Embedded Floating Auto Fish Feeder for Smart Pond Management System

Sai Krishna Vaddadi, S.S.Sadistap, A.P.Sharma, and Pankaj Kumar

Agri-Electronics Group, CSIR-Central Electronics Engineering Research Institute, Pilani, India – 333 031

Electronic Auto Feeder System

Sai Krishna Vaddadi, Scientist, AEG, CSIR-CEERI, Pilani, India.

Email: saishrustee@gmail.com, sai@ceeri.ernet.in

S.S.Sadistap, Group Leader, AEG, CSIR-CEERI, Pilani, India.

Email: ssadistap@yahoo.co.in, shashikant_s@ceeri.ernet.in

Abstract: Proper feeding of the fish is necessary to make them stress free and to get better yield in fish pond management. A Floating mechanism "**Embedded Auto Fish Feeder**" is developed which feeds fish at regular interval and measures the pond parameters like dissolved oxygen, pH, TDS and temperature which are critically important for fish growth and aquaculture. The acquired data is compared to set limit of critical parameters and transmit wirelessly the data along with decision regarding action to be taken to the host computer in order to reduce the stress on fish and improve the fish growth. The system operates with a 12 V DC rechargeable battery which at fully charged can full fill 3-4 days of feed and sensing of pond parameters. The measured parameters are stored in the embedded system along with date and time. The developed system prototype not only provides a better method to feed fish in precise amount at proper time but also improves feed efficiency, reduces manpower time and cost. It is accurate, reliable and fully automated floating feeder system, with feeding

while moving in order to get good spreading of fish food across the pond. The system is successfully deployed in centre with anchor of the half to one hector fish pond at CIFA Bhubaneswar so that it can move slowly with wind and cover around 10 meter area.

Keywords: Floating Auto Feeding System, Water Parameters, Pond Management

1. Introduction:

Aquaculture and fisheries are important for the incomes and food supply of millions of people worldwide. Consequently, in addition to increasing the production of agriculture with new scientific methods, Indian government is also considering aquaculture to be an excellent prospect for providing occupation & revenue generation. Blue revolution [1] is started, to increase the production capacity of Indian fisheries industry and also to introduce more scientific methods into the aquaculture production. India is the resource of various kinds of fishes and diverse water resources ranging from deep seas to rivers & lakes. Presently India occupies third position in global scenario in terms of production of fishes which is 4.4 %of global fish production [2]. India presently provides employment directly or indirectly to 14 million people [2] through fisheries industry. Although the higher concentration of people employed in this sector, the average annual production per person is less when compared with European and North American Countries [3]. One of the reasons for low annual production in India is due to traditional fish farming practices and outdated fish capturing techniques used in fish farming. Due to this the expenditure on the fish farming is increasing and subsequently income decreasing, therefore there is a need for more sophisticated engineering practices and scientific tools or methods to be used in fish farming.

In this paper we have discussed about a floating electronic auto feeding system with measurement of pond parameters for fresh water aquaculture. The developed system is helpful in providing timely good quality supplementary feed as well as monitoring the pond water quality. This auto feeder system feeds the fish automatically at regular interval of time which reduces the cost for feeding of fish and the wastage of feed. Manual feeding by human across the pond is difficult and cumbersome. The developed system blows the feed into the pond with a blower at regular time intervals set by the user. Feed parameters like feed rate, feed quantity can be adjusted from a remote location by using wireless communication. The main features of the systems are it is battery operated with a 12V DC rechargeable battery, self diagnostic, 10 Kg feed capacity in one load, online monitoring of water quality parameter to determine stress on the fish, wireless communication for remote control and data transfer features.

2. System Design:

Figure 1 shows the basic building blocks of the embedded auto feeder system. The system is built on 4” PVC pipe. 3 meter diameter hexagonal shape is fabricated using the PVC pipe.

