

Long term port monitoring system (PMS)

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NIOT has developed and operated a Port Monitoring System (PMS) at Gujarat Pipavav Port Limited (GPPL) to measure tide and current on real time. PMS consists of a pressure based tide gauge and a Horizontal Acoustic Doppler Current Profiler (H-ADCP) installed at 5 m depth w.r.t Chart Datum (CD). Tide, current speed and direction are measured and transmitted to NIOT server in real time and data is presented through web application after quality check (QC). The success and high utility of the data at GPPL has resulted in requests for similar installations in other ports (Mundra, Dahej, Hazira, Vizhinjam, Dhamra and IGCAR) which enabled NIOT to expand the PMS network. The system can be used with different communication links like GPRS, UHF and INSAT. Using GPRS link, the sensors can be configured remotely to change the sampling regime and communication interval. Being a modular design, the PMS has an option for integrating more sensors for met-ocean and water quality parameters depending on site or study specific requirement. The paper discusses the basic architecture, options that can be built and the experience gained during development, installation and operation in various site conditions.

[Keywords: Tide, Current, Navigation channel, Real time monitoring]

Introduction

In India there are 13 major ports without long term oceanographic observations or real-time monitoring system for met-ocean parameters. NIOT while involving in coastal studies and ocean observations, has initiated a development program for the ports to install and maintain an observatory system measuring tide, current, wave and meteorological parameters. PMS¹ is a modular system consisting of two sensors at present to observe tide and current. It has facility to add more sensors with minor modifications to main system whenever required.

Materials and Methods

Gujarat Pipavav port limited (GPPL) is a major private port in the west coast of India (Fig.1), where vessel traffic movement is restricted due to macro-tidal regime² and current flow in the navigation channel. The current magnitude and direction varies from place to place with respect to depth and channel design. NIOT in association with GPPL has initiated to install a real-time observation system at the harbour premises. The current in the channel is measured using Horizontal ADCP³ deployed under jetty pile. Pressure gauge based instruments measured the water level^{4,5}. The integrated system along with a data

logger and communication component makes a PMS as indicated in Fig.2.

Results and Discussion

Instrumentation

The PMS structure basically consists of data acquisition system, data transmission system and a number of measurement systems.

Data acquisition System

The data is collected from various measurement systems through serial ports. The serial ports can be increased at any time for future expansion. Embedded PC provides the customized user interface (GUI) package. The data acquisition system collects data through serial port and stores them in SQL database. This collected data is transferred to server through internet/GPRS until the transmission is successful. The current and water level data backup is maintained at data acquisition system even though it is being transmitted for redundancy purpose. The data flow architecture is as below (Fig. 3).

Data Transmission system

The real-time data transmission is carried out through internet media. The current and water level

data measured at field is transmitted to server through internet. In addition to that a two port GPRS modem is also connected with measurement system to transmit the data to server. This serves as secondary communications and database.

Measurement System

The Measurement system in GPPL-PMS consists of two units namely the H-ADCP and Water level recorder. Horizontal Acoustic Doppler Current Profiler (H-ADCP) is selected for current measurement, with acoustic transducer facing horizontally towards shipping channel. This was an important consideration to measure horizontal component of current profile in the shipping channel. The system was configured with a sampling rate of 2 Hz, measuring burst cycle of 1 minute and the data transmission interval with



Fig. 1—Typical Installation of PMS in the Harbour

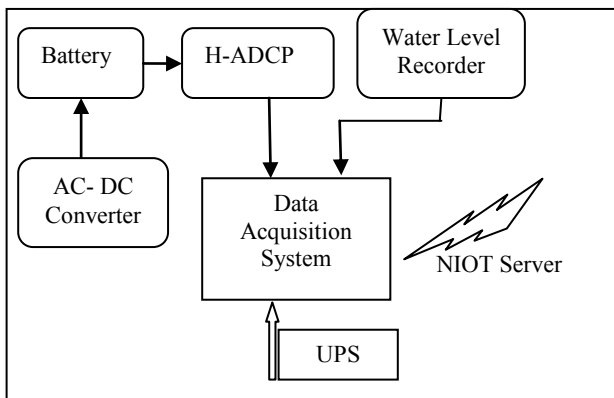


Fig. 2—Block Diagram of PMS

6 minutes. Fig. 4 describes the profiling method of H-ADCP.

A Pressure based water level recorder was selected for tide measurement with 1 Hz sampling rate, measured for every one minute burst with interval of 6 minutes.

