), pp 807-815.

[5] Thornton, C., Shanahan, M. and Williams, J. (2003). From wetlands to wastelands: Impacts of shrimp farming. Wetland Science and Practice 20(1), pp 48–53.

[6] [6] Karunasagar, I., Otta, S. K. and Karunasagar, I. (1997). Histopathological and bacteriological study of white spot syndrome of Penaeusmonodon along the west coast of India. Aquaculture 153, pp 9–13.

[7] Lo, C., Leu, J., Ho, C., Chen, C., Peng, S., Chen, Y., Chou, C., Yeh, P., Huang, C., Chou, H., Wang, C. and Kou, G. (1996). Detection of baculovirus associated with white spot syndrome (WSBV) in penaeid shrimps using polymerase chain reaction. Diseases of Aquatic Organisms 25, pp 133–141.

[8] Naylor, R. L., Goldberg, R. J., Primavera, J. H., Kautsky, N., Beveridge, M. C. M., Clay, J., Folke, C., Lubchenco, J., Mooney, H. and Troell, M. (2000). Effect of aquaculture on world fish supplies.Nature 405, pp 1017– 024.

[9] Joseph, I., Abraham, M. and Pillai, S. M. (2001). Polyculture – A viable alternative for less productive tide-fed brackishwater ponds.Fishing Chimes 21(3), pp 18–20.

[10] Li, P., Mai, K., Trushenski, J. and Wu, G. (2009). New developments in fish amino acid nutrition: towards functional and environmentally oriented aquafeeds. Amino Acids 37(1), pp 43–53.

[11] Biswas, G., Ananda Raja, R., De, D., Sundaray, J. K., Ghoshal, T. K., Anand, S., Kumar, S., Panigrahi, A., Thirunavukkarasu, A. R. and Ponniah, A. G. (2012). Evaluation of productions and economic returns from two brackishwater polyculture systems in tide-fed ponds. Journal of Applied Ichthyology 28(1), pp 116–122.

[12] Pillay, T. V. R. (1954). The ecology of brackishwaterbheri, with special reference to the fish-cultural practices and the biotic interaction.Proceedings of the National Institute of Sciences of India 20 (4), pp 399–427.

[13] Beveridge, C. M. M and Little D. C. (2002). The history of aquaculture in traditional societies. Ecological Aquaculture: The evolution of the blue revolution © Blackwell Science Ltd pp 3–14.

[14] Srivastava, U. K., Dholakia, B. H. and Vathsala, S. (1987). Brackish Water Aquaculture Development in India: Status and Task Ahead. © The Editors. Published by Naurang Rai: 121–122.

[15] Rana, K. J., Siriwardena, S. and Hasan, M. R. (2009). Impact of rising feed ingredient prices on aquafeeds and aquaculture production. FAO Fisheries and Aquaculture Technical Paper 541, 63p.

[16] Cho, C. Y. and Bureau, D. P. (2001). A review of diet formulation strategies and feeding systems to reduce excretory and feed wastes in aquaculture. Aquaculture Research 32(1), 349–360.

[17] Webb, Jr. K. A. and Gatlin III, D. M. (2003). Effects of dietary protein level and form on production characteristics and ammonia excretion of red drumSciaenopsocellatus. Aquaculture 225, 17–26.

[18] Fleming, A. E., Barneveld, R. J., and Hone, P. W. (1996). The development of artificial diet for abalone. Aquaculture, 140, 5-53.

[19] APHA, Standard Methods for the Examination of Water and Wastewater 20th ed American Public Health Association Washington DC, USA, 1998.

[20] Brown, M. E. (1957) "The Physiology of Fishes", Vol 1, Academic Press Inc. New York, pp 447.

[21] Ali, M. S., Shofiquzzoha, A. F. M. and Ahmed, S. U. (1999) "Effect of submerged aquatic vegetation on growth and survival of Penaeusmonodon (Fab.)". Bangladesh J. Fish.Res., Bangladesh Fish. Res. Institute, Mymensingh 3, 145–149.

[22] Chakraborti, R. K., Sundaray, J. K. and Ghoshal, T. K. (2002) Production of Penaeusmonodon in the tide fed ponds of Sundarban.Ind J Fish. 49: 419–426.

[23] Mariscal-Lagarda, M. M., Esquer-Méndez, J. L., and Páez-Osuna, F. (2010). Shrimp study uses low salinity groundwater in Sonora, Mexico. Global Aquaculture Advocate, November/December pp 43.

[24] Roy, L. A., Davis, D. A., Saoud, I. P., Boyd, C. A., Pine, H. J. and Boyd, C. E. (2010). Shrimp culture in inland low salinity waters. Reviews in Aquaculture 2, 191–208.

[25] Chanratchakool, P., Turnbull, J. F. and Limsunean, C. (1994). Health management in shrimp ponds. Aquatic animal Health Research Institute, Department of Fisheries, Kasetsart University, Bangkok.

[26] Nammalwar, P. and Kathirvel, M. (1988). Preliminary experiment on monoculture of *Chanos chanos* (Forsskal) and its polyculture with *Penaeus Monodon* (Fabricus). Indian J Fish 35, 197–204.

[27] De Silva, S. S. (2006). Reducing feed costs in aquaculture: Is the use of mixed feeding schedules the answer for semi-intensive practices? Aquaculture Asia 11(4), 7–12.

[28] Meyers, S. P. (1994). Developments in world aquaculture, feed formulations, and role of carotenoids. Pure and Applied Chemistry 66(5), 1069–1076.

[29] Lemme, A. (2010). Availability and effectiveness of free amino acids in aquaculture. Avances en NutriciónAcuícola X – Memorias del Décimo Simposio Internacional de Nutrición Acuícolapp 264–275.

[30] Chang, C. F., Su, M. S., Chen, H. Y. and Liao, I. C. (2003). Dietary β-1,3-glucan effectively improves immunity and survival of Penaeusmonodon challenged with white spot syndrome virus. Fish & Shellfish Immunology 15, 297–310.

[31] Ganguly, S. (2013). Feed supplements for sustainable aquaculture with special emphasis to immunostimulant additives for prevention of disease transmission in aquatic habitats: An editorial. Research Journal of Chemical and Environmental Sciences 1(3), 1 – 2.

[32] Prabu, D. L., Sahu, N. P., Pal, A. K., Dasgupta, S. and Narendra, A. (2014). Immunomodulation and interferon gamma gene expression in sutchi cat fish, *Pangasianodon hypophthalmus*: effect of dietary fucoidan rich seaweed extract (FRSE) on pre and post challenge period. Aquaculture Research 1 – 20 doi:10.1111/are.12482.

[33] Chotigeat, W., Tongsupa, S., Supamataya, K. and Phongdara, A. (2004). Effect of fucoidan on disease resistance of black tiger shrimp. Aquaculture 233, 23–30.

[34] Holdt, S. L. and Kraan, S. (2011). Bioactive compounds in seaweed: functional food applications and legislation. Journal of Applied Phycology 23, 543–597.

[35] Chojnacka, K., Saeid, A., Witkowska, Z. and Tuhy L. (2012). Biologically active compounds in seaweed extracts - the prospects for the application. The Open Conference Proceedings Journal 3 (Suppl 1-M4), 20 – 28.

[36] Ringo, E., Olsen, R. E., Vecino, J. L. G., Wadsworth, S. and Song, S. K. (2012). Use of immunostimulants and nucleotides in aquaculture: a review. Journal of Marine Science Research and Development 1: 104 doi:10.4172/2155-9910.1000104

RSSI Based Indoor human activity Recognition System

Mayumi Mukherjee
Electronics and Communication Engineering
Techno India University, West Bengal, Salt Lake,
Kolkata 700091, India
mayumimukherjee@gmail.com

Asit B. Bhattacharya
Electronics and Communication Engineering
Techno India University, West Bengal, Salt Lake,
Kolkata 700091, India
bhattyacharyaasitbaran@gmail.com

Abstract- **Being a good reflector, the human body can be recognized with the variation of radio signal. In this work we would show how this can be possible by a sequence of methods. First, we create a wireless sensor network (WSN) in a closed surface area and then we monitor the variation of the signal in that surface in presence of human being. In addition we monitor the radio signal also for the gesture movement. The variations are recorded by received signal strength indicator (RSSI). We then develop another human activity recognition system using radar and compare the accuracy for the two adopted systems. Some interesting results have reported in the paper.**

Keywords: RSSI, WSN, human body, gesture activity recognition

I. INTRODUCTION

We know that human body is a good reflector of radio signal. Hence human activity can be recognized using radio signal. Radio wave (ranges from 3 KHz to 300 GHz) is called electromagnetic wave, when propagates through the earth surface, it will affected by various objects. These effects are reflection, refraction, diffraction, scattering etc. The strength or magnitude of the wave is varied depending on these events. Sometime the wave can directly reach to the destination if no obstacle comes in its path. This is called line of sight (LOS) communication. Our research is based on the monitoring of the fluctuation of the radio wave in presence of any object like human body.

A system can be implemented for tracking of human being with his different gesture position even if when he is standing at a particular point as well as when he is moving through the area. In this case he need not to carry any wireless device like mobile phone, pager etc. This is done by analyzing the radio signal in that area which is varied due to the presence of the Person. Device-free radio-based recognition can extend the awareness of wireless-enabled devices over the device boundaries.

It might be applied for mobile phones, laptop computers or consumer products incorporating an interface to the wireless channel.

The system typically employs multiple wireless devices like sensor nodes or Wi-Fi router which are installed around the area. The nodes communicate over one shared radio channel and continuously monitor strength of signals received from other nodes. This is called received signal strength indicator (RSSI). Due to the interactions of radio wave with human body (such as diffraction, reflection, scattering) amplitude of the received signal are measurable changed. Current systems require deployment of multiple wireless devices which actively transmit, receive, and analyze radio signal. Due to radio spectrum recognition these devices are typically limited to only one or few frequency channels in a narrow band frequency spectrum. The frequency modulation technique is used here.

II. BACKGROUND

As a distributed system WSN can be deployed in any physical system for monitoring and tracking purpose. Besides sensing and monitoring another important characteristic of WSN is the defining of the position and the tracking of the static or moving object. Typically location determination system requires the presence of a physical device that is closed to the person that is being tracked. In addition, they usually require the tracked device to participate actively as activity recognition system. The system goes by monitoring and processing changes in the received physical signals at one or more monitoring points to detect changes in the environment. Among traditional localization techniques, the use of global positioning systems (GPSs) is not always the optimal solution because of the huge amount of costs. Moreover, GPS cannot be efficiently used for indoor applications because of interference. A main advantage of radio waves lies in their ability to penetrate smoke, nonmetallic barriers and walls. The standard devices used for tracking and monitoring of an object, may have to face several difficulties for example in a very low light or clumsy closed surface these devices may not work properly. Along with they may get damaged by any unavoidable circumstances. These hamper the efficiency of a tracking system. From this point of view the idea for device-free activity localization has been formulated. Such systems are based on the analysis of the variations of some physical quantities available at the WSN nodes and useful for solving the location and tracking problems. The

measurement of the RF signals has been thoroughly exploited since the values of their descriptive parameters (e.g., the RSS) are available at the physical layer of each node without the need of any additional hardware. As a matter of fact, the potential of radio waves to penetrate nonmetallic walls can be very useful also for building surveillance, monitoring, and tracking [1]. Although being a pioneering area of research, some studies have been already carried out.

Activity recognition systems are a large field of research &development for innovation in the field of hardware architecture. Activity recognition aims to recognize the actions and goals of one or more agents from a series of observations on the agents' actions and the environmental conditions. Since the 1980s, this research field has drawn the interest of several computer science communities due to its strength in providing personalized support for many different applications and its connection to many different fields of study such as medicine, human-computer interaction, or sociology. Sensor-based activity recognition connects the emerging area of sensor networks with novel data mining and machine learning techniques to model a wide range of human activities [2]. Activity recognition research sets out to chart a particularly difficult terrain of objects of cognition. When a novel sensor is introduced it is specialized in representing a single facet of the environment at a certain level of details. Due to the highly innovative nature of activity and context recognition, new sensors are continuously being introduced as inputs for activity classification. The sensors themselves vary greatly in terms of physical phenomena measured, data output format, size, accuracy, reliability, and resource consumption. Recognizing an activity in a given situation correctly would therefore mean that a) the activity which has been recognized actually is present in the physical environment at the time, b) that the sensor is able to create and relay a useful and reliable representation of physical parameters of the environment that are affected by the activity, and c) that the classification algorithm is able to decipher these intricacies, yielding a correct activity classification. Our topic is based on Human activity recognition (HAR) system [3]. Human activity recognition (HAR) is a highly dynamic and challenging research topic. It aims at determining the activities of a person or a group of persons based on sensor and/or video observation data, as well as on knowledge about the context within which the observed activities take place. In general, the HAR process involves several steps – from collecting information on human behavior out of raw sensor data to the final conclusion about the currently performed activity [4]. These steps are as follows: (1) pre-processing of the raw data from sensor streams for handling incompleteness, eliminating noise and redundancy, performing data aggregation and normalization; (2) segmentation – identifying the most significant data segments; (3) feature extraction– extracting the main characteristics of features (e.g., temporal and spatial information) from the segmented data by using, e.g. statistical moments;(4) dimensionality reduction– decreasing the number of features to increase their quality, and reduce the computational effort needed for the classification; (5) classification, the core machine learning and reasoning – determining the given activity. The main goals of HAR systems are to observe and analyze human activities and to interpret ongoing events successfully. Using visual and non-visual sensory data, HAR systems retrieve and process contextual (environmental, spatial, temporal, etc.) data to understand the human behavior [5].

III. Wireless Sensor Network

A wireless sensor network (WSN) is a wireless system consisting of spatially dispersed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes [6].

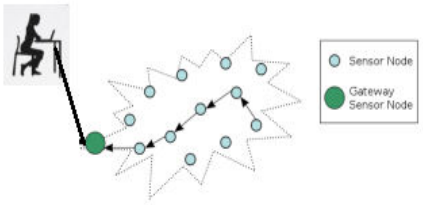


Fig.1. Sensor and gateway sensor nodes

An activity recognition system simply monitor and classify different human action like ‘walking’, ‘crawling’, ‘siting’, ’lying’, and ‘standing’. Depending on the variation of the radio signal these human gestures are recognized by the RSSI indicator.

III. Activity recognition systems

Existing activity recognition systems can be classified into four categories: RSSI based, specialized hardware based, Radar based, and CSI based [19].

A. RSSI Based

In case of received signal strength Indicator (RSSI) based human activity recognition systems, the strength or amplitude of received signal changes because of human activities. These systems have limited accuracy. The accuracy may be improved by software implication. As a result the resolution of captured data increases. The accuracy and

coverage of CSI based human Activity Recognition and Monitoring system (CARM) is much greater than RSSI based activity recognition systems although the RSSI based system is much simpler than CARM. So it can be easily deployed in any environment [7].

B. Specialized Hardware Based

Software defined radios or specially designed hardware can report fine-grained signal measurements. For example, WiSee uses USRP to measure the Doppler shift in wireless signals and achieve an activity recognition accuracy of 95%. Allsee proposes a short range (less than 2.5 feet) solution for gesture recognition by using a special low-power circuit to extract the envelope of the received signal [7]. Wisee explores the possibility of reconstructing an image of the target using the wireless signal received by multiple antennas. WiSee is a novel interaction interface that leverages ongoing wireless transmissions in the environment (e.g., WiFi) to enable whole-home sensing and recognition of human gestures. Since wireless signals never require line-of-sight and can travel through walls, WiSee can enable whole-home gesture recognition using few wireless sources (e.g., a Wi-Fi router and a few mobile devices in the living room). Using WiSee different home allowances like switch on-off of light control of TV without remote and many other is possible by the human being gesture recognition. The results show that WiSee can identify and classify a set of nine gestures with an average accuracy of 94%.

Existing gesture-recognition systems consume significant power and computational resources that limit how they may be used in low-end devices. AllSee is the first gesture-recognition system that can operate on a range of computing devices including those with no batteries [8]. AllSee takes three to four orders of magnitude lower power than state-of-the-art systems and can enable always-on gesture recognition for smart -phones and tablets. It extracts gesture information from existing wireless signals (e.g., TV transmissions), but does not incur the power and computational overheads of prior wireless approaches. AllSee prototypes can identify gestures on RFID tags and power-harvesting sensors. The hardware can be integrated with a smart phone [9]. This enables gesture control such as volume changes while the phone is in a pocket.

C. Radar Based

Human activity recognition can also be possible using Radar. Much higher bandwidth is associated with this type of the system, e.g., Frequency Modulated Carrier Wave (FMCW) radar can take up to 1.79 GHz bandwidth while WiFi uses only 20 MHz bandwidth usually. The micro-Doppler information can be extracted and about approximately 20 cm higher distance resolution can be obtained using Radar-based systems [10]. However, specific hardware have been required for both the Radar-based and specialized hardware-based systems, while CARM runs on COTS WiFi devices.

D. CSI Based

Recently another recognition system for human activity has been provided by the wireless network (wifi). It is channel state information (CSI) based activity recognition system. In this process CSI values are taken from wifi network interface card to monitor the different human movement activity like presence of person in a particular area, movement in daily living and other home appliances, counting of human number in a crowded area etc. CSI also have the capabilities to detect and monitor a small change in human movement and his gesture position like leap movement, heartbeat etc. The system is very costly and very complex in nature but a greater accuracy level can be obtained.