2.1 Platform

A tripod based support system is build for holding the feed container at the top using high quality metal rods on top of the hexagonal shape pipe structure. All the components like blower, battery, sensor unit, feed container and embedded system are fixed on it (platform). Compression spring based mechanism is used to control the height of the platform manually.

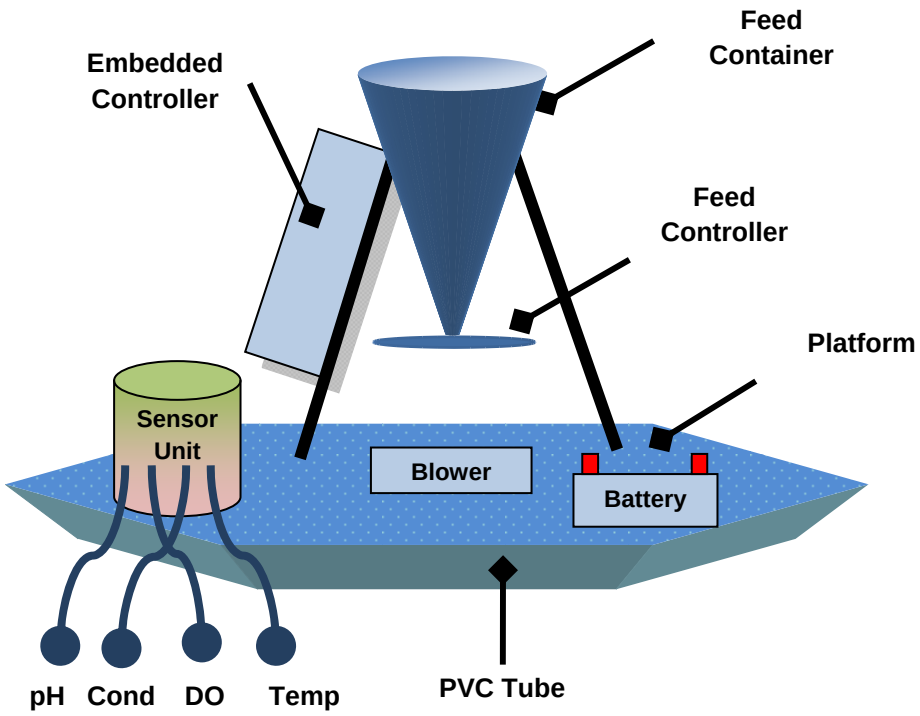


Figure 1: Sketch of Embedded Auto Feeder System

2.2 Sensors

Four sensors viz. dissolved oxygen (DO) (0-200%) [4], pH (0-14) [5], temperature (0-100°C) and conductivity (0.01-2 milli Siemens) [6] along with transmitter are used to monitor the water quality of the pond. The operating voltage of the sensors are 9-36 VDC and they have inbuilt transmitters. The sensors give current output.

2.3 Feed Container

Feed container unit is a low cost, low weight plastic (PVC) unbreakable unit. The feed container can hold maximum up to 10 Kg floating palette feed. A tripod based support system is build for holding the feed container. The tripod arrangement is firmly fitted on the platform. The feed container is fitted with feed detection unit and feed controller. The feed detection unit will raise an alarm if the feed in the container is less than 5% of total

feed. Also provision is made for the placement of silicon bags. These bags will be helpful to remove any moisture present in the container.

2.4 Feed Controller

Feed controller unit controls the opening and closing of the feed container. It consists of DC geared motor, sliding door and two limit switches. The limit switches are used to know the position of the sliding door. A mechanical arrangement is made to convert the circular motion of the geared motor to linear motion. By default, the feed controller unit will be in closed position.

2.5 Blower

DC Blower is used to blow the feed into the pond and outside the auto feeder system. The operation of blower is controlled by the embedded controller. The blower is placed exactly below to the feed container and a funnel is fitted on top of the blower to collect the feed.