Installation

The pile no.1 of jetty was chosen as an ideal location for H-ADCP deployment as it is situated near the entrance of the main navigational channel between Port jetty and Shivalpet Island. A huge (8 m) SS frame was made with a guiding facility so that, the ADCP can be raised and lowered during maintenance

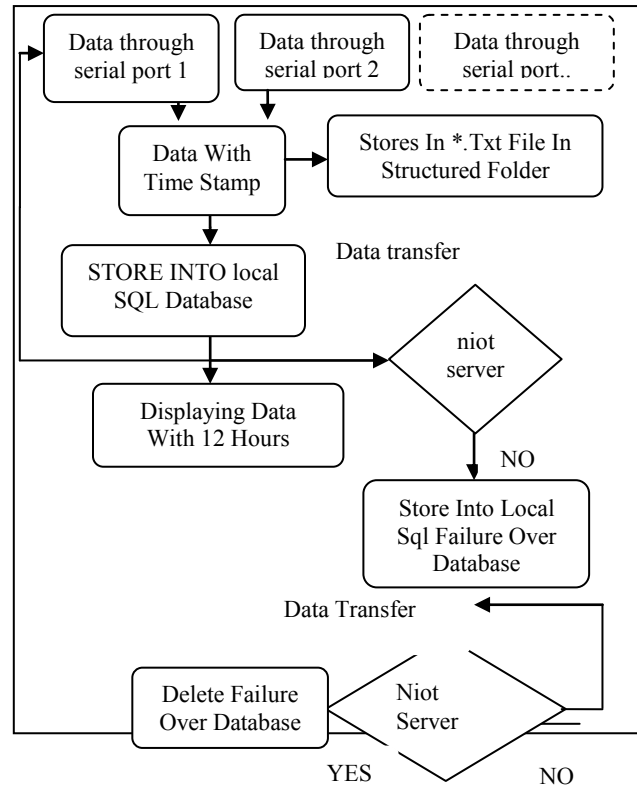


Fig. 3—Data Flow In Port Monitoring System



Fig. 4—H-ADCP Profiling method.

and deployment proposes. Mounting frame has a “C” clamp attachment to hold the pile. The current profiler frame was installed with the help of diving team. The H-ADCP was placed at the top of the frame and it was lowered down and fixed at 5.7 m W.r.t CD. Fig. 5 shows the installation details with Datum correction.

The Water level recorder was also installed on the same frame. H-ADCP and water level recorder cables were routed under jetty and connected to data acquisition system located at the observation chamber. H-ADCP power is supplied through 24V battery which is being charged by an AC-DC converter. The primary data transmission link is established via the wireless LAN from GPPL. Fig. 6 shows deployment of H-ADCP unit and frame.

Operation

The data acquisition system computes a value of the current and water level at every 6 minutes interval. Each measurement is assigned an index number and stored in a text file as well as in a SQL database. The same value is being transmitted to server database without any delay. Also it is displayed in a local embedded computer with 12 hours history.

A new PMS website was developed under this program to present real time data to the users. The tide data is presented in a graphical view which gets

updated by every 6 mins. The website also has the facility to upload predicted tide and bathymetry survey charts. Fig. 7 shows the GUI package displaying real time tide data.

The current data is displayed with peak magnitude value, direction and estimated current in channel centre. All these values are put together in a graphical view in the GUI package for easy understanding. It also has a facility to view offline data. Further the GUI has a direction map showing the current direction in real time basis. Fig. 8 shows the GUI package displaying real time current data.

Validation and modeling

The current data obtained from the H-ADCP was validated with various sources to ensure its accuracy. The data was first compared with the single point current meter (RCM9) data which was deployed 100m away from H-ADCP (Fig. 9). The result was found to be in good agreement. Both the direction and magnitude were compared and found to be identical.