V. EXPERIMENTAL PROCESSES

We have proposed here a non-adhoc active device free recognition system. For that we have chosen a closed office room surface and place four sensor node in some height towards the ceiling of the room in four corners. These sensors are highly specializing in representing a single facet of the environment at a certain level in detail. We implement our experiment in both RSSI and SDR based device free RF based system [10, 11]. The operating frequency for configured WSN is 2.36 GHz. It use IEEE 802.15.4 WSN standard. The distance between two nodes is kept at an average 6m. So that the sensor can detect some human activities if a human being enter into the room. Four different gestures have been detected by the sensor nodes- walking, crawling, standing, and sitting. All sensors are trans-receiver which can send 100 data packet per second. The sampling rate is 40 Hz.

We examined the variation radio signal both in RSSI and SDR based system. In RSSI, the variation of signal is received by the sensor and we observed the total power of the signal by an indicator called receive signal strength indicator (RSSI) [11]. With the knowledge of node positions and their RSSI level, user's location can be directly inferred. There is a relationship between the reduced signal power, node distance and the transmit power.

Here we emphasize the activities not only the position. Therefore four activities are classified and detected by the receiver. When a person is entering in the room, his position is recognized by the RSSI [12, 13]. We made our experiment in four different sequences of activities conducted by the person.

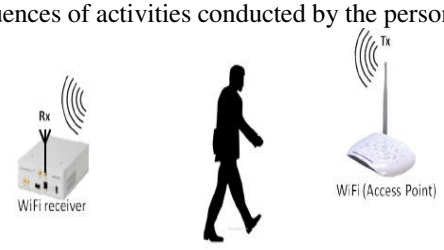


Fig.2. Recognition of human activation in presence of wifi network

Situation 1: In first sequence, the person entering into the room and walking towards the centre of the room and then came back to the entering position and left the room.

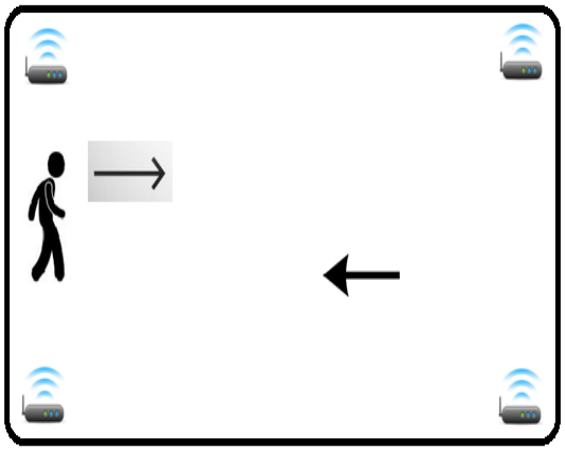


Fig.3. Person entering into the room and walking towards the centre

Situation 2: In the second case the after entering into the room walking up to certain distance then stood for a while and come back. Finally he leaves the room.

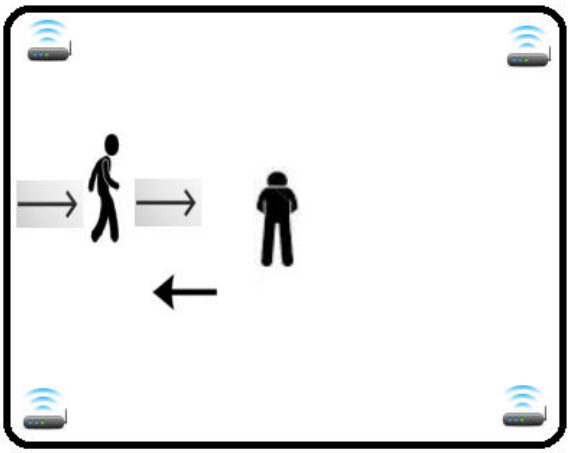


Fig.4. Person entering into the room walking up to centre, stood and come back

Situation 3: In the third case the person after entering walked to the centre. At centre a chair is kept. He sat on the chair for some instance and then stood in front of the chair and finally came back to his entering position.

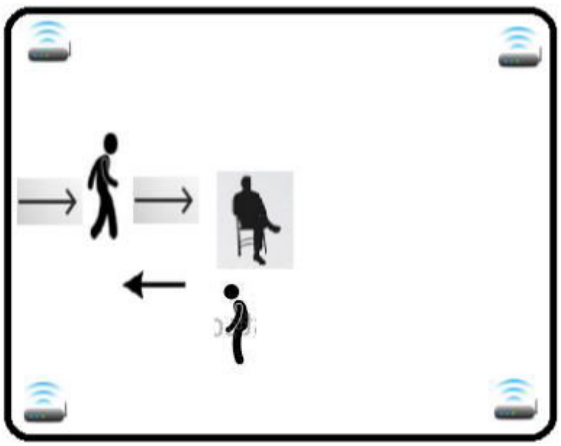


Fig.5. The person after entering walked to the centre, sit and come back

Situation 4: In the fourth sequence the man walking towards the centre of the room and at a point before centre he stopped. The remaining distance he was crawling and reached to centre. He sat on the chair. Again standing up and come back by crawling to the first position and left the room. In each position where the person moved or changed his posture the variation of signal is recorded and shown by RSSI. The signal flowed in all direction in the room as the antenna was Omni-directional.

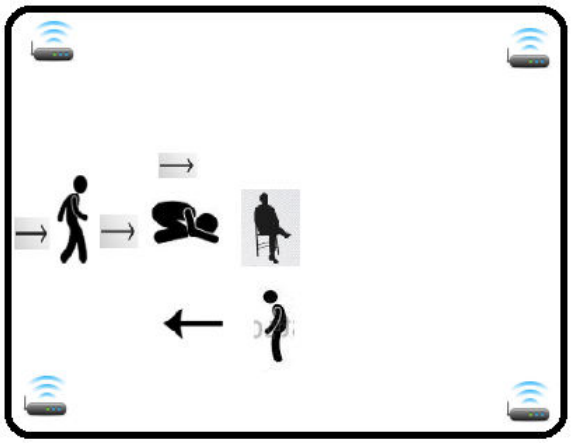


Fig.6. The man walking towards the centre of the room, crawl then sit and finally come back

The case studies were conducted during a period of a period of through a day and the sampled data are continuously collected by the RSSI sensor. For detection the shortest path distance from the object to the sensor is taken and the variation of the signal through this path is observed. As well as the other path of the signal is also considered and the variation is recorded. Then the average value of RSSI is taken as sample data.

VI. RADAR BASED APPROACH

Unlike wireless sensor networks, Radar have been a subject of much interest due to its wide area surveillance. Typically, sensors such as acoustic, seismic, infrared, magnetic, and ultrasonic sensor have been engaged to data transfer [13]. Radar can also be used for such data processing. Ability to operate in all weather conditions and night-time is the added advantage of it. But due to its high power requirements, high cost, and large size it is not much used in these systems. Recently, however, low-cost, COTS radar nodes have been developed so that it can be used as part of a wireless surveillance network [14]. One such example is the BumbleBee Radar which is considered as part of a wireless radar network to monitor the human moving activity within the sensing region of the network. The human micro-Doppler signature measured by the BumbleBee radar is shown for a variety of activities and used as a basis for recognition. Various schemes for fusing sensor data are explored.

In a workshop conducted by the US Army Research Laboratory, it was stated that the sensors with large power supply and communication cannot be used everywhere instead of that simple inexpensive individual devices can be deployed in large number. There is the implication of Radar, possessing important advantages such as being able to operate in all weather conditions and in every time. The BumbleBee Radar is a 5.8 GHz coherent, pulse Doppler radar capable of making measurements at a relative accuracy of about 3 mm for targets lying within a sensing region of 1.5 m to 9.5 m, possessing a radial velocity of 2.6 cm/s to 2.6 m/s, and a maximum Doppler frequency of 100 Hz. Most human motion falls within the operational constraints of the BumbleBee radar. There have been just a few works that have employed using the BumbleBee radars till date. In 2010, the Bumble Bee radar was used to track a non cooperative target based on radial velocity measurements with an Extended Kalman Filter (EKF) by the researchers from Johns Hopkins University [15]. This work was implemented by researchers from Michigan Technological University, who found that the EKF worked well for linear trajectories, but exhibited degraded performance over nonlinear paths. The Bumble Bee, however, is proficient of providing much more target data than just radial velocity, as users are able to directly access the raw data measured by the radar [16]. The micro Doppler signatures of targets were extracted, and it was used as a basis for classification between humans and dogs by the researchers at Ohio State University. In many works Micro-Doppler has been taken as a basis for target identification, with important applications to pedestrian safety using automotive radar networks. In 2010, with a COTS FMCW radar network using human micro-Doppler as a basis, human arm swing was classified by van Dorp and Groen [17, 18]. The purpose of this effort is to examine the application of cheap radar sensors which provide a measure of human micro-Doppler of much poorer quality (lower signal-to-noise ratio, SNR) than conventional military radars, for the purpose of human activity recognition. The micro-Doppler signature for several different human activities (walking, running, and crawling) is presented. Varying the aspect angles relative to the target motion experiment is conducted by using Bumble Bee Radar and then measured data is compared and assessed. Methods for selecting and fusing sensor data for optimal classification performance are discussed here.

A. Technical Specifications

The Bumblebee radar is a battery operated coherent, pulsed Doppler radar for wireless sensor network applications. The central frequency is 5.8GHz while its internal antenna possesses a conical coverage of 60°. Targets with speeds ranging from 2.6 cm/s-2.6 m/s can be detected at a maximum distance of 10 m. The radar provides two outputs as an in-phase signal (I) and quadrature phase signal (Q), which are periodically sent to the Host PC at a frequency of approximately 185Hz. Aside from the center frequency, documentation provides on the BumbleBee radar provides little information parameters of the transmitted chirp signal, such as bandwidth or chirp slope, pulse duration, and pulse repetition frequency (PRF). Thus, the BumbleeBee radar was identified by making measurements of the transmitted waveform using 700 MHz - 18 GHz horn antenna and feeding the received signal to spectrum analyzer. The frequency domain by the spectrum analyzer of the received signal spectrum is that of corresponds to the Fourier transform of pulsed Doppler envelope. Thus, the bandwidth of the LFM waveform was measured to be 240 MHz [19]. Using the pulse analysis module of the spectrum analyzer, the transmitted waveform was measured. From this measurement it was found that the pulse duration was 40ns, while the pulse repetition frequency (PRF) was 2 MHz.

VIII. CONCLUSIONS

The advantage of RSS-based systems is mainly related to the use of data already available at the WSN nodes without any additional hardware. Indeed, the RSS indicator is available at the physical layer of the node structure and it is not directly concerned with the “quality” of the signal, but to the received power It is a number of 8 or 10 bits depending on the hardware of the WSN node and directly related to the accuracy of the tracking system. A comparison of variation of used signal frequency with further accuracy for detecting the human movement, particularly the activity of senior citizens, will be reported in due course.

Acknowledgment

We are thankful to the authority of Techno India University, West Bengal for providing research facilities.

References

[1] M. Beigl, H.W. Gellersen, and A. Schmidt., (2001) "Experience with design and use of computer-augmented everyday artefacts"; *Computer Networks*, 35(4):401–409.

[2] S.W. Lee, and K. Mase, (2002) "Activity and location recognition using wearable sensors."; IEEE Pervasive Computing, 1:24–32.

[3] G. Ogris, M. Kreil, and Paul Lukowicz, "Using fsr based muscule activity monitoring to recognize manipulative arm gestures."; In ISWC '07: Proceedings of the 2007 11th IEEE International Symposium on Wearable Computers, pages 1–4, Washington, DC, USA, 2007. IEEE Computer Society.

[4] D. Gordon, H. Schmittke and M. Beigl, "Introducing New Sensors for Activity RecognitionDistributed and Ubiquitous Systems"

[5] S. Sigg, M. Beigl and B. Banitalebi, (2011) "Efficient adaptive communication from resource restricted transmitters, In Organic Computing - A Paradigm Shift for Complex Systems"; Christian Mueller-Schloer and Hartmut Schmeck and and Theo Ungerer, Springer.

[6] M. Reschke, J. Starosta, S. Schwarzl and S. Sigg, (2011) "Situation awareness based on channel measurements"; 2011 73rd IEEE Vehicular Technology Conference (VTC Spring), pp.1-5, 15-18 May.

[7] F. Viani, P. Rocca, G. Oliveri, D. Trinchero, and A. Massa, (2011) "Localization, tracking, and imaging of targets in wireless sensor networks: An invited review.", 10 September.

[8] F. Li , Md. A. A. Al-qaness , Yong Zhang , Bihai Zhao1and Xidao Luan, (2016) "A Robust and Device-Free System for the Recognition and Classification of Elderly Activities"; Academic Editors: Mianxiong Dong, Zhi Liu, Anfeng Liu and Didier El Baz, 1 December

[9] S. Sigg, S. Shi, Y. Ji, (2013) "RF-Based Device-Free Recognition of Simultaneously Conducted Activities."; UbiComp'13 Adjunct, September 8–12, Zurich, Switzerland.ACM 978-1-4503-2215-7/13/09.

[10] M. A. Youssef and A. Agrawala, (2005) "The Horus WLAN Location Deter-mination System."; in Communication Networks and Distributed Systems Modeling and Simulation Conference, , pp. 205–218.

[11] M. Moussa and M. Youssef, (2009) "Smart Devices for Smart Environments: Device-free Passive Detection in Real Environments."; in The IEEE International Workshop on Intell. Pervasive Devices (PerDev09).

[12] R. R. Bouckaert and E. Frank, (2004) "Evaluating the Replicability of Signifi-cance Tests for ComparingLearning Algorithms," in PAKDD. Springer, pp. 3–12.

[13] Md. A. A. Al-qaness , F. Li , X. Ma, Y. Zhang and G. Liu, (2016) "Device-Free Indoor Activity Recognition System."; Academic Editors: Plamen Angelov and José Antonio Iglesias Martínez, 1 November

[14] J. Wilson, N. Patwari, "Radio Tomographic Imaging with Wireless Networks.", IEEE Transactions on Mobile Computing. 2009;9 (5):621–632.

[15] K. Woyach, D. Puccinelli, M. Haenggi, "Sensorless Sensing in Wireless Networks: Implementation and Measurements.", 4th IEEE International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks. 2006:1–8.

[16] M. Youssef, M. Mah, A. Agrawala, (2007) "Challenges: Device-free Passive Localization for Wireless Environments.", Proceedings of 13th ACM International Conference on Mobile Computing and Networking;. pp. 222–229.

[17] X. Chen, A. Edelstein, Y. Li, M. Coates, M. Rabbat, A. Men, (2011) "Sequential Monte Carlo for Simultaneous Passive Device-Free Tracking and Sensor Localization Using Received Signal Strength Measurements", 10th IEEE International Conference on Information Processing in Sensor Networks (IPSN); pp. 342–353.

[18] O. Kaltiokallio, M. Bocca, N. Patwari, (2012) "Long-Term Device-Free Localization for Residential Monitoring.", 37th IEEE International Workshop on Practical Issues in Building Sensor Network Applications, 991–998.

[19] W. Wei, A. X. Liu, Md. Shahzad, K. Ling, S. Lu, "Device-Free Human Activity Recognition Using Commercial WiFi Devices.", IEEE Journal on Selected Areas in Communications (Volume: 35, Issue: 5, May 2017), Page(s): 1118 - 1131, 09 March 2017 ,Print ISSN: 0733-8716, INSPEC Accession Number: 16899027, DOI: 10.1109/JSAC.2017.2679658.

Sustainable Livelihoods - Educational Interventions

Maumita Sengupta
CASD, School of Management
Techno Indian University, West Bengal
Kolkata 700090, India
maumitasengupta@outlook.com

Abstract - **Livelihood is the one element that is absolutely essential for the survival and propagation of the human civilization. There are physical, intellectual, psychological and emotional connotations to livelihood, the arrangement of livelihoods and activities on an over-populated planet also leading to many problems in the very environment which is being shared by all living beings on earth. Thus arises the concept of Sustainable Livelihoods, which can withstand and recover from stresses and shocks, can maintain or enhance a household's assets while not undermining the natural resource base, and the move for education has to be towards the development of KBS (Knowledge Based Societies) if we are to address ALP (Alternative Livelihood Projects), an inclination towards better socio-ecological occupations. The boundaries that highly formalised education systems place on teachers and students, undermine instinct, talent, interests as well as applicability. The future through KBS is towards breaking down of the barriers that so-called formal education places in society, and educating for life-support systems in society. Information can no longer be considered synonymous with knowledge, as technology ensures it's free and reasonably fair availability.**

Keywords - Sustainable Livelihoods; KBS (Knowledge Based Societies); ALP (Alternative Livelihood Projects); life-support systems

I. INTRODUCTION

Livelihood is the one element that is absolutely essential for the survival and propagation of the human civilization. There are physical, intellectual, psychological and emotional connotations to livelihood, as it is intimately associated with the well-being, health, self-esteem, interest, satisfaction and cohesiveness of individuals, families and communities. In the present day and age, there are concerns that the arrangement of livelihoods and activities on an over-populated planet is leading to many problems in the very environment which is being shared by all living beings on earth. Thus arises the concept of Sustainable Livelihood, which can be defined as "a form of human occupation which can withstand and recover from stresses and shocks, and can maintain or enhance a household's assets while not undermining the natural resource base". Sustainable livelihoods are not threatened by, but complement technological changes. The problem happens when the population in general, is expected to make livelihood choices according to these parameters. The perspective here is, not just ecological, but socio-ecological. Livelihood choices are made on the basis of certain factors such as

- ✓ Perceiving an optimal balance between material gains and risk - safety and security are two aspects which have to be looked at by every human being in living their lives and what they want or do not want to do. Also, the general psyche of the community and the way they go about their day-to-day tasks has a bearing on whether a high risk high gain attitude is preferred or not.
- ✓ Varying attitudes to risk - myriad personality traits have many different ways of visualising risk and fear. Some activities can be deemed risky by some and fun, adventure or a normal course of things by others. Habit, familiarity, training (all aspects of informal education) all have a major impact on what is considered risky or dangerous by whom.
- ✓ Interest, enjoyment and finding meaning in tasks - this, probably, is or should be the most important consideration in the choice of livelihoods. It is impossible for the human, in their very long span of life, to go on doing something they really don't want to do.
- ✓ Social mores and conditioning - social conditioning has a major role to play in how any human being runs his/her life, as his aspirations, comfort and emotional security is

developed in the socio-cultural milieu that one grows up in. All humans have a major need for acceptance and support of their family, peers etc. and livelihood choices of individuals and communities are determined by how well they will be accepted by people around them.