2.6 Embedded Controller:

The embedded system is an electronic unit build using PIC microcontroller which controls the operation of the auto feeder system. The system main functions are pond parameters measurement, data validation, storage, feed control, blower operation, wireless connectivity and self diagnostic check with indications like feed container empty, battery low, parameter out of limit etc. Wireless Zigbee communication protocol is developed to monitor and control the embedded system from remote location situated up to 1000 meter (line of sight) [7].

2.7 Battery

The entire auto feeder system runs with a 12 V DC rechargeable battery. A battery cabinet is provided to protect the battery from weather. If the battery voltage drops below minimum operating voltage, the embedded control will send indicate it to the remote location.

3. Hardware, Firmware and Software Design:

3.1 Hardware

Figure 2 shows the basic building blocks of hardware used for embedded auto feeder system. The hardware is build around an 8-bit RISC architecture based PIC® 18F4520 [8] microcontroller. The microcontroller controls A/D, real time clock, memory storage, and data validation, operation of blower, motor, display, keypad and wireless transmission.

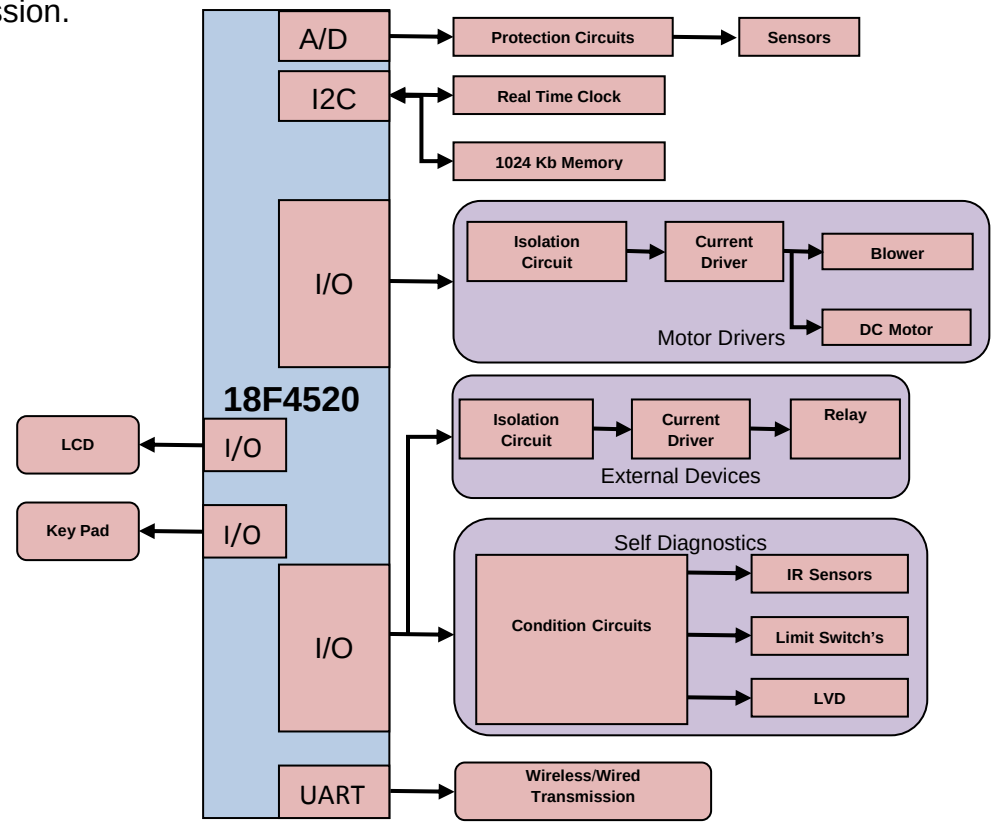


Figure 2: Hardware Block Diagram Auto Feeder System

The transmitters DO [9], pH [10], temperature and conductivity [11] with transmitters having output 4-20 mA are used for monitoring the water quality of the pond. Interface circuit is used to convert the current signal into voltage signal in order to feed to the A to D channels of the microcontroller thorough a protection circuit to protect the microcontroller inputs damage due to high voltage signals. External memory and real time clock (RTC) are connected to microcontroller through I^2C peripheral interface. The memory device is used to store the monitoring data. It can hold data of last 27 days. RTC is used to set the system date and time for data real time logging, feeding etc., The feed details like next feed time, feed duration are also stored in the internal memory of the RTC.