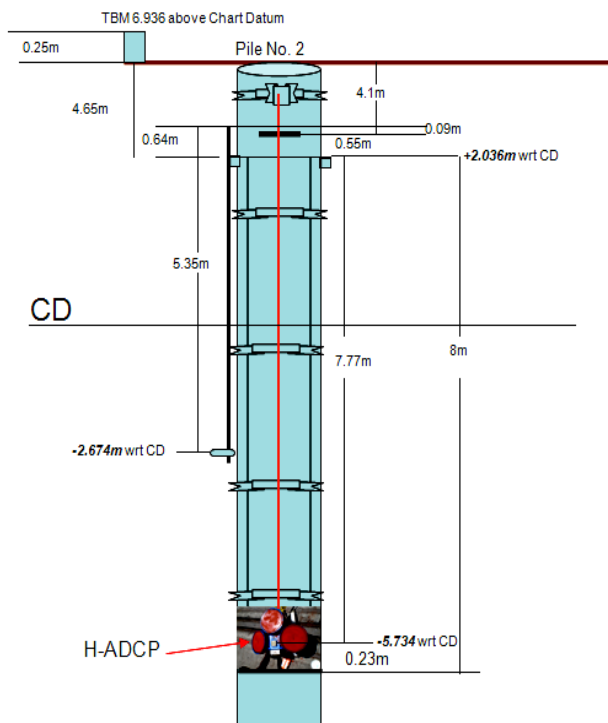


Fig. 5—Installation of Tide gauge & H-ADCP with datum details



Fig. 6—Installation of Current Profiler

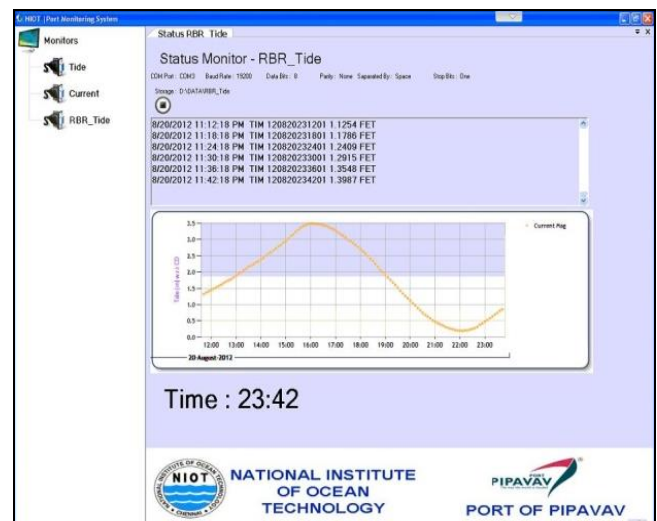


Fig. 7—Real time Tide data presentation

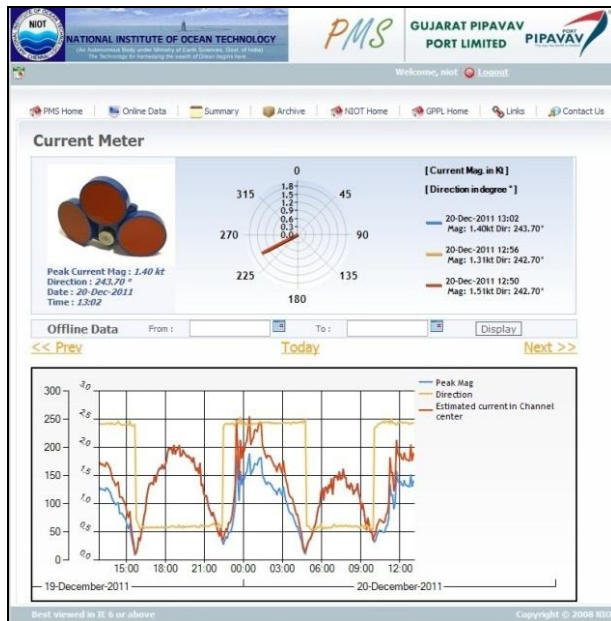


Fig. 8—Real time ADCP data presentation

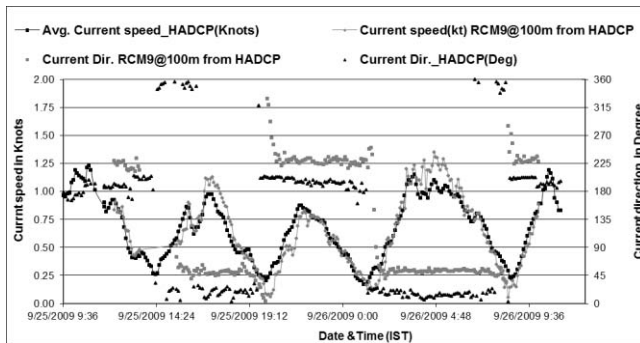


Fig. 9—Data Comparison of H-ADCP, Single Point CM

From comparing the direction component of both the data, a standard offset was obtained and incorporated into PMS.

The H-ADCP data was also compared with an online single point current meter. It was measured at two places, one at 100 m away from H-ADCP which was absolutely matching, and other at the channel (250 m from ADCP) which was having a small offset from the H-ADCP value. The detailed view of the same is given in the graph above.