- ✓ Geo-political considerations - geographical location and relief of the area where people stay, particularly for a long time, play a major part in the decisions of the various occupations that are taken up by them. Climatic conditions, soil types, availability of water, availability of land, language, culture etc. are all major determinants of livelihood choices and execution.

II. EXPLAINING THE CONCEPT OF LIVELIHOODS

Now where does education feature in this scenario? In one simple word: everywhere. All these five factors are essentially influenced by the educational trends and facilities in any particular society, thus linking education integrally with the socio-ecological concerns that we all are facing. The move for education has to be towards the development of KBS (Knowledge Based Societies) if we are to address ALP (Alternative Livelihood Projects) interventions, that is to say, an inclination towards better socio-ecological occupations by a significant reduction of activities deemed to be environmentally damaging. When we talk about ALP, we have to let go of the flawed assumption that one livelihood can easily be substituted by another, as need be socio-ecologically. But reality is not so simple. A livelihood can only be viable for an individual and a community if it is

- ✓ Effective - an effective livelihood is one that provides the right fit for the right individual in a community, taking into account personalities, multiple intelligences, specific strengths of specific communities, special abilities, talents and interests. In fact, the freedom to choose livelihoods and education without compulsions or prejudices is a major component for sustainable livelihoods.
- ✓ Efficient - efficiency of a livelihood pertains to it being adequate for providing for the needs of the individuals and the communities they belong to. These needs and the ways of fulfilling them differ according to regions and cultures.
- ✓ Lower or at least comparable risk involvement - human beings need physical and emotional security for their survival. We have discussed earlier that threat analysis of risks do vary from individual to individual, but a certain sense of safety and self-preservation is essential for humans in any sort of occupation that they are in. In fact, most people have a low threshold for accepting higher risks when it comes to livelihoods, as it not only impacts themselves but also their families, making the threat perception much higher.
- ✓ Pertains to real, locally defined needs - Livelihoods in any community or place develop taking into account various socio-cultural and geopolitical considerations. The history, geography, sociology, climate, fauna, flora, natural resources all have a bearing in the kind of livelihood choices people anywhere in the world will and should make.
- ✓ Leads to positive social outcomes - this is probably the most important consideration when it comes to livelihood determination in societies and communities. Livelihoods have to create a better ambience for the entire community, not just for certain individuals. A better ambience indicates not just better incomes, but better lifestyles in toto, including food, water, air, health, education, infrastructure, leisure and well-being.

Livelihoods have recently been defined by UNDP in terms of a development goal, subsuming but most certainly, not limited to employment. They state that "livelihoods, essentially are activities, means and entitlements by which, individuals make a living. Sustainable livelihoods, are defined as human goals; are derived from peoples' capacities to exercise choice, and to access opportunities and resources, and use them for their livelihoods in ways that do not foreclose options for others to make a living, either now, or on the future". According to the Oxfam Handbook of Development and Relief, (1995), sustainable livelihoods is described as taking a systems approach, "looking for impacts on social and gender equity, patterns of resource use, the creation of opportunities that do not involve cost shifting to the environment and that make peoples' lives better without impoverishing others or the next generation. Another relevant term that one comes across here is livelihood systems, which have been defined as "sets of economic, social and physical elements and interrelationships which form the basis of livelihood decisions".

Herein lies the dilemma of the oft abused term sustainable livelihood to mean sustainable economic growth. This over insistence on the financial or market oriented connotation of livelihoods or the Western mathematical model has created a problem, because replacing labour with energy, derived from cheap fossil fuels is one of the primary engines of economic growth. Thus, we tend to ignore the [5] anthropological contexts of

livelihoods, wherein one can see that the central processes of making a livelihood are culturally modelled. It is this synergy of different institutional arrangements (kinship, political,magico-religious as well as market) which is at the core of any understanding that we need to have about sustainable livelihoods, as well as the educational preparations needed so that populations move towards such livelihood options. Moreover, sustainable livelihoods are essentially subsumed in the larger concept of a sustainable, healthy community with a web of symbiotic relationships, among humans and between man and nature.

III. EDUCATION FOR SUSTAINABLE LIVELIHOODS

Many educators chafe at the boundaries that highly formalised education systems place on them and their students, somehow undermining instinct, talent, interests as well as applicability. The acknowledgement of the future being that of a KBS is actually the first step towards breaking down of the barriers that so-called formal education places in society. Information, after all can no longer be considered synonymous with knowledge, as technology ensures it's free and reasonably fair availability. Education needs creation of a climate in which students come naturally to link their intuitive ways of knowing, [4] with scholastic and academic forms of knowing. Knowledge, in all it's forms (academic, vocational, traditional, environmental, interpersonal) needs to be encouraged to drive humanity ahead.

Any member of society, at any age can be taught reflectively for the encouragement of critical analysis and synthesis of ideas that contribute to the following life-support systems (LSS):

- ✓ Economic development - as has been pointed out earlier, a narrow numbers based concept of economy is not the answer for livelihoods any longer. With rapid changes in the society and environment due to huge population growth and automation, the ecological cost and footprint of economic activities need to be clarified to students at every stage of their education. Changes in consumption patterns, focus of occupational ventures that lead to the preservation, conservation and restoration of the already stretched survival resources [9] is the educational need of the hour. The balance of the anthropocentric and eco-centric value of a resource is to be constantly addressed in all economic activities, and the training to do so has to become part and parcel of education at every level.

  In fact, by the mid-1990s, it became clear, that the moral or aesthetic approach towards natural resource management is not going to work very effectively, and there has been a lot of disenchantment amongst social planners. Then has come the "New Conservation Paradigm" which essentially talks about stressing on the economic value of nature. For example, the economic value of a rainforest in providing sustainable livelihoods is much more if it stands in terms of availability of flora and fauna, ecotourism, prevention of natural disasters, adequate rainfall rather than the one-time benefit of cutting it for timber. Education, if focussing on these aspects, not only through a subject lens, but letting students discover these meanings proactively, will actually lead to behavioural pattern and attitude changes.

- ✓ Social cohesion - A main focus area of sustainability is a more equitable distribution of resources amongst the world population, within the carrying capacity of the environment. This is what creates a society that thinks about their fellow-beings just in humanitarian terms, and not in terms of blue-collar or white-collar workers, status in numerical or materialistic terms. This can only be rendered by education supported by survival and symbiotic skills of choice and ability, not on the price tag of degrees and jobs. The dialogical ethic in education, leads to an enrichment of ideas, for people from all walks of society.

- ✓ Care for resources, biodiversity and the earth ecosystem so as to meet the need of the present without compromising the ability of future generations to meet their needs - this, essentially is the crux of the matter pertaining to sustainable livelihoods and thus, this is where the educational thrust needs to be the maximum. One can say that this is nothing new, we are trying to inculcate the appreciation of resources in children with the help of environmental education. But can appreciation really be developed by teaching a text-book oriented form of the subject where students just memorize a few concepts, give an examination and move on?

  The answer is a resounding no. Education for sustainable environment and by that corollary, sustainable livelihoods needs to be life oriented, practice driven and application focused. The questions that need to be answered through education is not what is wrong, but what can be done by us in our everyday lives and in our professions to make it right, and how to go about doing it.

The best way is to integrate traditional ecological knowledge and modern science in a practical application orientation. A good example is the [1] Satoyama and Satoumi landscaping experiments of Japan, the awareness and activities beginning at the school level and continuing as a part of day to day living in many areas of the country. These are essentially land and water body planning concepts forming dynamic mosaics of managed socio-ecological systems (secondary forests, farmlands, grasslands, irrigation ponds, coastal fisheries along with dense human settlements) producing a bundle of ecosystem services for sustainable living. Education focusing on such initiatives can create citizenry capable of countering eco-environmental threats and also encourage livelihoods which can be beneficial to mankind irrespective of age and technology.

- ✓ Employment and employability - educating for 'jobs', today, is increasingly challenged by the need to build human capacity not only for earning their 'bread and butter', but for broader lifelong learning as well as for adapting and 'coping' livelihood strategies in a fast moving and complicated world. The problem is this completely blind belief that the global economy, based on free markets, economic competition and international trade is the manna from heaven when it comes to employment, or the more or less democratic political institutions have the onus for cushy, comfortable elite tertiary employment. But all these, and the golden dream of greater prosperity attached with them come with a big tag of being wholly reliant on the burning of cheap fossil fuels and fulfilling of services that can be easily taken over by machines.

  So how can we educate for Competency Based Education (CBE), or skill development that requires predominantly human qualities, sensory inputs, judgement and aesthetics? The answer is to create changes in curricula, teaching learning activities, environments and evaluation so that the insistence on rote memorisation, paper-pencil testing and numerical marking is reduced. Education can consist of internships and learning on the job, leading to experiences beneficial for contributing to society instead of just earning a certain salary. Lots of Kolkata based entrepreneurs are providing such in-service education, a worthy example being Naman Ajitsaria from Noodle Story, teaching all employees not only people skills, but to become chefs in their own right, and stepping up instead of just hanging in.

- ✓ Healthcare - in the last 5 decades or so, medical science has grown by leaps and bounds. There are many positives associated with this phase, the negatives too cannot be ignored. Longevity has definitely gone up, so have lifestyle diseases such as diebetes, heart disease and orthopaedic problems; disorders specifically related to environmental degradation such as COPD, allergies, gastroenteric problems; and another tip of the iceberg i.e drug resistant pathogens. Education has to play a major part if the human race has to create the healthier self for itself.

  Popping pills seems to be as much a part of pop-culture as disco music and denims, particularly among the younger generation. Educational curricula need to stress that there are no easy roads to good health and being healthy does not mean submitting to a western ideal of the human corporeal form. The importance of exercise and yoga for physical well-being and mental agility, medicinal qualities of natural produce and the ill-effects of indiscriminate medication will have to be emphasised through education, not through prescriptive text but through experimentation, discovery and a facilitating approach. [8] The impact on sustainable livelihoods is great, because these indigenous medicinal forms provide employment in a world striving to save and create a better environment.

- ✓ Family welfare practices - as has been emphasised time and again, overpopulation can pose huge risk to sustainability of health, environment and livelihoods, and also emphasised is the point that a prescriptive family planning regime for India, at least, is doomed to fail. The only voice that will reach the people is of education, which on one hand,

  - ➢ will encourage better care, nutrition and progressive rearing and educational practices for both girl and boy children
  - ➢ will also provide livelihoods, independence and self-esteem for the mothers through a more professional approach to handicrafts, handlooms using natural ingredients, dyes, fabrics, yarn, food materials sans chemical preservatives etc.

  In fact, this is where the role of extensive educational interventions needs to be reiterated again and again. The potential of education in creating personal wealth and well-being in a sustainable environment is truly immense. And this is where the failure has been great, because the current educational model has been geared towards very limited skill oriented traditional

tertiary jobs leading to lopsided demographic movement creating ill-equipped overcrowded urban spaces, unsustainable in terms of resources and health.

- ✓ National and International citizenship - somewhere we have to start with the conviction that education is to facilitate the building of communities. Sustainable livelihoods are possible if and only if a community pertains to mutual support and symbiotic activities, wherein adequate care is taken to handle the environment as mankind should, delicately. And it's easier than it sounds. After all, the traditions of self-restraint, sharing and avoidance of 'waste' have characterised people about a generation back. Suddenly, in a span of two decades, the idea of ostentatiousness has gained hold, rampant urbanisation and the resulting centralisation of employment and health services push people towards more air travel, car ownership, central heating and cooling, even in the pursuit of the so-called 'best' educational services, which further leads to huge prominence being given to rational pursuit of economic self-interest.

  According to [2] Chris Goodall, "voluntary self-restraint may be the most important way for responsible individuals to create communities in a sustainable environment, where education has to try to break the fallacy of an economic system that proposes that greater and greater happiness will follow every increase in our personal incomes and spending".

- ✓ Consumer consciousness - the importance of awareness generation for using products that are environment friendly, buying local produce to cut down transportation costs, creating local produce which in the long run, can lead to choice of sustainable livelihoods, cannot be emphasised enough. The main thrust in this area can be made in education, concepts such as fair trade, environment-friendly lifestyle patterns, interventions such as resource harvesting becoming part and parcel of the educational curricula right from the primary stage. The Scandinavian countries, in fact, have done away with traditional book-based curricula and moved on to a problem sensitisation approach where students learn by discussion and research from the experiences they have in their daily activities and environment.

- ✓ Good governance and individual safety - good governance, in the present parlance, means minimum governance, and as stated before, educational thrust has to be to encourage livelihood in entrepreneurship, skill development and citizen and community efforts. Semi-skilled pencil pushing comfortable government sponsored tertiary jobs are a drain on resources, leading to they being replaced by machines and also become an issue for environmental sustainability. Unemployment generated this way can become the cause of youth unrest and diminishing of personal safety for individuals as well as communities. The sooner education understands this dilemma and remoulds itself to present day socio-economic-environmental requirements, the better, or we may heading for major social crisis, and students need to be trained in self-defense techniques as well as employable skills to subvert and cope with this crisis.

- ✓ Strong value orientations inculcating positivity and optimism - ethics are what make for advanced human civilisations, be it justice, care or the adherence to truth, and who better than a teacher to promote and reflect these ideals? And that is the reason why, teacher education for a qualitative rather than a quantitative approach to education is the need of the hour, which will lead to better adaptation and sustenance of students in a constantly emerging livelihood scenario. Teachers have to become part and parcel of [3] PLCs (Professional Learning Communities) for a collaborative, enquiry based approach to learning, for both teachers and pupils, wherein constant action research and critical reflection on findings, and sharing those ideas become important tools to bringing about change in education.

  There can be no better description than this quote by Azim Premji,

  "the progress of India will be determined by the capacity and motivation of the frontline in all fields of human development, teachers being the forerunners there. Human capacity in the frontline supported by an empowering culture is the crux of making our country more just, equitable humane and sustainable."

IV. THE ROLE OF THE ORIENT

There needs to be sizeable exchange of cultural knowledge and ideas through education between the oriental cultures, as they have a very rich heritage, and the world, reeling under the ill effects of rampant westernisation or [6] cultural homogenisation (which has suppressed local preferences in providing goods, media and education whose content has been dictated by foreign entities), needs an alternative viewpoint, philosophy and way of life for sustainable livelihoods.

This cultural homogenisation in the name of technological advancement definitely has it's merits, but it is also gradually leading to a reduction in cultural diversity, through the popularisation and diffusion of a wide array of cultural symbols, mainly customs, ideas and values, where local cultures are completely subsumed by a dominant, pervasive influence. Older cultures are more vulnerable, but they also have the richness and resilience to make this a two-way process i.e. to influence and transform the dominant culture in many ways. The west has actually already started to sit up and take notice of us, as the Indians and other oriental cultures are most successfully bridging the gap between the traditional and the modern world, keeping the values of both intact, making the negatives a part of the learning curve (Yin and Yang) and benefitting from both.

What can be achieved by the strengthening of the educational and cultural exchange systems between the countries of the Orient is a process of reverse cultural homogenisation. How can that be brought about? Glocalisation (a portmanteau of globalisation and localisation) is the adaptation of international products around the particularities of a local culture in which they are sold. [7] The term first appeared in a late 1980s publication of the Harvard Business Review. At a 1997 conference on "Globalisation and Indigenous culture," sociologist Roland Robertson, said that glocalisation "means the simultaneity – the co-presence – of both universalising and particularising tendencies."

Interestingly, the concept comes from yet another powerful Asian culture. It is derived from the Japanese word dochakuka, which means global localisation. It originally referred to the adaptation of general farming techniques to local conditions of weather, soil, availability of labour etc. In the present context of sustainable employment, glocalisation could on the one hand mean, more fusion, mixing and matching of distinctive aspects of Asian cultures to create a stronger and enlightened hybrid leading to a better existence for the human and his environment. On the other hand, it would mean designing alternative education systems highlighting dynamic livelihood trajectories, stepping up and out of traditional stereotypes to learn and earn while making it possible to do so for the coming generations.

References

[1] Nakamura, D. Watanabe, T. Nishi ED. (2012). Satoyama Satoumi Ecosystems and Human Well-Being: Socio-Ecological Production Landscapes in Japan. United Nations University Press.

[2] Goodall, C. (2007). how to live a low-carbon life, Earthscan, London.

[3] Forde, M. and Martin (2011). Contemporary issues in learning and teaching. Sage, London.

[4] Scottish Executive Education Department (SEED) (2002) Determined to Succeed: A review of Enterprise in Education. Edinburgh, the stationary office.

[5] Wiener MJ. (2004). English Culture and the Decline of the Industrial Spirit. Cambridge University Press.

[6] Sengupta, M. (2016). Indo-China, The cultural Terra-firm of the World. paper read at International Management Instiute.

[7] Shamsuddoha M. (2008). Globalisation to Glocalisation: A conceptual analysis. University of Chittagong.

[8] Young Jacqueline "Eastern Healing" Duncan Baird (2001).

[9] Weiler and Hall (ed.). (1992). Special Interest Tourism, Belhaven Press.