Operation of blower, dc geared motor for feed opening/closing are driven using I/O ports of the microcontroller. Optical Isolation of 4 KV is provided between the I/O and the current driver. L298 dual full bridge driver circuit is used for the blower and the DC geared motor operations. The blower will start blowing 10 seconds before the feed opening so as to make sure there are no feed obstructions in the blower funnel.

IR sensor based feed empty detection circuit is developed to know the feed status. Two pairs of IR sensors are placed (90 ° apart) on the circular wall of the feed container. These sensors are placed such that the transmitter and receiver are facing each other. Two pairs are used for reliable operation and also to eliminate any unwanted noises.

Feed controller unit open/close the feed container. It consists of dc geared motor, mechanical assembly for circular to linear motion conversion and limit switches. Whenever the dc motor is energized the feed controller will open/close, depending on

the limit switch signal, we can open/close the feed container. These limit switches are placed at each end of the mechanical assembly.

Low voltage detection circuit is developed to measure the battery voltage, if the battery reaches threshold operating voltage it will raise a signal. On receiving the signal the microcontroller will transmit information to the remote user for battery replacement.

The Zigbee transreceiver is connected to the UART of the microcontroller. Asynchronous serial communication with programmable baud rate is used between the microcontroller and the PC to transmit data in real time.

LCD and Keypad are interfaced to the microcontroller, LCD displays all the relevant information like current process parameters value, real time, next feed details, feed available, battery status etc., Through the keypad the user can set the feed details, date and time of the auto feeder system. The gain and offset of the sensors can be adjusted through the keypad.

3.2 Firmware

The flow chart of the developed firmware for monitoring and controlling of auto feeder system is shown in figure 3. The firmware for the PIC18F4520 is developed in C language. All the routines like A to D conversion, UART, diagnostics features are interrupt driven by using this we can keep the microcontroller in sleep mode, thus increasing the battery life of the system. A to D conversion is driven through the timer of the microcontroller. The timer is loaded with a pre defined value, on expiry of the timer the A to D conversion will start. The sampling rate of the A to D is reconfigurable; and it can be adjusted from 1 KHz to 1 Hz. The read values of the individual channel are stored in a buffer; these samples are integrated every one second.