A hydrodynamic model output available for GPPL port was also extracted for comparison purposes. Two test points were considered for this purpose – one at 100 m away from sensor and second at the middle of navigation channel. Using the model we have calculated the current speed and direction 100 m away from HADCP in the channel. From the model it

was understood that during ebb tide the current speed is almost same at both the places, but during the flood tide the current speed at the channel is higher than the point at 100 m away from HADCP (Fig. 10). A scale factor was arrived based on model simulation and incorporated in live website.

Maintenance

There are many factors that affect the data quality of the instruments in marine environment. In general, the instruments are physically affected by bio-fouling, corrosion, sediment deposition, debris deposition etc. That affects the data quality and may lead to instrument failure or data loss. Hence periodical maintenance is required to avoid the data loss and to increase the life time of the instrument.

Maintenance was carried out periodically for every 6 months by NIOT instrumentation engineer. The poly-urethane face of H-ADCP is often subjected to bio-fouling, which may lead to sensor damage. There are some precautionary measures that have to be followed periodically to avoid the same. The best way is to clean the faces often, but practically it is not possible, so the other ways are to cover the sensor face with anti foulant paint or antifouling grease. The best way is to apply a mixture of chilli powder with silicon grease. The silicon grease avoids the washing of chilli powder from the sensor face. The water level recorder is also subjected to the same kind of actions. In our case the pressure sensor has a diaphragm which is the sensing part of the transducer. The diaphragm face is often filled with dust and marine growths, hence as a part of maintenance schedule, the pressure sensor is also cleaned and reinstalled periodically to maintain the quality of data.

The other problem that the HADCP is subjected to is bi-metal corrosion. The outer body of HADCP is made of Aluminium Alloy, when it was fixed with an SS-frame; the contact between the two materials caused the corrosion in the body. Later we placed a rubber sheet between the two surfaces to avoid the physical contact.

The sub-con male end connector of the HADCP should be properly fixed to the serial data cable with utmost care, as it is more prone to water leakage between the joint for continuous deployment. So we had to ensure that the connector end is properly water proofed after connecting the cable to it. We used an armoured cable to connect the HADCP to the Data Acquisition system to avoid physical

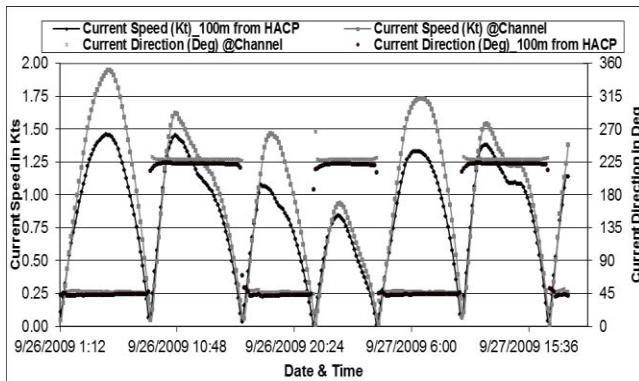


Fig. 10—Current Data extracted from Model

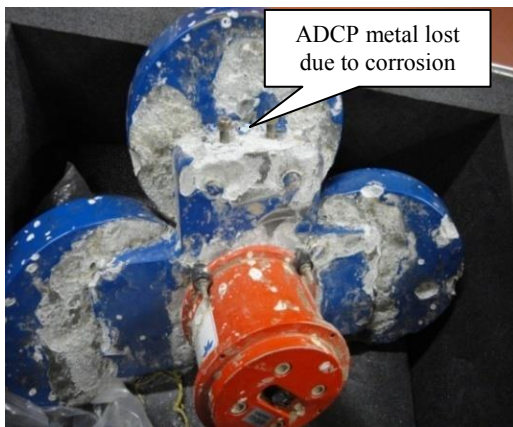


Fig. 11—H-ADCP retrieved after 11 month deployment

damage. This cable was properly secured and routed before finishing the installation.

Conclusion

A modular observatory called Port Monitoring System aimed at providing real time data source to

ports for vessel navigation. The first operational system was handed over to GPPL with guidance from NIOT. This system has proven to be useful for the regular operation requirements of the port and future development. The system is user friendly and amenable to add more parameters if required. The entire system can be powered via solar panel backup also. To make the system portable the embedded computer can also be replaced with a two port GPRS modem to log and transmit the data. With the experience gained at GPPL operation, PMS has been further improved and installed at seven more sites along Indian coast for long term data collection.

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