Concentrated Solar Power as Renewable Energy and Perception of Risks

Chayan Dey
Techno India University
West Bengal, Kolkata 700091, India
chayan_dey@rediffmail.com

Asit Baran Bhattacharya
Techno India University
West Bengal, Kolkata 700091, India
bhattacharyaasitbaran@gmail.com

Gautam Sengupta
Vice chancellor,
Techno India University
West Bengal, Kolkata 700091, India
vicechancellor.tiu@gmail.com

Abstract — ***Beginning with the surge in coal use which accompanied the industrial revolution, energy consumption has steadily transitioned from wood and biomass to fossil fuels .The early development of solar technologies starting in the 1860s was driven by an expectation that coal would soon become scarce. However, development of solar technologies stagnated in the early 20th century in the face of the increasing availability, economy, and utility of coal and petroleum. Solar concentrating technologies such as parabolic dish, trough and Scheffler reflectors can provide process heat for commercial and industrial applications. The main concern about both types of solar power generation – photo voltaic and concentrated solar power – is that they can potentially cause the displacement or exclusion from important habitats of nationally and/or globally threatened, rare, endemic or range-restricted bird species. Other potential risks include collision with the reflective surfaces. All these factors have been duly emphasized in the paper with suggested remedies of the probable environmental hazards.***

Keywords — ***Photo voltaic, Concentrated Solar Power, energy consumption, solar technologies, Scheffler Reflectors***

I. Introduction

The problem of bird deaths at solar power farms is a complex one. Some solar developers have been powering down bright lights that had attracted insects at night, or switching to LEDs, and using nets to keep birds at bay. But that apparently is not enough. "The diversity of birds dying at these solar facilities, and the differences among sites, suggest that there is no simple 'fix' to reduce avian mortality," the federal report states [1]. The report recommends improving bird- and bat-death monitoring through the use of sniffer dogs, video cameras, and daily surveys. It also lists recommendations for directly reducing avian mortality. Those recommendations include clearing vegetation around solar towers to make the area less attractive to birds, retrofitting panels and mirrors with designs that help birds realize the solar arrays are not water, suspending operations at key migration times, and preventing birds and bats from roosting and perching at the facilities. The recommendations are being considered by regulators. The Center for Biological Diversity supports those proposed measures. It also suggests restoring bird habitat elsewhere to draw birds away from the solar facilities, which could help the rails and other species recover. And it wants the government to undertake new scientific research -- research that could offer clues for better protecting birds from solar power farms. The first commercial system was the Solar Total Energy Project (STEP) in Shenandoah, Georgia, USA where a field of 114 parabolic dishes provided 50% of the process heating, air conditioning and electrical requirements for a clothing factory. This grid-connected cogeneration system provided 400 kW of electricity plus thermal energy in the form of 401 kW steam and 468 kW chilled water, and had a one-hour peak load thermal storage. Evaporation ponds are shallow pools that concentrate dissolved solids through evaporation. The use of evaporation ponds to obtain salt from seawater is one of the oldest applications of solar energy. Modern uses include concentrating brine solutions used in leach mining

and removing dissolved solids from waste streams. In some states of the United States legislation protects the "right to dry" clothes. Unglazed transpired collectors (UTC) are perforated sun-facing walls used for preheating ventilation air. UTCs can raise the incoming air temperature up to 22 °C and deliver outlet temperatures of 45–60 °C. The short payback period of transpired collectors (3 to 12 years) makes them a more cost-effective alternative than glazed collection systems [2]. As of 2003, over 80 systems with a combined collector area of 35,000 square meters had been installed worldwide, including an 860 m^2 collector in Costa Rica used for drying coffee beans and a 1,300 m^2 collector in Coimbatore, India, used for drying marigolds.

II. CSP Projects and the Technology involved

Working with member countries, Solar Power and Chemical Energy Systems (Solar PACES) has compiled data on concentrating solar power (CSP) projects around the world that have plants that are either operational, under construction, or under development. CSP technologies include parabolic trough, linear Fresnel reflector, power tower, and dish/engine systems. The National Renewable Energy Laboratory's CSP Program assists Solar PACES in maintaining the projects database behind this Web site. Project operators or developers supply information for the key data fields for their projects. Solar PACES experts then review the information to ensure accuracy and completeness. Solar PACES, an international program of the International Energy Agency, furthers collaborative development, testing and marketing of concentrating solar power plants. Activities include testing large-scale systems and developing advanced technologies, components, instrumentation, and analysis techniques. Concentrating solar power (CSP) technology may be categorized as: (a) Parabolic Trough Systems—line-focus systems that use curved mirrors to focus sunlight on a receiver, (b) Linear Fresnel Reflector Systems—line-focus systems that use relaxed and flat mirrors arranged to focus sunlight on a receiver, (c) Power Tower Systems—point-focus systems that use heliostats to focus sunlight on a tower-mounted receiver, (d) Dish/Engine Systems—point-focus systems that use curved mirrors to focus sunlight on a receiver. Solar Photovoltaic (PV) electricity generation converts solar radiation directly into electricity through a solar panel. PV Solar Farm consists of an area covered by photovoltaic panels. PV uses semi-conductor materials to convert sunlight directly into electricity. PV panels can be fixed or track the sun in one or two axes. Concentrated Solar Power (CSP) farms (plants), on the other hand, consists of a series of mirrors/heliostats/trough panels that reflect sunlight. CSP farms consist of a series of heliostats/trough panels with mirrors which concentrate sunlight on a receiver tower (although some CSP farms are developed without receiver towers). CSP farms potentially have greater impacts on birds than PV farms because of the associated central receiver tower, standby focal points and heliostats. It operates by concentrating the suns energy to produce heat which either drives a steam turbine or an external heat engine to produce electricity. A liquid [known as heat transfer fluid (HTF) which usually consists of a mix of oils] or a gas medium is heated and this is used to convert water to steam, which is used to generate electricity through a steam turbine generator. The reflected heat is mostly concentrated onto a central receiver tower and standby focal points (although other technology within CSP exists). The heat is used to raise steam to drive turbines and generators. Linear concentrators are curved panels that reflect and focus the sun's rays onto a tube that runs the length of the panel. The tube contains a fluid that heats up creating steam which is used to drive a turbine. The two main configurations are the parabolic trough type, where the tube runs along the focal line, and the linear Fresnel type, which uses Fresnel lenses to collimate the reflected beam such that one receiver tube can be positioned over several mirrors. This type provides greater mobility in tracking the sun and is also less expensive. A typical arrangement of photovoltaic panels is shown in Figure 1. Figure 2 (a), on the other hand reveals Concentrated Solar Power (CSP) facility. The Parabolic troughs are used to concentrate sunlight on the central receiver tower. Figure 2(b) shows a schematic presentation of CSP technology and the layout of a CSP facility. CSP operates by concentrating the Sun's energy to produce heat which either drives a steam turbine or an external heat engine to produce electricity. The heat transfer fluid (HTF) medium is then cooled, condensed and reused [3].

Fig.1. Photo-voltaic (PV) solar farm showing typical arrangement of photovoltaic panels .
Credit Alamy stock photo

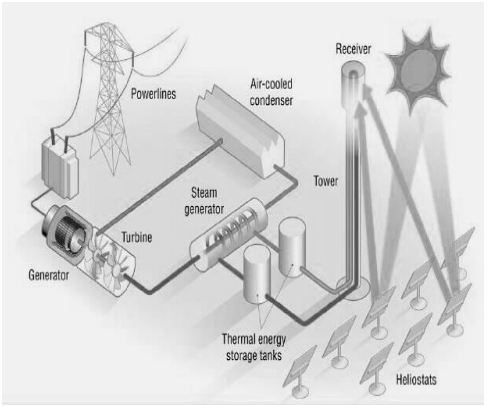


Fig. 2 Concentrated Solar Power (CSP) Facility - Parabolic troughs concentrating sunlight on the central receiver tower with schematic presentation of CSP technology and the layout of a CSP Facility. CSP operates by concentrating the sun's energy to produce heat which either drives a steam turbine or an external heat engine to produce electricity. The heated liquid (HTF) or gas medium is then cooled, condensed and reused, Credits.solar energy org.edu

A. Schffler Reflectors

Scheffler reflector is a solar device for the concentration of solar light that allows, amongst other applications, to cook with solar energy. The aim that led to the development of the Scheffler reflector was to make solar cooking more comfortable. With this idea, the German physician Wolfgang Scheffler designed a solar cooker that allowed the cooking focus to be still while the sun kept its apparent path in the sky, and that had a structure that would allow cooking from inside of the building. After passing the opening the light is redirected by a small reflector (secondary reflector) to the black bottom of the cooking pot. There it is absorbed and transformed into heat. The efficiency for cooking, i.e. heating water from 25°C to 100°C, can reach up to 57% and depends on the cleanliness of the reflector-surface and the state of insulation of the cooking-pot. At the focal-point itself we have measured optical efficiency of up to 75% (with 2mm ordinary glass mirrors). Depending on the season an elliptical reflector of 2,8m x 3.8m (standard size of 8m² Scheffler-Reflector) collects the sunlight of a 4,3m² to 6,4m² area, measured perpendicular to the direction of the incident light (aperture). That way the cooking power varies with the season. As an average a 8m² Reflector can bring 22 liters of cold water to boiling temperature within one hour (with 700W/m² of direct solar radiation) [4].

Fig.3 A Scheffler reflector being used as a solar cooker to cook food by concentrating the sunlight. Credit Alamy stock Photo

The output of a reflector with a surface of 10 square meters varies depending on the season of the year between 2.2 kW during summer and 3.3 kW during winter, assuming solar radiation of 700 watts per square meter. At our latitudes, the power (energy per unit time) of the Scheffler mirror is higher in winter than in summer as the area of the mirror is used more effectively when the sun is lower in the sky. The total energy received during a day is however still greater during summer as there are more hours of sunshine. [5]

III. GREEN JOB HAZARDS: SOLAR ENERGY

Solar is a growing sector for green energy and green jobs. Various worker health and safety hazards exist in the manufacture, installation, and maintenance of solar energy. Employers working in the solar energy business need to protect their workers from workplace hazards and workers need to understand how to protect themselves from hazards. Two commercially viable solar energy sectors are

solar electric and solar thermal or solar water heating [6].

A. Solar Electric

Solar energy can be converted into electricity using photovoltaics (PV), or concentrating solar power (CSP). PV systems are the most common and use semi-conductors and sunlight to make electricity. The more solar modules a PV system or array has, the more electricity will be generated. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, microcrystalline silicon, cadmium telluride, and copper indium selenide/sulfide and many more [7].

B. Solar Thermal or Solar Water Heaters

Types of solar water heating systems include direct and indirect (Glycol) systems and are chosen largely by climate; freezing temperatures can damage some types [8].

IV. Hazards and Controls

Workers in the solar energy industry are potentially exposed to a variety of serious hazards, such as arc flashes (which include arc flash burn and blast hazards), electric shock, falls, and thermal burn hazards that can cause injury and death. Solar energy employers (connecting to grid) are covered by the *Electric power generation, transmission, and distribution* standards and therefore may be required to implement the safe work practices and worker training requirements of OSHA's Electric Power Generation, Transmission and Distribution Standard, 29 CFR 1910.269. While solar energy is a growing industry, the hazards are not unique and OSHA has many standards that cover them. This page provides information about some hazards that workers in the solar industry may face. Workers, who install and/or maintain solar panels often work on roofs, use ladders and scaffolding, are in proximity of ledges and sunroofs, and are exposed to fall hazards. As more solar panels are installed on the surface of a roof, the walking area which may once have been available may no longer be available to workers. This may force workers to squeeze by or walk very close to skylights and/or roof hatches. To protect workers from these potential fall hazards through skylights, roof edges and roof hatches, employers must make sure that skylights are guarded or that workers near skylights use personal fall protection. Solar energy equipment can generate electrical energy and may be connected to electrical circuits. Workers may be exposed to electrical hazards from solar panels and from electrical circuits. While installing or servicing solar panels, employers should assure that workers cover the solar panels, in addition to protecting workers from electrical circuits. Workers performing servicing or maintenance of solar panels may be exposed to injuries from the unexpected energization or release of stored energy in the equipment [9].

V. COMMERCIAL DEPLOYMENT OF CSP AROUND THE WORLD

The commercial deployment of CSP plants started by 1984 in the US with the SEGS plants. The last SEGS plant was completed in 1990. From 1991 to 2005 no CSP plants were built anywhere in the world. Global installed CSP-capacity has increased nearly tenfold since 2004 and grew at an average of 50 percent per year during the last five years. In 2013, worldwide installed capacity increased by 36% or nearly 0.9 gigawatt (GW) to more than 3.4 GW. Spain and the United States remained the global leaders, while the number of countries with installed CSP was growing. There is a notable trend towards developing countries and regions with high solar radiation.CSP is also increasingly competing with the cheaper photovoltaic solar power and with concentrator photovoltaics (CPV), a fast-growing technology that just like CSP is suited best for regions of high solar insolation. In addition, a novel solar CPV/CSP hybrid system has been proposed recently [10].

Table 1: Worldwide Concentrated Solar Power since 2010

Year	2010	2011	2012	2013	2014	2015	2016
Installed	307	629	803	872	925	420	110
Cumulative	969	1598	2553	3425	4335	4750	4815

Data Sources REN21・CSP-world.com IRENA

VI. EFFECT ON WILDLIFE

Insects can be attracted to the bright light caused by concentrated solar technology, and as a result birds that hunt them can be killed (burned) if the birds fly near the point where light is being focused. This can also affect raptors who hunt the birds. Federal wildlife officials have begun calling these power towers "mega traps" for wildlife. According to rigorous reporting, in over six months, actually only 133 singed birds were counted. By focusing no more than four mirrors on any one place in the air during standby, at Crescent Dunes Solar Energy Project, in three months, the death rate dropped to zero [11].

Fig 4 Dead warbler burned in mid-air by solar thermal power plant Credit

VII. SOLAR FARMS THREATEN BIRDS

Certain avian species seem to crash into large solar power arrays or get burned by the concentrated rays. Fewer than 1,000 are thought to still be sloshing about in cattail-thick marshes from Mexico up to Utah and across to California. But if you were lucky enough to spot one, you might chuckle at its oversized toes. When officials with the National Fish and Wildlife Forensics Laboratory saw one of these endangered birds last year, it was no laughing matter. It was dead. It was one of 233 birds recovered from the sites of three Californian desert solar power plants as part of a federal investigation. The laboratory's wildlife equivalents of CSI stars concluded that many of the birds had been fatally singed, broken, or otherwise fatally crippled by the Facilities [12].

Fig 5 Yuma clapper rail. *Credit: Fish & Wildlife Services*

Conservationists say they're also worried about yellow-billed cuckoos, which might be added to the federal government's list of threatened species, and endangered southwestern willow flycatchers, though none of those birds have been found dead at any of the solar sites. The effects of wind turbines on birds, which research suggests kill far fewer birds per megawatt hour than do fossil fuel plants; have long been a source of consternation for many environmentalists. Their bird-killing effects have been serious enough to kill and hamper some planned projects. Now, as concentrated solar farms start to sweep the globe, solar energy developers are facing similar outcries and opposition for the harm that their clean energy facilities can cause to wildlife.

VIII. THREATS TO THE ENVIRONENT

Reports have emerged about high numbers of birds burned to death at a solar energy facility in the southwestern US. One hundred forty-one bird carcasses were found at Ivanpah from June 2012 to December 2013, one-third of which likely died from the solar flux, with telltale signs including feather curling, charring, melting and breakage. Most were house finches and yellow-color warblers whose diets consist mostly of insects. Finding a way to keep the birds from flying into the concentrated beams, just because the energy is green doesn't mean our responsibilities end there. The main goal should still be to reduce emissions AND reduce the impact to local ecosystems. And that doesn't just apply to energy producers, but to manufacturers, infrastructure, consumers and builders, too. The main concern about both types of solar power generation – photovoltaic and concentrated solar power – is that they can potentially cause the displacement or exclusion from important habitats of nationally and/or globally threatened, rare, endemic or range-

restricted bird species. Other potential risks include collision with the reflective surfaces [13].

A. Role of Environmental Regulatory Bodies on death of Birds

The Ivanpah solar thermal power plant in the Southern California desert supplies enough carbon-free electricity to power 140,000 homes. The intense light that surrounds the top of Ivanpah's power towers attracts insects, including Monarch butterflies. It is claimed that these events represent the combustion of loose debris or insects. But from a bird's eye view, a sea of those shiny bluish panels can literally look like a sea, a desert oasis for them to alight. For birds, bats and butterflies, though, the futuristic project is the Death Star, incinerating anything that flies through a "solar flux" field that generates temperatures of 800 degree Fahrenheit when 300,000 mirrors focus the sun on a water-filled boilers that sit on top three 459-foot towers.At times birds flew into the solar flux and ignited."It appears Ivanpah may act as a 'mega-trap,' attracting insects which in turn attract insect-eating birds, which are incapacitated by solar-flux injury, thus attracting predators and creating an entire food chain vulnerable to injury and death," concluded scientists with the National Fish and Wildlife Forensics Laboratory in a report that investigated 233 bird deaths representing 71 species at three Southern California solar power plants.It's important to put that death toll in context. Every year as many as 988 million birds—that are not a typo—or nearly 10 percent of the United States's avian population, die from colliding with windows, according to a study published in March. The feds saw what appeared to be a bird goes up in flames every two minutes, according to the report. "Given that Ivanpah has only been operational for a short period of time, it is premature to determine the significance and extent of impacts to insects, birds, or bats.""Climate change is by far the biggest concern for all forms of wildlife on the planet and we have spent millions of dollars on projects like Ivanpah in our quest to find ways to provide clean, sustainable and renewable energy," Holland added.While about 60 percent of the 233 bird deaths occurred at Ivanpah, solar technologies considered more environmentally benign also proved fatal to birds. The Desert Sunlight project developed by First Solar, for instance, deploys hundreds of thousands of solar panels like those found on residential rooftops. The birds killed at Ivanpah include a peregrine falcon, a red-shouldered hawk and an ash-throated flycatcher. The report recommends among other things that NRG shut down the power plant during peak migration times for some bird species and install video cameras to monitor birds as they fly into the solar flux.NRG spokesman Jeff Holland took issue with some of the recommendations."While the report provides some initial data on bird mortality at the Ivanpah project, it also presents premature conclusions regarding the severity of impacts and proposed recommendations which are not supported by scientific literature, nor standard protocols and processes that are necessary prior to drawing scientific conclusions," he told The Atlantic in an email. The construction of Ivanpah, which was built by BrightSource Energy and now is operated by NRG Energy, faced delays when it turned out the site 45 miles south of Las Vegas is a hot spot for the imperiled desert tortoise.The Fish and Wildlife biologists cautioned that their results are preliminary and that much more research needs to be done on avian mortality around solar power plants.But the scientists and members of the Fish and Wildlife Service's Office of Law Enforcement (OLE) saw first-hand those trade-offs when they visited Ivanpah, where mirrors called heliostats heat water to generate steam to drive an electricity-generating turbine [14].