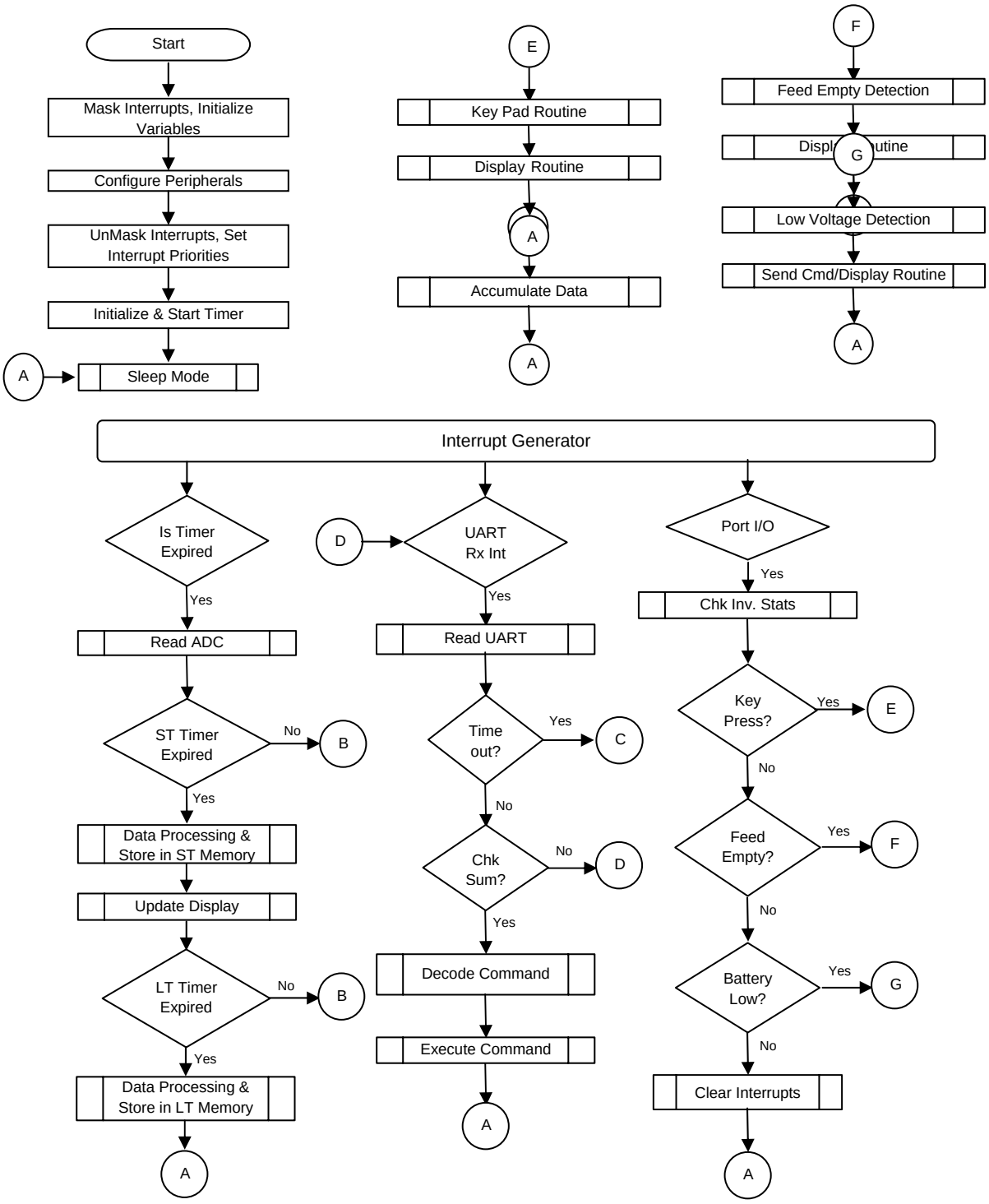


Figure 3: Flowchart firmware Auto Feeder System

The integrated values along with the number of samples are stored in short term memory in a data packet format. The buffer will accumulate the values till the long term

timer is expired. The duration of this timer is five seconds. These values are again integrated and stored in long term memory. The short term memory will hold the information of last four hours with one data packet per one second. The long term memory will hold the information of last 27 days with one data packet per five seconds. The data packet consists of pre defined header (which is separate for long term and short term), date and time, data of individual channels and footer. The footer is the check sum of all the bytes from header to data. The date and time is available from the real time clock. The RTC is read through I^2C for every one second. The display will display the DO, pH, temperature, conductivity, feed details and status of feed and battery; this information is updated for every 30 seconds.

The feed details of the auto feeder system can be entered either through the keypad or through the application software. Maximum 10 feed details can be stored and executed, the feed details consists of six bytes. Two bytes for hour, two bytes for minutes and two bytes for duration, one byte will be used extensively for feeds remaining. Whenever the feed time is greater than or equal to the system time, the blower will be on and after ten seconds, the feed controller will open the feed. Once the feed duration is elapsed, the feed controller will close the feed and after ten seconds the blower will be off. After successful completion of feeding, number of feeds remaining is decreased by one and stored. Interrupt will be generated if any of the following conditions are generated i.e., If feed is empty or battery is low or any key is pressed. Based on the interrupt generated, the corresponding function will service the request like sending an message to the remote server if battery is low or feed is empty.