IX. DISCUSSIONS

The construction of solar panel farms and concentrated solar power are both booming businesses. In California, industrial-scale facilities like these are helping utilities meet a state mandate that 20 percent of electricity sold by 2017 is renewable. But if the problem of wildlife impacts festers, the growth of concentrated solar, which by one recent estimate could grow to a $9 billion worldwide industry in 2020, up from $1 billion in 2013, could be crimped by lawsuits and opposition from conservationists. Much of the problem appears to lie in the "lake effect," in which birds and their insect prey can mistake a reflective solar facility for a water body, or spot water ponds at the site, and then hone in on it. Because of the power of the lake effect, the federal investigators described such solar farms as "mega-traps" in their report. The Associated Press reported last week on "streamers" at Bright Source Energy's concentrated solar plant -- a futuristic-looking facility that gamers pass as they drive through the desert between Las Vegas and Los Angeles. That's the name given to birds as their feathers ignite, mid-air, after flying through a concentrated beam of sunlight. Such hapless birds can be burned to death, killed by brute force when they crash to the ground or eaten a predator swoops in to claim their maimed body. These are just some of the ways that large solar plants can kill birds. It's not known how many birds are being felled by the groundswell of such facilities, but the numbers are high enough to concern bird and conservation groups -- regardless of the environmental benefits of solar

power. The other solar farms analyzed by the investigators were of the newfangled trough and solar power tower varieties. They included the Genesis Solar Energy Project, also in Riverside County, which uses a trough system in which parabolic mirrors focus sunrays into a tube where water boils into steam that spins a turbine to produce electricity. The mirrors pose similar threats to birds as solar panels. The third facility studied was the Ivanpah Solar Electric Generating System in Bernardino County, Calif., where birds can be burned as they pass through concentrated sunrays that are reflected off thousands of mirrors toward a solar power tower, where water is boiled to produce electricity-generating steam [15].

X. CONCLUSIONS

Space-based solar power (SBSP) is the concept of collecting solar power in outer space and distributing it to Earth. Potential advantages of collecting solar energy in space include a higher collection rate and a longer collection period due to the lack of a diffusing atmosphere, and the possibility of placing a solar collector in an orbiting location where there is no night.[16] A considerable fraction of incoming solar energy (55–60%) is lost on its way through the Earth's atmosphere by the effects of reflection and absorption. Space-based solar power systems convert sunlight to microwaves outside the atmosphere, avoiding these losses, and the downtime due to the Earth's rotation, but at great cost due to the expense of launching material into orbit. SBSP is considered a form of sustainable or green energy, renewable energy, and is occasionally considered among climate engineering proposals. It is attractive to those seeking large-scale solutions to anthropogenic climate change or fossil fuel depletion (such as peak oil).Various SBSP proposals have been researched since the early 1970s, but none are economically viable with present-day space launch infrastructure. A modest Gigawatt-range microwave system, comparable to a large commercial power plant, would require launching some 80,000 tons of material to orbit, making the cost of energy from such a system vastly more expensive than even present day nuclear plants. Some technologists speculate that this may change in the distant future if an off-world industrial base were to be developed that could manufacture solar power satellites out of asteroids or lunar material, or if radical new space launch technologies other than rocketry should become available in the future. Besides the cost of implementing such a system, SBSP also introduces several technological hurdles, including the problem of transmitting energy from orbit to Earth's surface for use. Since wires extending from Earth's surface to an orbiting satellite are neither practical nor feasible with current technology, SBSP designs generally include the use of some manner of wireless power transmission and its concomitant conversion inefficiencies, as well as land use concerns for the necessary antenna stations to receive the energy at Earth's surface. The collecting satellite would convert solar energy into electrical energy on board, powering a microwave transmitter or laser emitter, and transmit this energy to a collector (or microwave rectenna) on Earth's surface. Contrary to appearances of SBSP in popular novels and video games, most designs propose beam energy densities that are not harmful if human beings were to be inadvertently exposed, such as if a transmitting satellite's beam were to wander off-course [16]. But the vast size of the receiving antennas that would be necessary would still require large blocks of land near the end users to be procured and dedicated to this purpose. The service life of space-based collectors in the face of challenges from long-term exposure to the space environment, including degradation from radiation and micrometeoroid damage could also become a concern for SBSP.SBSP is being actively pursued by Japan, China, and Russia. In 2008 Japan passed its Basic Space Law which established Space Solar Power as a national goal and JAXA have a roadmap to commercial SBSP. In 2015 the China Academy for Space Technology (CAST) briefed their roadmap at the International Space Development Conference (ISDC) where they showcased their road map to a 1 GW commercial system in 2050 and unveiled a video and description of their design [16].

Acknowledgements

We are very grateful to Techno India University, West Bengal, for all supports and encouragement and all the other resources used in the present study for gathering information and collecting the required data. We are grateful to IRENA, CSP-World and other sources for providing information of some valuable data used in the paper.

References

[1] John Upton (2014). "Solar Farms Threaten Birds" Scientific American 27 August

[2] Brandon Robertson "Zeus and RA Digital Space Bible" Edition 4 part 2, https://books.google.co.in/books?id=rcxp BQAAQBAJ

[3] "Solare Termodinamico, una ricchezza per il paese, p.21" (PDF). Associazione Nazionale Energia Solare Termodinamica (in Italian). Retrieved 2016-02-07.

[4] S S Junare ,S V Zamre ,M M Aware,"Scheffler Dish & its Application"ICEMESM-2017

[5] https://www.tamera.org/pt/projetos/autonomia- tecnologia/espelho-scheffler

[6] https://www.osha.gov/dep/greenjobs/solar.html

[7] http://www.gosolarcalifornia.ca.gov/solar_basics/how.p hp

[8] http://www.folkecenter.net/mediafiles/folkecenter/pdf/S olar-Water-Heaters.pdf

[9] Mustapha Hatti (2014) "Operation and Maintenance Methods in Solar Power Plants", Springer M. Yadav , A. Yadav "Development of Solar Power Electricity Plants in India" IJATES Vol 5,Issue 5 2017

[10] Sebastian Anthony, (2014) "California's new solar power plant is actually a death ray that's incinerating birds mid flight ,EXTREMETECH

[11] https://www.scientificamerican.com/article/solar-farms- threaten-birds'

[12] https://www.eenews.net/stories/1060011853

[13] https://www.theatlantic.com/technology/archive/2014/0 4/how-to-stop-solar-power-plants-from-incinerating- birds/361318/

[14] "Linear-focusing Concentrator Facilities: DCS, DISS, EUROTROUGH and LS3". Plataforma Solar de Almería. Archived from the original on 2007-09-28. retrieved 2007-9-29.

[15] Deloitte Touche Tohmatsu Ltd, (2011) "Energy & Resources Predictions 2012", 2 November

[16] Goossens, Ehren, (2011) "Chevron Uses Solar-Thermal Steam to Extract Oil in California", "Bloomberg", October 3,

Face-to-face Encounter of the Space Craft Juno with Jupiter having strong source of Radio Signal: a survey

Shankar Prasad Mitra
Department of Physics
Techno India University, West Bengal, Kolkata 7000091
shankarmitra35@gmail.com

Debasmita Datta
Department of Electronics and Communication Engineering
Techno India University, West Bengal, Kolkata 7000091
Debasmitadatta98@gmail.com

Asit B. Bhattacharya
Dean of Research
Techno India University, West Bengal, Kolkata-700091, India
bhattacharyaasitbaran@gmail.com

Abstract— **Jupiter has been one of the biggest mysteries of solar system over years and astronomers rigorously trying to reveal its secrets. Since the accidental discovery of Jupiter's radio signal in 1955 scientists continuously observing the planet in radio, UV and IR frequency. After ground based study for a long period, the researchers feel the necessity of a close look to the planet to solve the mystery of our solar system, origin and evolution of the gas giant, its dynamic magnetosphere, interior structure, atmospheric dynamics, chemical composition and its intense aurora. In pursuance of these aspects of astrophysics the space research institute NASA and Jet Propulsion Laboratory (JPL) added a new feather in the form of a fastest man made, solar powered space craft Juno. In this paper, we have critically discussed the different types of signal and radio burst that is emitted from Jupiter and their mechanism considering the vital role of its nearest moon Io followed by the exploration with earlier space probes and an overview of the new mission Juno. The space craft Juno is a highly equipped instrument with titanium made body having a unique polar orbit to reach very close to the planet than else before. After a five-year long journey Juno started to interact with the planet by crossing the bow shock and magnetopause several times through which the purpose of observing Jupiter's magnetic field has been solved. We have emphasized the radio and plasma wave observations in Jupiter's polar magnetosphere during Juno's first perijove pass on August 27, 2016 (DYO 240), electron energy spectrogram and the plasma wave signals from Jupiter's ionosphere that observed by Juno.**

Keywords— radio signal, dynamic magnetosphere, aurora, and radio burst, plasma wave, electron energy spectrogram

I. INTRODUCTION

The study of the largest planet Jupiter of the solar planetary system has special importance as it covers a strong source of radio signal, contributing the planet earth by different means. Dipole antenna is a simple instrument for analyses of Jovian Radio signal for ground based study. For better understanding of the planet we need a close look to it. A solar powered spacecraft Juno, launched on August 5, 2011 provides formation of Jupiter, the inside mechanism of the planet including the size of its dense core, the movement of the deep interior, the physical processes that power the auroras and about its pole. In this paper we have focused on the characteristic changes in the received radio signal by Juno when it reaches to the close vicinity of Jupiter.

II. BACKGROUND STUDY AND RADIO TELESCOPIC RESEARCH

In 1610 Galileo Galilei discovered the four largest moons of Jupiter which are Io, Europa, Ganymede and Callisto using a telescope considered as the first telescopic observation of moons other than Earth's [1]. In 1660s using a new telescope Cassini discovered some spots and colorful bands on Jupiter. He observed that the planet appeared oblate and was able to estimate the rotation period of the planet [2]. In 1690 Cassini further observed that the atmosphere undergoes differential rotation [3] and a prominent oval-shaped feature in the southern hemisphere of Jupiter, so called the Great Red Spot. The pharmacist Schwabe produced the earliest known drawing to find the details of the Great Red Spot in 1831 [4]. The Red Spot was reportedly lost from sight on many occasions between 1665 and 1708 before becoming famous in 1878. It was recorded

as fading in 1883 and also at the start of the 20th century [5]. In 1955 a mysterious signals from space were accidentally discovered by radio astronomers Burke and Franklin [6] and they realized that Jupiter was in the beam of the cross antenna at all the time when signals were recorded at the operating frequency of 22.2MHz and there were some special longitudes of Jupiter where the radio emission was much more likely to be heard than others. These longitudes were like "landmarks" on a planet which mean that Jupiter does not spread radio waves in every direction but rather it beams the radio waves into space. We know that Radio waves can be polarized or unpolarized but most of the radio waves from Jupiter are polarized which signifies that thesewaves are coming from a zone where magnetic field is present. This was in fact one of the first evidence that Jupiter has a magnetic field [7].

After collecting years' worth of datascientists discovered that radio signals transmittedfrom Jupiter in three forms.

(i) *Decametric radio bursts:* This nonthermal radiation (λ ~10 m) arises due to charged particle, emitted from volcanic moon Io, get accelerated under the influence of the strong magnetic field [8] of Jupitercalled synchrotron emission [Fig 1]

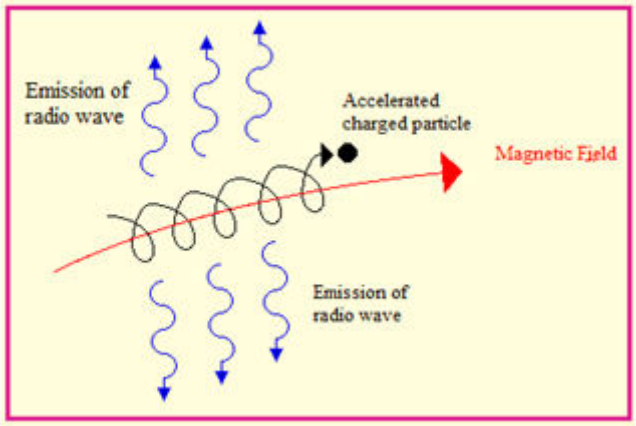


Fig. 1 Synchrotron Emission: A charged particle encounters a strong magnetic field and accelerated along a spiral path following the magnetic field and produces synchrotron radio emission

(ii)*Decametric radio emission:*The volcanic emission of Io forms a torus-shaped belt around Jupiter's equator [Fig 2]. This ring of charged particlesspiraling in Jupiter's intense magnetic fieldproduces cyclotron emission[9]. The decametric radio waves have frequencies in the range between 10 and 40 MHz.It was first observed byDrake and Hvatum in 1959[10]. The radio emission pattern is not isotropic. They waves are emitted along a thin hollow cone. Io-controlled Decametric Radiation (Io-DAM) emissions are only observable when the emission cone is illuminating the observer.

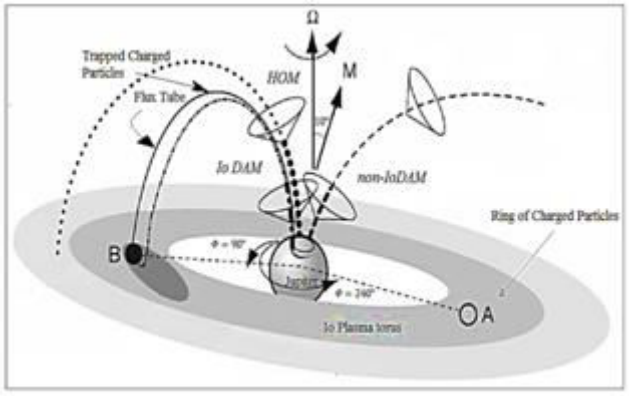


Fig.2. Radio emissions are emitted by the accelerated electrons along magnetic field lines in the Jovian aurora regions. In the plasma wake of Io for Io-DAM emissions or in the plasma disk for non-Io-controlled Decametric Radiation (Non-Io-DAM) and Hectometric Radiation (HOM) emissions (A and B represents two position of Io for azimuthal angle 90°and 240° respectively)

(iii) **Thermal radiation** which arises mainly from the heat in the atmosphere of Jupiter [11].

III. JUPITER'S MAGNETOSPHERE

A magnetosphere is the sphere of influence of the magnetic field of a planet that surrounds planets and affects the region around it which is produced by a planet having sufficient amount of magnetic material, producing a substantial amount of current.The internal pressure of the magnetic field of a planet when interacts and balanced by the external pressure of the solar wind, a magnetosphere is formed. The size of a planet's magnetosphere depends on both the strength of the magnetic field and the strength of thesolar wind. Jupiter's internal dynamo generates its intense magnetic field with a dipole moment nearly18000 times stronger and about 10 times greater than that of our Earth [12].

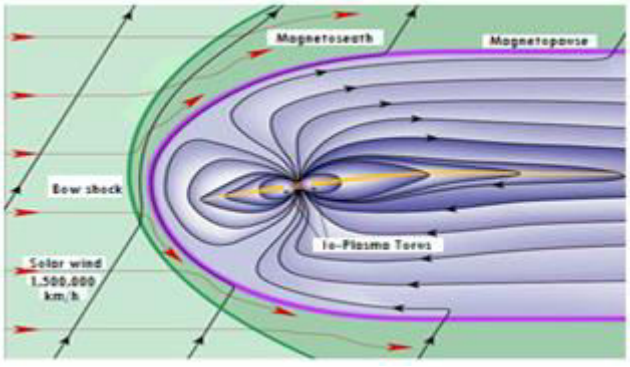


Fig. 3 Jupiter's magnetosphere is formed by balancing the external pressure of the solar wind with the internal pressure of the magnetic field of a planet

In our solar system the Jupiter's magnetosphere is the largest and most powerful. The region where the ionized solar wind is abruptly decelerated and heated by the obstruction created by Jupiter's magnetic field called bow shock (BS). Downstream this region there is a turbulent flow called the magnetosheath which separates bow shock from the magnetopause (MP) region [Fig 3].As discussed above the existence of Jupiter's magnetic field was first known from the observations of radio emissions and was directly observed in 1973 by the spacecraft Pioneer 10.Jupiter's internal magnetic field is produced by electrical currents in its outer core, which is made up of liquid metallic hydrogen. Another fact that charged particles emitted from volcanic Io surface get trapped by the Jupiter's magnetic field and generates strong currents around the poles of the planet which creates Jupiter's auroras. It can be observed in almost all parts of the electromagnetic spectrum i.e. X-rays, UV, visible and IR. Jupiter's magnetosphere is very dynamic because of three factors:(i) very strong planetary magnetic field, (ii) rapid rotation of the planet and (iii) the low density of the solar wind at the orbital position of Jupiter. The magnetosphere of Jupiter is shaped by the solar wind which continuously pushes back Jupiter's magnetic field [Fig.3].