3.3 Software Design

Application software is developed to monitor and control the auto feeder system. The software configures feed details, date and time of auto feeder system and memory settings. The application software is developed in Lab VIEW. The software communicates with the feeder system in a pre defined command format. The command format consists of header, meter number, request and check sum. The request can be read/write date and time, read/write feed details, read/erase memory, read data and status. Figure 4 shows the GUI for monitoring and control of auto feeder system.

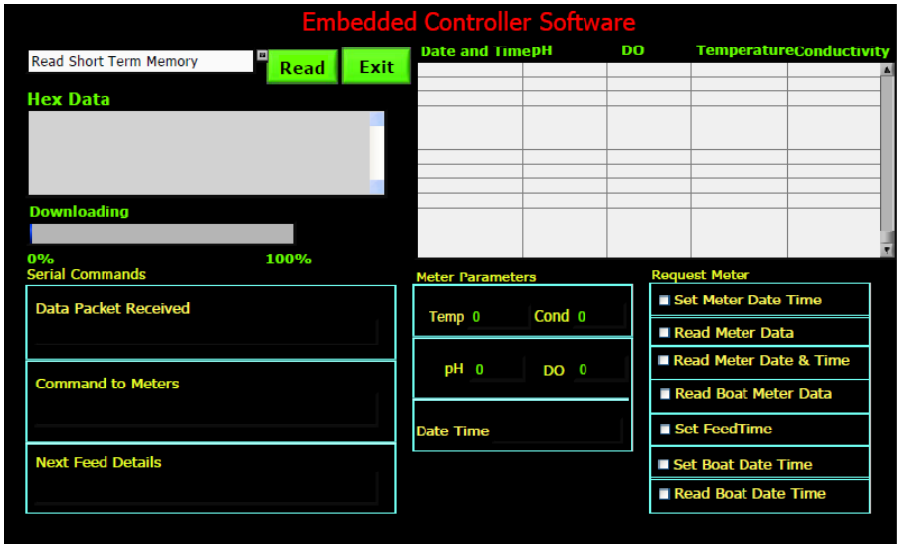


Figure 4: GUI of Application Software

4. System Testing and Deployment

The system is extensively tested in a cemented pond at CIFA Bhubaneswar. It is observed that the feed is getting struck in the funnel and the blower is not running sufficient time to blow all the feed that it dropping down from the feeder. The operation of blower is changed from synchronized operation with feeder opening to starting and stopping the blower 10 seconds before the feed opening and closing.

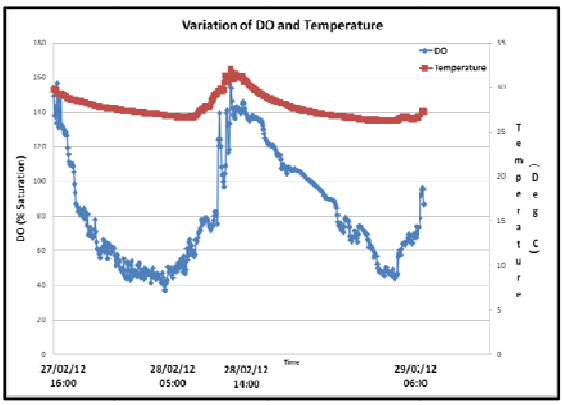
Also the feed funnel diameter is increased and advised the farmers to make sure the feed is uniform. It is observed the sensors are not dipping fully into the water, so the base height is changed so the sensors are fully immersed into the water. The figure 5 shows the testing of auto feeder system in a cemented pond. After successfully testing different functions like communication for data transfer, feed opening/closing of the auto feeder system, the systems is calibrated for amount of feed for one opening. It is set at 150-165 grams of feed for one opening.

Figure 5: Deployment of System in a Cemented Pond & Natural Pond

The system is tested with both the sinking pellet and floating pellet. Based on the feed type the user can adjust the feed opening through application software, so the desire amount of feed can be delivered. Then the system is installed in a one hector pond and anchored to the center of pond.

5. Results and Discussions

The system monitors the pond parameters throughout the day. It is observed that the variation of DO is following with the variation of temperature. The variation of DO, pH, conductivity and temperature is shown in Figure 6 and Figure 7.



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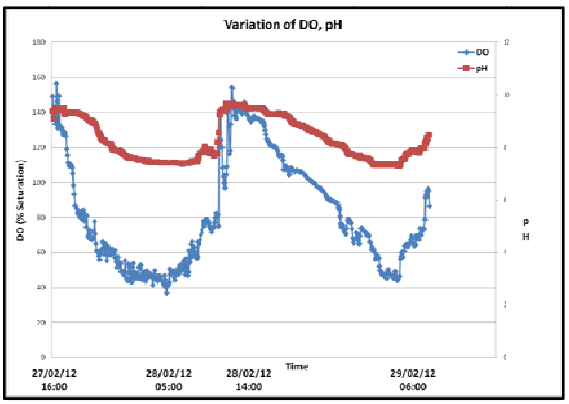
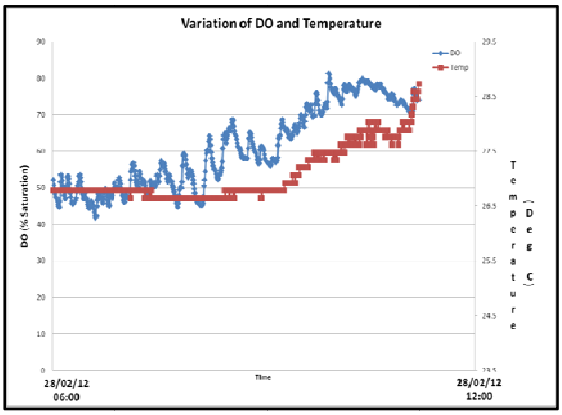


(b)

Figure 6: Variation of DO, pH and Temperature (2 Days)



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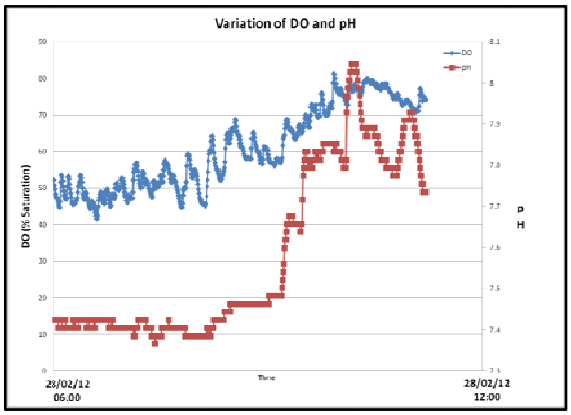

(b)

Figure 7: Variation of DO, pH and Temperature (5 hours)

The automatic feeder system improves feed efficiency and reduces labour costs. Since supplied feed starts deteriorating from the moment it comes in contact with water, greater retention between supply and consumption leads to poor feed quality. However, using automatic feeding device, feed can be dispensed in water on demand or in a small fractions which facilitate feeding and thus reduces the water retention prior to consumption. Earlier to feed the fish particularly at dusk or at night, it is very risky for human to feed, because of threat due to snakes or other reptiles. Using this system, one can feed the fish at any time. Generally these systems will be located in high humid

regions; it is observed that the electronic components and mechanical parts can become rusty. Protective coating is applied on all electronics circuits and boards.

6. Acknowledgements

The authors thank DBT Delhi for approving and funding this project. Also authors thank CSIR-CEERI Director Dr. Chandra Shekar for allowing us to publish this work. Thanks are due to AEG team members who helped us in successful completion and installation of the auto feeder system. Also special thanks to Dr P.C. Das, Senior Scientist, ICAR-CIFA, Bhubaneswar and his team for providing support during testing and installation.

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