IV. EXPLORATION WITH SPACE PROBES

Jupiter is the largest planet of our solar system and probably formed first, it is very much like the Sun in composition. We have lost the history of Earth, but not Jupiter's. To learn more about Jupiter we need a close look to the planet for which some spacecrafts have been sending there in last few decades. In 1973, the first spacecraft Pioneer 10 was send, followed by Pioneer 11 space probe [13, 14].The closest approach of different space crafts and the corresponding distances [15] are presented in Table 1.

Table 1 The closest approach of different space crafts and the corresponding distances

Spacecraft	*Closest approach*	*Distance*
Pioneer 10 (flyby)	December 3, 1973	130,000 km
Pioneer 11 (flyby)	December 4, 1974	34,000 km
Voyager 1 (flyby)	March 5, 1979	349,000 km
Voyager 2 (flyby)	July 9, 1979	570,000 km
Ulysses (gravity assist)	February 8, 1992 February 4, 2004	408,894 km 120000000km
Galileo (orbiter)	Orbit insertion December 8,1995	
Cassini (gravity assist)	December 30, 2000	10,000,000 km
New Horizons (gravity assist)	February 28, 2007	2,304,535 km
Juno (Orbiter)	Orbit insertion July 5, 2016	

V. OVERVIEW OF THE NEW MISSION JUNO BY NASA

In 1995, NASA'sspacecraftGalileo has dropped a probe into Jupiter's atmosphere which yields a surprising result that Jupiter's composition was different from that scientists thought and their theories of planetary formation proved to be wrong. Today scientists havesome major unanswered questions about this giant gaseous planet and it is believed that the clue of origin of our solar system hidden beneath the clouds and massive storms of Jupiter's upper atmosphere. To reveal the story a space craft was launched by NASA on August 5, 2011 from Cape Canaveral Air Force Station [16] Juno is the fastest man made solar powered spacecraft. Juno's primary goal is to search for clues about of the formation and evolution of the planet Jupiter. The Juno Mission also serves the objective of understanding Jupiter's gravity and magnetic fields, atmospheric dynamics and composition the coupling between the interior atmosphere and magnetosphere that determines the planet's properties and drives its evolution taking the advantage of its unique elliptical polar orbit using long-proven technologies on the spinning spacecraft. The spacecraft will also observe physical processes that power theauroras. [17, 18] The understanding of the origin and evolution of Jupiter will help us to understand the origin of our solar system and other planetary systems around other stars.

VI. JUNO'S FLIGHT TRAJECTORY

Earth flyby: The spacecraft Juno was built by Lockheed Martin and is operated by NASA's Jet Propulsion Laboratory (JPL). After launching on August 5, 2011, the spacecrafttraveled for two years in an elliptical heliocentric orbit around Earth. Then Juno slingshot itself towards the Jovian system using Earth's gravity to pass by Earth in October 2013 (gravity assist) [19].

Jupiter's orbit insertion (JOI): Solar poweredJuno is the second spacecraft to orbit Jupiter after the nuclear powered Galileo orbiter. Juno completed its five-year journey to Jupiter on July 5, 2016after traveling a total distance ofnearly 2.8 billion kilometers [20]. Strong gravitational field of Jupiter accelerated the spacecraft to around 210,000 km/h [21].Then an insertion burn in its main engine for 2,102 seconds decelerated Juno by 542 m/s [22]for changing its trajectory from a hyperbolic flyby to an elliptical polar orbit having a period of about 53.5 days [23]. The spacecraft successfully entered in its orbit around Jupiter on July 5, 2016 at 03:53 UTC [24].During almost next 20 months of science phase of the mission, the spacecraft will execute a close flyby above Jupiter's cloud tops every 14 days.The spacecraft will orbit Jupiter 37 times and at the end of the last orbit it will be de-orbited into the planet [25].

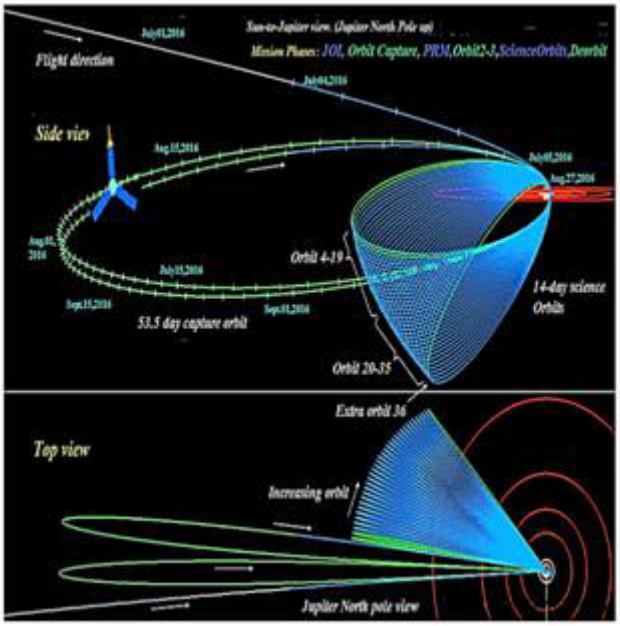


Fig. 4 Mission orbits diagram. The tilt of Juno's orbit relative to Jupiter changes over the course of the mission, sending the spacecraft increasingly deeper into the planet's intense radiation belts (Credit: NASA/JPL)

Mission summary:

Table 2. From launch to deorbit [20, 23, 24, 25, 26-35]

Launch	August 5, 2011
Deep Space Maneuvers	August/September 2012
Earth flyby gravity assist	October 2013
Jupiter arrival	July 2016
Period of orbiter of Juno	20 months(37orbits)
Perijove 1	August 27, 2016
Perijove 2	October 19,2016
Perijove 3	December 11,2016
Perijove 4	February 2, 2017
Perijove 5	March 27,2017
Perijove 6	May 19,2017
Perijove 7 (fly-over the GRS)	July 11, 2017
End of mission (deorbit into Jupiter)	February 2018

VII. SCIENTIFIC INSTRUMENTSUSED FOR JUNO

Table 3. Instruments of juno and their scientific objectives [36-50]

Name of the Instrument	*Scientific Objective*
Microwave Radiometer (MWR)	It is a microwave radiometer of multi-wavelength range which will measure the abundance of water and ammonia in the deep layer of Jupiter's atmosphere up to 200 bar.
Jovian Infrared Auroral Mapper (JIRAM)	It is an image spectrometer.Its goal is to probe the upper layers of Jupiter's atmosphere (to a pressures of 5–7 bars) at infrared wavelengths (2–5 μm) using an image and a spectrometer to study the dynamics, chemistry in Jupiter's atmosphere and perhaps to determine how Jovian hot spots formed.
Magnetometer (MAG)	It is used to map the magnetic field of Jupiter and to determine the dynamics of Jupiter's interior and the three-dimensional structure of the polar magnetosphere and its auroral region.
Gravity Science (GS)	It is an experiment and instrument of Juno to monitor Jupiter's gravity using the high-gain K-band and X-band. It willgive a map of Jupiter's gravitational fieldwhich will help us tounderstand the interior of Jupiter.
Jovian Auroral Distributions Experiment (JADE)	This instrument will return data in situ on Jupiter's auroral region and magnetospheric plasmas, bydetecting and measuring electrons and ions in this region.
Jupiter Energetic-particle Detector Instrument (JEDI)	It is used to collect data on "energy, spectra, mass species (H, He, O, S), and angular distributions" that will help us to study the energies and distribution of charged particles. It can detect particle 30 KeVto 1 GeV, whereas JADE, another instrument on the spacecraft, will observe particle below30 KeV.It is also designed to study the concept that energy from rotation of Jupiter is converted into its atmosphere and magnetosphere.
Radio and Plasma Wave Sensor (WAVES)	It is designed to detect radio spectra (50 Hz to 40 MHz) and magnetic fields (plasma spectra 50 Hz to 20 kHz) in the auroral region to identify the auroral currents that define Jovian Radio Emissions and acceleration of the charged particles in the auroral region.
Ultraviolet Spectrograph or Ultraviolet Imaging Spectrometer (UVS)	It is an imaging spectrometer that observes the ultraviolet range of light (70 nm to 200 nm) for remote observations of the aurora, detecting the emissions of gases (hydrogen) in the far-ultraviolet range. Its main focus is to find the source of aurora emissions of Jupiter
JunoCam (JCM)	It is the visible-light camera, not one of the core scientific instruments of Juno.All images taken by JCM will be available on NASA's website.

VIII. INTERACTION OF JUNO WITHJUPITER'S MAGNETIC FIELD

The spacecraft Juno faced for the first time the Jupiter's Bow shock just once on 24th June 2016, day of year (DOY) 176 when it was at a distance of $128R_J$, (Fig 5) where R_J = Jupiter's radius = 71,492 km.

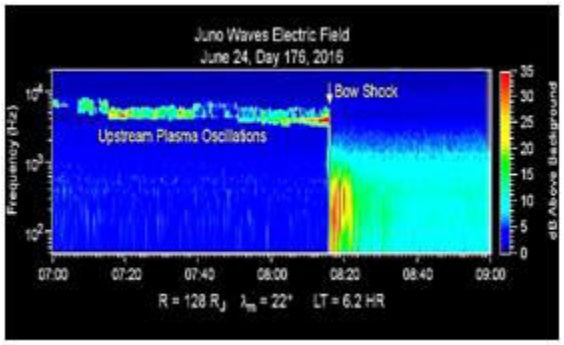


Fig. 5 This chart presents data recorded by Waves instrument of NASA's Juno spacecraft on June 24, 2016 as the spacecraft crossed the bow shock just outside of Jupiter's magnetosphere (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

The above figure (Fig 5) a frequency-time spectrogram withabscissa representing total elapsed time of two hours and ordinate representing frequency (in hertz). The vertical bar to the right of the chart indicates the color coding which is used to indicate wave amplitudes as a function of wave frequency in decibels (dB) above the background level detected by the Waves instrument. Each step of 10 decibels marks a tenfold increase in wave power.We know Jupiter's magnetic field is tilted about 10 degrees from the planet's axis of rotation.In the spectrogram $\lambda_m = 22^\circ$ indicates that at the time these data were recorded, the spacecraft was 22 degrees north of the magnetic-field equator and the "LT" indicates the local time on Jupiter at the longitude of the planet directly below the spacecraft, with a value of 6.2.Before reaching the bow shock the Waves instrument has recorded plasma oscillations of frequency just below 10 KHz. It shows a low density of electron in the region just outside Jupiter's bow shock. [51] Onthe very next day, June 25, 2016 the Waves instrument witnessed the crossing of the magnetopause. This frequency-time spectrogram, (Fig 6) is obtained from the data recorded by the Waves instruments of Juno at a distance of 114 $R_J$at $\lambda_m = 12^\circ$

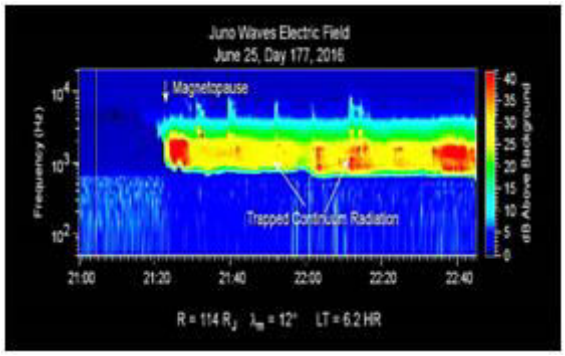


Fig. 6 Encounter of Juno with Jupiter's magnetopause (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

Here (Fig 6) "Trapped continuum radiation" indicates that waves transit into the lower density of the Jovian magnetosphere.In the next 5 days from June 25to June29, 2016 [DOY 177 to 181] Juno crossed magnetopause (MP) multiple times spanning at radial distances of 74 to 114 R_J, before orbit insertion (JOI) on 4 July (DOY 186). During DOY 199 to 210 it reaches the radial distances of 92 to 112 R_J, and on DOY 213 it was nearly at 113 R_J, and on DOY 221 to 224 it reaches at a distances of $102R_J$ to 108 R_J. Juno resides at distances of >92 R_J for little more than 29 days. Now on the course to continuous approach towards Jupiter the space craft goes into the orbit around Jupiter on July 4, 2016where the Science instruments detected changes in the particles and fields around the spacecraft as it transit from an environment dominated by the interplanetary solarwind to Jupiter's magnetosphere. Juno transit through the Jovian magnetosphere multiple times (Fig. 7) in which the measured magnetic field magnitude is compared with a magnetospheric model derived from earlier flybys. The variation in magnetic field magnitude throughout most of the 10-day interval centered on closest approach to Jupiter (1.06 R_J) at 12:53 UT is well understood based upon prior knowledge of the planetary magnetic field [52] and the Jovian magnetodisc [53]. The planetary magnetic field calculated using VIP4 spherical harmonic mode l [54] is also shown

here with the gray line. From Juno's first perijove pass a magnetic field of 7.766 G was observed (Fig 7).

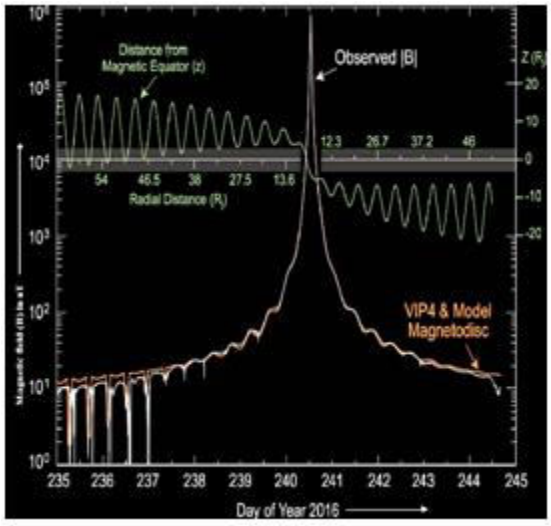


Fig. 7 Measured magnetic field magnitude (white, solid) and distance above the magnetic equator (gray) as a function of time and distance from Jupiter during Juno's first perijove pass

IX. RADIO AND PLASMA WAVES DETECTION BY WAVE INSTRUMENT OF JUNO

During the first perijove of Juno across the magnetic field lines around Jupiter's auroral region a strong auroral radio emissions at low altitudes was faced by it. According to plasma theory, the electron cyclotron frequency, f_{ce}(Hz) = 28|B| (nT). The radio emissions are generally confined to frequencies at or above f_{ce}, which probably produced by the cyclotron maser instability (CMI) at frequencies at or just below f_{ce} [55]. The intensity peak of the graph near the frequency line f_{ce} [Fig 8(A) and 8(B)] indicates that Juno passed very close to the source regions for the emissions.

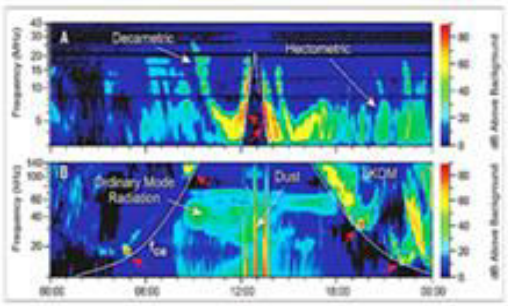


Fig. 8.Radio and plasma wave observations in Jupiter's polar magnetosphere during Juno's first perijove pass on August 27, 2016 (DYO 240) (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

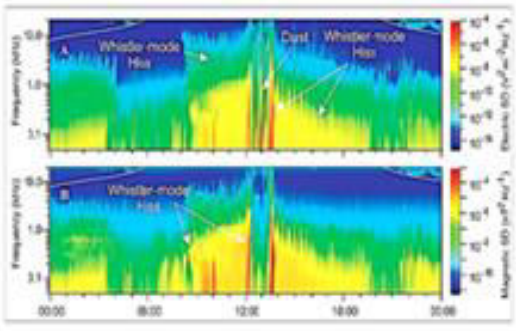


Fig. 9 Plot of electric and magnetic components Radio and plasma wave observations in Jupiter's polar magnetosphere during Juno's first perijove pass on August27, 2016 (DYO 240) (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

In the abovefrequency-time spectrogram (Fig 9) just after 12:00 and near 13:30 UT there are two intensity peak of emission which ensuresJuno's passage over Jupiter's main auroral region.These features are called auroral hiss [56] and correspond to features in the energetic electron distributions. These waves exist at frequencies below the lower of electroncyclotron frequency (f_{ce}) and electron plasma frequency (f_{pe}). The electron density (n_e) can be determined by using the relation $n_e = (f_{pe}/8980)^2$, where n_e is expressed in cm^{-3} and f_{pe} in Hz.

X. INTERACTION OF JUNO WITH CHARGED PARTICLES

On August27, 2016 i.e. on the same day when the previous observation was taken theelectron and ion observations obtained by Juno are presented in Fig.10.In the electron energy spectrogram in Fig10 there is a broad bright region between about 4:00 and 8:00 UT represents a period of time when the spacecraft dipped into Jupiter's radiation belts where Juno encounters high electron and ion intensities [57]. The energetic electron data measured by JEDI are plotted in Fig 10.

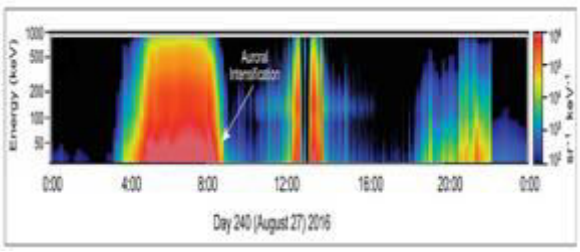


Fig. 10 Electron energy spectrogram obtained during Juno's first perijove pass (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

The white curve in the figures represents the electron cyclotron frequency and the red arrows in Fig 8(A) and Fig 8(B) identify emissions observed withincreasing intensity just above f_{ce}. The electric and magnetic components are plotted in Fig 9(A) and Fig. 9(B) respectively at frequencies below 20 kHz.

In Fig11 (A) and 11(B) the lower energy plasma data for ions and electrons are represented which are measured by Jovian Auroral Distributions Experiment (JADE).

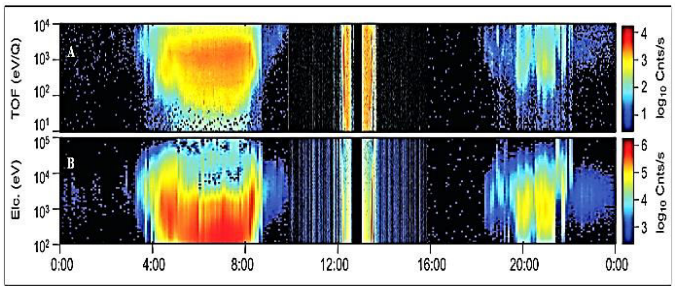


Fig. 11 Ions and electrons spectrogram obtained during Juno's first perijove pass (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

NASA's Juno spacecraft has observed plasma wave signals (Fig 12) from Jupiter's ionosphere. In the figure bellow (Fig 12) there is a frequency-time spectrogram which shows an increasing plasma density as Juno descended into Jupiter's ionosphere during its close pass by Jupiter on February 2, 2017. The intensity of the waves is displayed based on the color scale shown on the right. The actual observed frequencies of these emissions approach 150 kHz, which is above the human hearing range.

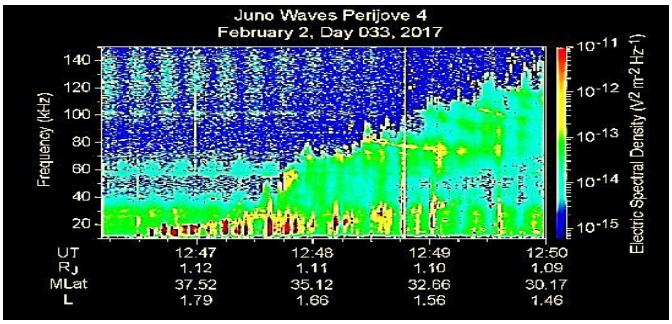


Fig. 12 Plasma wave signals from Jupiter's ionosphere observed by the space craft Juno (Credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

XI. CONCLUSIONS

Juno is equipped with latest technologies so better observations and analysis are expected compared to the previous space crafts. Juno has provided observations of fields and particles in the polar magnetosphere of Jupiter on basis of which its magnetic field has been predicted using VIP4 model.Juno has been the witness of the tossed up plasmas from the ionosphere of Jupiter providing a mechanism to populate its magnetosphere. It also provides information about the interaction between ionosphere and magnetosphere of Jupiter and an idea of ion density around Jupiter's atmosphere is developed. We also understand the mechanism that precipitating energetic particles associated with Jovian aurora are different from the energy distributions that power the auroral emissions at Earth.

Acknowledgment

We are thankful to the authority of Techno India University. The authors are indebted to all members of the Juno mission team and we are especially thankful to Victor Herrero radio astronomy blog (herrero-radio-astronomy.blogspot.com) and also to the web https://radiojove.gsfc.nasa.gov,from where we have used some relevant information.

References

[1] Galilei, Galileo, Sidereus Nuncius. (1989). Translated and prefaced by Albert Van Helden. Chicago & London: University of Chicago Press,pp. 14–16.
[2] D. P.Cruikshank, and R. M.Nelson, (2007). "A history of the exploration of Io," In Lopes, R. M.C. and Spencer, J. R., Io after Galileo, Springer-Praxis, pp. 5–33,
[3] B. A. Smith, et al., (1979). "The Jupiter system through the eyes of Voyager 1," Science, vol. 204, pp. 951–972,
[4] Great Red Spot Article Free Pass (http://www.britannica.com/EBchecked/topic).
[5] https://www.space.com/30827-jupiter-great-red-spot-shrinking-amazing-video.html
[6] Pawsey, J. L. and Bracewell, R. N., (1955) Radio Astronomy. Clarendon Press, 361 pages.
[7] E. J.Smith, L. Davis, D. E. Jones, D. S. Colburn, P. J. Coleman, P. Dyal, C. P. Sonett, (1974) "Magnetic Field of Jupiter and Its Interaction with the Solar Wind", Science Magazine, vol. 183, pp. 305-306.
[8] A. S.McEwen, and L. A.Soderblom, (1983) "Two classes of volcanic plume on Io," Icarus, vol. 55,pp. 197–226,.
[9] G. D. Clow, and M. H. Carr, (1980) "Stability of sulfur slopes on Io," Icarus, vol. 44, pp. 268–279.
[10] R. A. Treumann, (2006) "The electron-cyclotron maser for astrophysical application," Astron. Astrophys. Rev., vol. 13, pp. 229–315.
[11] A. P.Naumov, and I. P.Khizhnyakov, (1965) "Thermal Emission of Jupiter," Soviet Astronomy, vol. 9, pp.480,.
[12] C.T.Russell, (1993) "Planetary Magnetospheres" Reports on Progress in Physics, vol. 56, pp. 687–732,.
[13] https://solarsystem.nasa.gov/planets/Jupiter
[14] https://www.nasa.gov/centers/ames/missions/archive/pioneer.html
[15] https://www.space.com/12548-jupiter-missions-nasa-spacecraft-history.html
[16] https://www.nasa.gov/mission_pages/juno/overview/index.html

[17] "NASA's Shuttle and Rocket Launch Schedule". NASA. Retrieved February 17, 2011.
[18] NASA Selects New Frontiers Concept Study: Juno Mission to Jupiter | Jupiter Today – Your Daily Source of Jupiter News.
[19] "Juno – NASA's Second New Frontiers Mission to Jupiter". Retrieved October 24, 2007.
[20] "Earth Flyby - Mission Juno". Mission Juno. Retrieved October 2, 2015
[21] K. Chang, "NASA's Juno Spacecraft Will Soon Be in Jupiter's Grip," The New York Times, Retrieved June 30, 2016.
[22] K. Chang, "NASA's Juno Spacecraft Enters Jupiter's Orbit," The New York Times, Retrieved July 5, 2016.
[23] "NASA's Juno Spacecraft in Orbit around Mighty Jupiter," NASA. July 4, 2016, Retrieved July 5, 2016.
[24] S. Clark, "Live coverage: NASA's Juno spacecraft arrives at Jupiter". Spaceflight Now, Retrieved July 5, 2016.
[25] J. Foust, (2016) "Juno enters orbit around Jupiter". Space News. Retrieved August 25,.
[26] https://www.nasa.gov/mission_pages/juno/overview/index.html
[27] D. C. Agle, D. Brown,L. Cantillo, "NASA's Juno Successfully Completes Jupiter Flyby," Retrieved October 1, 2016.
[28] "Mission Prepares for Next Jupiter Pass". Mission Juno. Southwest Research Institute. October 14, 2016. Retrieved October 15, 2016.
[29] D. C. Agle, D. Brown, L. Cantillo, (2016) "NASA Juno Mission Completes Latest Jupiter Flyby". NASA / Jet Propulsion Laboratory. Retrieved December 12.
[30] A. Thompson, "NASA's Juno Spacecraft Preps for Third Science Orbit". Inverse. Retrieved December 12, 2016.
[31] "It's Never 'Groundhog Day' at Jupiter". NASA / Jet Propulsion Laboratory. February 1, 2017. Retrieved February 4, 2017
[32] D. C. Agle, D. Brown, L. Cantillo, (2017) "NASA's Juno Spacecraft Completes Fifth Jupiter Flyby". NASA, Retrieved March 31,.
[33] N. Anderson, (2017) "NASA's Juno Spacecraft Completes Sixth Jupiter Flyby". Sci-News, Retrieved June 4,.
[34] A. Witze, "Jupiter's secrets revealed by NASA probe," Nature, doi:10.1038/nature.2017.22027. Retrieved June 14, 2017.
[35] E. Lakdawalla, (2017)"Juno update: 53.5-day orbits for the foreseeable future, more Marble Movie," The Planetary Society, Retrieved June 14,.
[36] L. Grush, (2016) "Why NASA's Juno mission could last a lot longer than it was supposed to," The Verge, Retrieved December 12.
[37] P. Pingree,M. Janssen,J. Oswald,S. Brown, J. Chen,K. Hurst, A. Kitiyakara,F. Maiwald,S. Smith, "Microwave Radiometers from 0.6 to 22 GHz for Juno, A Polar Orbiter around Jupiter,"IEEE Aerospace Conference: 1–15, 2008.
[38] "Juno-Spacecraft: Instruments JIRAM," Juno.wisc.edu.2008-10-23.Archived from the original on 2016-02-04. Retrieved 2016-02-17
[39] https://junomag.gsfc.nasa.gov
[40] "Instrument Overview Juno" spaceflight101.com. Retrieved 2017-01-05.
[41] "Jupiter's Gravity Embraces NASA's Juno Spacecraft". Space.com. Retrieved 2017-01-05
[42] "Juno's Instruments, Mission Juno". Mission Juno. Retrieved 2017-01-05.
[43] "Juno's Instruments, Mission Juno". Mission Juno. Retrieved 2017-01-05.
[44] "Instrument Overview – Juno". Spaceflight101.com. Retrieved 2017-01-05
[45] S. Bolton, (2016)"Juno at Jupiter: Mission and Science," 41st COSPAR Scientific Assembly,
[46] D. K. Haggerty, B. H. Mauk, C. P. Paranicas, "JEDI -- The Jupiter Energetic Particle Detector for the Juno mission," 2008.
[47] "Juno's Instruments | Mission Juno," Mission Juno, Retrieved 2017-01-05.
[48] M. Sampl,T. Oswald, H. O. Rucker, R. Karlsson, D. Plettemeier, W. S. Kurth, "First results of the JUNO/Waves antenna investigations," Loughborough Antennas Propagation Conference: 1–4, 2011.
[49] G. Gladstone, "The Ultraviolet Spectrograph on NASA's Juno Mission," Space Science Reviews, 2014.
[50] "Malin Space Science Systems - Junocam, Juno Jupiter Orbiter". Retrieved 2016-07-17.
[51] J. E. P. Connerney, A. Adriani, F. Allegrini, F. Bagenal, S. J. Bolton, B. Bonfond, S. W. H. Cowley, J.C. Gerard, G. R. Gladstone, D. Grodent, G.Hospodarsky, J. L. Jorgensen, W. S. Kurth,S. M. Levin, B. Mauk, D. J. McComas, A. Mura, C. Paranicas, E. J. Smith, R. M. Thorne, P. Valek, J. Waite, (2017) "Jupiter's magnetosphere and aurorae observed by the Juno spacecraft during its first polar orbits," Science, vol. 356, Issue 6340, pp. 826-832,.
[52] http://factpub.org/wiki/index.php/A8c331172ace88b6ade063b2f1f81074_facts
[53] J. E. P. Connerney, M. H. Acuña, N. F. Ness, (1981) "Modeling the jovian current sheet and inner magnetosphere," J. Geophys. Res.,vol. 86, pp. 8370–8384,.
[54] J. E. P. Connerney,M. H. Acuña, N. F. Ness, T.Satoh, (1998) "New models of Jupiter's magnetic field constrained by the Io flux tube footprint," J. Geophys. Res. vol. 103, pp. 11,929–11,939,.
[55] R. A. Treumann, (2006) "The electron-cyclotron maser for astrophysical application," Astron. Astrophys. Rev. vol. 13, pp. 229-315,.
[56] D. A. Gurnett, (1966) "A satellite study of VLF hiss," J. Geophys. Res., vol. 71, pp. 5599–5615,.
[57] M. de Soria-Santacruz et al.,(2016) "An empirical model of the high-energy electron environment at Jupiter," J. Geophys. Res., vol. 121, pp. 9732-9743,.

Zn, Cu and Pb concentrations in different body parts of *Oreochromis niloticus*

Pallavi Dutta
Department of Oceanography,
Techno India University, West Bengal,
Kolkata 700091, India
pallavidutta83@gmail.com

Sufia Zaman
Department of Oceanography,
Techno India University, West Bengal,
Kolkata 700091, India
zamansufia123@gmail.com

Nabonita Pal
Department of Oceanography,
Techno India University, West Bengal,
Kolkata 700091, India
nabonita.pal2014@gmail.com

Abhijit Mitra
Department of Marine Science,
University of Calcutta,
Kolkata 700019, India
abhijit_mitra@hotmail.com

***Abstract* - Bioaccumulation of heavy metals in fish species (*Oreochromis niloticus*) is a matter of concern in the present *era*. Heavy metals on entering the body of the fish species gets distributed in several organs like muscles, gills and hepatopancreas etc. The current paper investigates the bioaccumulation pattern of Zn, Cu and Pb in these organs of *Oreochromis niloticus*. The fish samples were collected during March 2018 from control tank of Techno India University, West Bengal rooftop and Manoharpur area of Haldia in the East Midnapore district. The order of accumulation of heavy metals is Zn>Cu>Pb irrespective of the organs. Such studies are to be repeated with rigorous monitoring as fishes are consumed by a large percentage of people throughout the globe.**

***Keywords* - *Oreochromis niloticus*, heavy metals, organs, bioaccumulation**

I. INTRODUCTION

Heavy metal concentrations in the water and sediment of the aquatic ecosystems have increased greatly in recent years. This is mainly because of the rapid pace of industrialization, unplanned urbanization, mushrooming of shrimp culture units (where copper sulphate is mostly used as algaecides). In addition, antifouling paints used for preventing corrosion of fishing vessels and trawlers also contribute appreciable amount of Zn, Cu & Pb in ambient media (water plus sediment). In this study, heavy metals were selected mainly because they are widespread environmental contaminants, from either natural or anthropogenic sources and are believed to be a threat to the health and survival of many aquatic animals [1]. The contaminated fishes, in turn may become a public health concern, hence it is important to determine the concentration of heavy metals in commercial fish species in order to evaluate the possible risk of human consumption [2].

On the basis of this background, the present study was undertaken to evaluate the concentrations of Zn, Cu and Pb in the muscles, gills and hepatopancreas of *O. niloticus* collected from Manoharpur, in the east Midnapore district of West Bengal and control tank on the rooftop of Techno India University, Sector V, Salt lake City, Kolkata.

II. MATERIALS AND METHODS

A. Description of study site

Manoharpur village (22°13′03″N and 88°21′05″E) is located in Haldia in the Midnapore district of West Bengal. Similar sized fishes were collected during March 2018 which is the premonsoon season in the tropical belt. Similar sized fishes were also collected from control tank constructed at the rooftop of the Techno India University, West Bengal, in Salt lake city, Kolkata (22°34′02″N and 88°25′41.5″E).

B. Collection of fish samples and dissection

Similar sized fish samples of average weight 60 gm were collected from both the sites during March 2018.With a sterilized clean scalpel muscles, gills, hepatopancreas were dissected separately from fish samples collected from both the sites.

C. Analysis

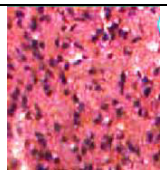
The dissected samples were oven dried overnight at 105°C. After complete drying, the samples were

powdered and stored separately by labeling the samples. 1 gm of dried portion (in 3 replicates) was mixed in 10 ml solution of HNO_3 and HCL in the ratio 1:3 (aqua regia). The solution was stirred for few minutes and kept overnight. The flask were then placed on a hot plate with tightly corked and allowed to digest until a transparent and clear solution was obtained. This solution was separately aspirated in AAS with Hydride module (NOVA 350) and mean readings were recorded after considering the blank correction.

III. RESULTS AND DISCUSSION

The bioaccumulation patterns of heavy metals exhibited the order Zn > Cu > Pb irrespective of all the body parts of fish species (Table1).

Table 1: Selected heavy metal concentrations in Tilapia fish

Species	**Metal concentration (mg/kg) dry wt. basis**		
	Zn	Cu	Pb
 Muscle	A =17.59 B =48.21	A =4.63 B =25.02	A =BDL B =4.17
 Gills	A =20.12 B =40.77	A =5.87 B =30.10	A =3.49 B =7.15
 Hepatopancreas	A =23.16 B =44.58	A =6.32 B =39.25	A =4.05 B =9.06

A= Control site B= Selected site

Fishes are common diet consumed by populations throughout the world and are essential sources of nutrients. Reports on metal concentrations in fishes are under natural conditions for coastal waters particularly in present area is limited [3-6]. The growing rate of anthropogenic waste inputs into the creeks and estuaries leads to a bioaccumulation of heavy metals in the aquatic organisms. Since fishes are consumed by most of the people throughout the world (preferably in the Bengal region of India) it is important to investigate whether the heavy metals are within the permissible level as prescribed by FAO/WHO [7]. The present paper clearly exhibits that all the heavy metals are much below in the control tank compared to the ponds in the Monaharpur area of Haldia. It is observed in muscle, gills and hepatopancreas the levels of Zn are 2.74, 2.03, 1.93 times higher in the samples of Manoharpur pond compared to the control pond. For Cu, the rate of increment in the muscle, gills and hepatopancreas are 5.40, 5.12 and 6.21 respectively in the Manoharpur pond compared to the control pond. Similar sequence is observed in Pb and interestingly the level of lead in the muscle of the fish species sampled from the control tank is below the detectable level.

Pollution enters in the fish species via 5 major routes viz. (i) food (ii) nonfood particles (iii) gills (iv) oral consumption of water (v) skin. Comparing the present data with guidelines and limits of US-FDA [8] levels of Zn (200 ppm) > Cu (60 ppm) > Pb (3 ppm) so it is seen that most of the metal concentrations found in the tissues of aquatic animals is below the tolerance level for human consumption. According to many researchers fishes by virtue of their mobile nature are fair indicator of aquatic contamination, but their regular consumption by human beings makes it absolutely necessary to monitor their different organs, which has been covered in the present work.

References

[1] Muthazhagan, K., Thirunavukkarasu, P., Ramanathan, T., & Kannan, D. (2014). Studies on phytochemical screening, antimicrobial and anti-radical scavenging effect coastal salt mash plant of a *Suaeda monoica*. Res. J. Phytochem, 8, pp 102-111.

[1] Lorenzon, S., Francese, M., Smith, V. J. & Ferrero, E. A. (2001). Heavy metals affect the circulating haemocyte number in the shrimp Palaemon elegans, Fish & shellfish immunology, 11, pp 459–472.

[2] Cid, B. P., Boia, C., Pombo, L. & Rebelo, E. Determination of trace metals in fish species of the Ria de Aveiro (Portugal) by electrothermal atomic absorption spectrometry, Food Chemistry, (2001). 75, pp 93-100.

[3] Mitra, A., Sengupta, K. & Banerjee, K. (2011). Standing biomass and carbon storage of above-ground structures in dominant mangrove trees in the

Sundarbans, Forest Ecology and Management, 261(7), pp 1325-1335.

[4] Mitra, A. & Zaman, S. (2014). Carbon Sequestration by Coastal Floral Community. The Energy and Resources Institute (TERI), TERI Press, India.

[5] Mitra, A. & Zaman, S. Blue carbon reservoir of the blue planet, Springer, ISBN 978-81-322-2106-7 (Springer DOI 10.1007/978-81-322-2107-4), 2015.

[6] Mitra, A. & Zaman, S. Basics of Marine and Estuarine Ecology, Springer, ISBN 978-81-322-pp 2705-2, 2016.

[7] Krishnamurti, J. A. & Nair, R. V. (1999). Concentration of metals in shrimps and crabs from Thane-Bassein creek system, Maharastra, Indian Journal of Marine Science, 28, pp 92-95.

[8] U.S. Department of Health and Human Services, "Public Health Service, Food and Drug Administration, 2003", Guide for the Control of Molluscan Shellfish, National Shellfish Sanitation Program.

Effect of Fin Width and Fin Height on Threshold Voltage for Tripple Gate Rectangular FinFET

Subham Banerjee
Electronics & Communication Engineering
Techno India University, West Bengal
Kolkata, India
subhamb741@gmail.com

Eshita Sarkar
Electronics & Communication Engineering
Techno India University, West Bengal
Kolkata, India
eshitasarkar14@gmail.com

Atin Mukherjee
Electronics & Communication Engineering
Techno India University, West Bengal
Kolkata, India
mukherjeeatin@gmail.com

***Abstract* — FinFET isadevice of great importance in the semiconductor industry. Various short channel effects can be avoided by the use of finFET. The paper describes the variation of the threshold voltage with the variation in the intrinsic parameters of the finFET like fin width and fin height. Here we plot the threshold voltage of finFET in MATLAB with the minimum carrier charge density and observe the effect on threshold voltage by varying the fin width and the fin height.**

Keywords—Tripple gate rectangular finFET, MATLAB, fin height, fin width.

I. INTRODUCTION

According to Moore's law,the number of transistors per chip doubles every 18 months[1]. Our main purpose is to incorporate minimum number of transistors in a chip. This is because it reduces area, leakage current and heat dissipation. But according to Moore's law, the number of transistors in a chip is increasing day by day. One of the ways to reduce area is to scale down the size of the device. As the devicesare scaled down, planar transistors have brought various degrading effects such as carrier velocity saturation, mobility degradation, hot electron effect, leakage current increment, drain induced barrier lowering, punch-through and lowering of the threshold voltage [2]. All these unwanted effects come under the short channel effect (SCE). Due to these, the devices cannot be scaled down in a rapid way. There are some possibilities which include use of silicon-on-insulator (SOI) finFET or bulk finFET. Hence the concept of multi-gate device came into existence.Recent trends show that tri-gate (TG) field-effect transistors (FETs) have been chosen as thesuitable alternative for the sub-22 nm regime because it is capable of suppressing the short channel effects.

Transistor evolution from vacuum tube, followed by the BJT'shaving a problem of static power dissipation which can be reduced using the CMOS technology draws almost zero static power. One of the shortcomings of the CMOS technology is that the leakage current increases, on further scaling down the size of the transistors (i.e. at below 22 nm regime).To overcome this problem, SOI finFET or bulk finFET replaced planner bulk transistor.In this paper, we present the effect of threshold voltage variation with minimum carrier charge density by varying the fin width and the fin height.

Variables and constants used – Threshold voltage, minimum carrier charge density, fin width, fin height,Vd(channel potential near the drain side), acceptor and donor concentration($N_a$and N_d), intrinsic carrier concentration, A_1 and A_2, Built-in potential (V_{bi}), Boltzmann constant, absolute temperature, electronic charge.

II. STRUCTURE AND OPERATION OF FINFET

A. Structure of finFET

The main idea of finFET and the Ultra-thin body SOI device has been given in [3].The structure of finFET comprises of a thin, vertical fin of silicon body on a substrate. The gate is wrapped around the channel from all the three sides of the channel. This structure is known as finFET because the silicon body looks like the back fin of a fish.

In a bulk MOSFET, the channel is horizontal while in case of finFET, the channel is vertical. Thus, the width of the channel is determined by the height and width of fin.The width of the transistor is given by (2*fin_ height + fin_width).

B. Operation of finFET

The body of the finFET is very thin. The leakage current is very low in case of finFET.The drain current increases by increasing the fin height.

We can increase the drain current by making use of parallel multiple fins connected together. The channel width is a multiple of the fin height. Thus, the overall width of the device becomes quantized. The finFEThas very less dopant-induced variations.In case of the finFET, the gate wraps around the

channel and the body are very thin, thus reducing the short channel effects.

III. MATLAB Simulation Set-Up

Here we have performed a MATLAB simulation showing the threshold voltage variation with the minimum carrier charge density. We observe that the threshold voltage increases with increase in charge density. We also observe that with the increase of fin width and fin height, the threshold voltage decreases.

A. Abbreviations

Some of the abbreviations used in this portion are Vt, Qth, Wfin, and Hfin. Here Vt denotes the threshold voltage, Qth indicates the minimum carrier charge density, Wfin represents fin width, and Hfin denotes fin height.

B. Units

The threshold voltage is of the order of millivolt.The fin width, the fin height, and the width of the transistor is of the order of nanometer.

C. Equations

The Threshold voltage is the minimum gate voltage required to set up a conduction path between the source and the drain. Some of the equations that we have used in the MATLAB simulation process are listed below:

$$V_t = V_{fb} - \frac{1}{(1-(A_1 - A_2))} \times \begin{pmatrix} A_1(V_{bi} + V_d) + A_2 V_{bi} \\ -V_{th} \ln\left[\frac{Q_{th} N_a}{n^2_i W_{fin}}\right] \end{pmatrix} \quad ..(1)$$

Where, V_{fb} is the flat band voltage. The built-in potential, V_{bi} is given by V_{bi}= kT/q (ln (N_aN_d/n_i^2)).

Width of the transistor = (2 * fin_height) + fin_width (2)

Where A_1 and A_2 are the parameters which are the functions of natural length and channel length and it has finitevalues for short channel devices but for long channeldevices their values are 0. V_{bi} is the built-in potential. V_d is the channel potential at the drain side. V_{th} is the thermal voltage, which is equal to kT/q, where k is the Boltzmann constant, T is the absolute temperature, and q is the electronic charge. Q_{th} is the charge density, N_a is the acceptor concentration, N_d is the donor concentration, n_i is the intrinsic carrier concentration, W_{fin} is the fin width, and H_{fin} is the fin height. Equation (1) is taken from [4].

IV. Results and Discussions

A. *Threshold voltage variation with the minimum carrier charge density*

In this paper we study the variation of threshold voltage with respect to minimum charge density by taking the constant values of acceptor and donor concentration.

From Table1, we can conclude that with the increase of charge density, the threshold voltage increases. This is further proved by the curve in Fig. 1.

Table 1 Variation of threshold voltage with charge density

Minimum Carrier Charge Density (Qth)	Threshold Voltage (mV)
1	3.1333
2	3.1513
3	3.1619
4	3.1693
5	3.1751

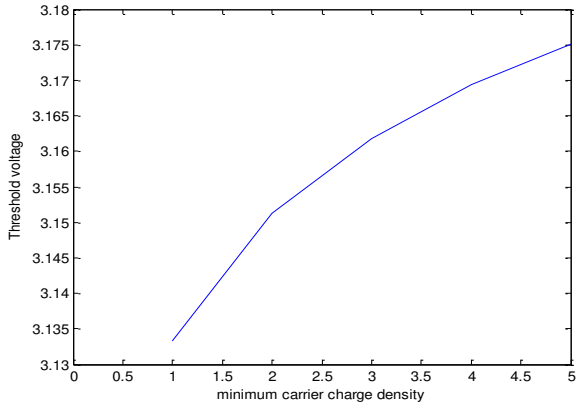


Fig. 1. Plot of V_t

From Fig 1, we can draw a conclusion that if the charge density is low, then the threshold voltage obtained will be low. It means that we need low gate voltage to turn on the device. On the other hand, subthreshold leakage will increase if we keep the threshold voltage low. On keeping threshold voltage high, we need high gate voltage to turn on the device. Thus, we have to choose optimum threshold voltage to avoid suchproblems. This can be done by adjusting the charge density in such a way that we can achieve the optimum threshold voltage.

B. *Threshold voltage variation for different values of fin width*

A very important geometrical parameter of finFET is fin width. The threshold voltage of the device has been observed in this study by varying the fin width in Table 2. From Table 2, it is clear that the value of the threshold voltage increases with the corresponding increase in the value of the charge

density. If the device dimensions i.e. the fin width changes, the value of the threshold voltage also changes accordingly.

Table 2 Variation in Threshold voltage by varying the width & the Charge density.

Fin Width (nm)	Charge Density (Qth)	Threshold Voltage(mV)
0.1	1	3.1513
	2	3.1693
	3	3.1799
	4	3.1874
	5	3.1932
0.2	1	3.1333
	2	3.1513
	3	3.1619
	4	3.1693
	5	3.1751
0.3	1	3.1228
	2	3.1408
	3	3.1513
	4	3.1588
	5	3.1646

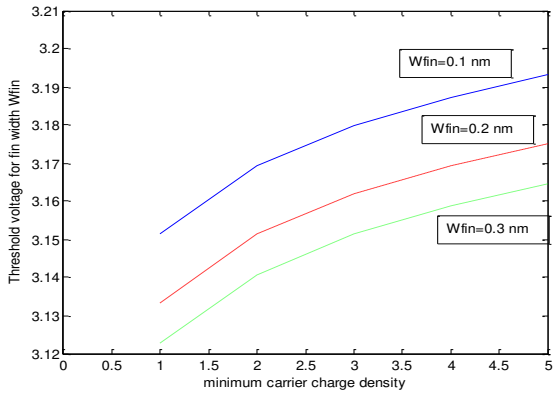


Fig.2 Plot of V_t vs. Q_{th} by varying Fin Width

The curve, which is obtained from MATLAB simulation, is given in Fig. 2.

From the curve in Fig. 2, we can draw a conclusion that a change in the dimension of the device (i.e. a change in the fin width) affects the threshold voltage of the device. The threshold voltage of the device is inversely proportional to the fin width of the device.

C. Threshold Voltage variation for different values of fin height

We know that the width of the transistor = (2 * fin_height + fin_width). From the concept of general mathematics, if the width of the transistor is fixed and the device dimension (i.e. the fin height) increases or decreases, then the threshold voltage increases or decreases respectively. This is exactly, what is observed from the Table 3, where we have considered the width of the transistor to be 1nm.

Table 3 Different Threshold voltages with respect to varying height & Charge density with fixed Width of the Transistor

Fin Height (nm)	Minimum carrier charge density (Qth)	Threshold Voltage (mV)
0.1	1	3.0973
	2	3.1153
	3	3.1258
	4	3.1333
	5	3.1391
0.2	1	3.1047
	2	3.1228
	3	3.1333
	4	3.1408
	5	3.1466
0.3	1	3.1153
	2	3.1333
	3	3.1438
	4	3.1513
	5	3.1571

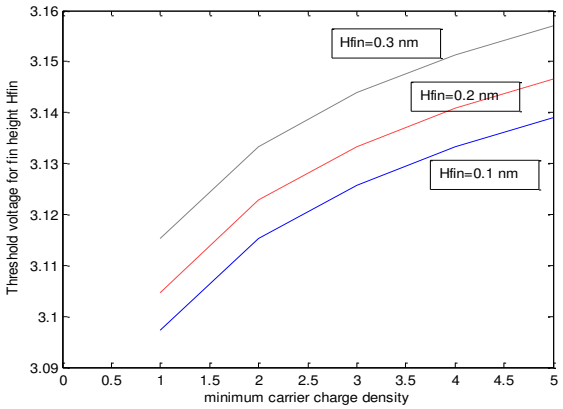


Fig. 3 Plot of V_t vs. Q_{th} by varying fin height

Whatever we have discussed before prove to be true from the values of the threshold voltage given in Table 3. The curves are provided in Fig. 3 to make it easier for the readers to understand the fact more clearly.

From (2), it is obvious that if both the width of the transistor and the fin_height increase, then the threshold voltage decreases and vice-versa.Table4 proves the above-mentioned fact.

From Table 4, we can observe that the threshold voltage decreases with the corresponding increase in the width of the transistor and the fin_height. This is because as the width of the transistor and the fin_height increase, the fin width also increases, resulting in decrease of the threshold voltage. This can be clarified further by the curve shown in Fig. 4.

Table 4 Different Threshold voltages with respect to varying height & Charge density with varying Width of the Transistor

Width of the transistor (nm)	Fin Height (nm)	Minimum carrier charge density (Qth)	Threshold Voltage (mV)
1	0.1	1	3.0973
		2	3.1153
		3	3.1258
		4	3.1333
		5	3.1391
2	0.2	1	3.0792
		2	3.0973
		3	3.1078
		4	3.1153
		5	3.1211
3	0.3	1	3.0687
		2	3.0867
		3	3.0973
		4	3.1047
		5	3.1105

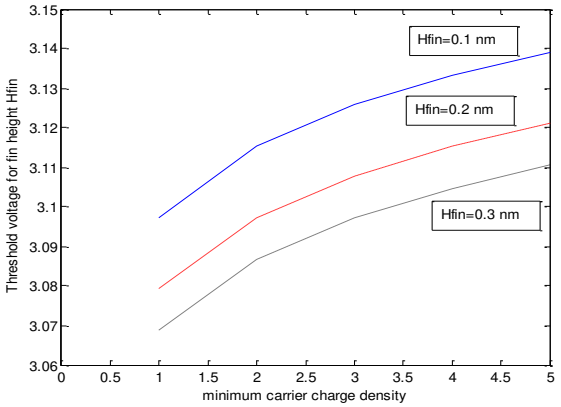


Fig. 4 Plot of V_t vs. Q_{th} by varying fin_height

Now, it becomes easier to understand about the threshold voltage variation with the corresponding change in the width of the transistor and the fin_height.

V. CONCLUSION

In this paper, MATLAB simulationof thresholdvoltage is carried out. We observe and analyze the variation of threshold voltage with different values of fin_width, and fin_ heights. Short channel effect is less in rectangular finFET.

References

[1] Moore, G. (1998) "Cramming more components onto integrated circuits", Proc. of the IEEE, Vol. 86, pp. 82-85,.

[2] Taur, Y., Liang, X., Wang, W., and Lu, H., (2004) "A Continuous, Analytic Drain-Current Model for DG MOSFETs", IEEE Trans. Electron Devices, Vol. 25, pp. 107-109.

[3] Hsu, F.C., Ko, P.K., Tam, S., Hu, C., Muller, R.S., (1982) "An Analytical Breakdown Model for Short Channel MOSFETs," IEEE Trans. Electron Devices, Vol. 29, No. 11, pp. 1735-1740.

[4] Musalgaonkar, G., Chatterjee, A. K., (2015) "Tcad Simulation Analysis And Comparison Between Triple Gate Rectangular And Trapezoidal Finfet" Journal of Electron Devices, Vol. 21, pp. 1881-1887.

COVER PICTURES

TOP LEFT: Biodiesel prepared from vegetable oil

TOP RIGHT: Photo-voltaic (PV) solar farm showing typical arrangement of photovoltaic panels. *Credit Alamy stock photo*

BOTTOM LEFT: Radio and plasma wave observations in Jupiter's polar magnetosphere during Juno's first perijove pass on August 27, 2016 (DYO 240) (Image credit: NASA/JPL-Caltech/SwRI/Univ. of Iowa)

BOTTOM RIGHT: Recognition of human activation in presence of wifi network

Visit our Website: www.tijhems.com Email ID: editormails@tijhems.com
Published by Prof. A. B. Bhattacharya, Dean of Research, Techno India University, West Bengal, EM Block, Sector V, Salt Lake City, Kolkata, West Bengal 700091, India